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Soil biota and agriculture production in conventional and organic farming

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Sustainable food production for a growing world population requires a healthy soil that can buffer environmental extremes and minimize its losses. There are currently two views on how to achieve this: by intensifying conventional agriculture or by developing organically based agriculture. It has been established that yields of conventional agriculture can be 20% higher than of organic agriculture. However, high yields of intensified conventional agriculture trade off with loss of soil biodiversity, leaching of nutrients, and other unwanted ecosystem dis-services. One of the key explanations for the loss of nutrients and GHG from intensive agriculture is that it results in high dynamics of nutrient losses, and policy has aimed at reducing temporal variation. However, little is known about how different agricultural practices affect spatial variation, and it is unknown how soil fauna acts this. In this study we compare the spatial and temporal variation of physical, chemical and biological parameters in a long term (13-year) field experiment with two conventional farming systems (low and medium organic matter input) and one organic farming system (high organic matter input) and we evaluate the impact on ecosystem services that these farming systems provide.
Soil chemical (N availability, N mineralization, pH) and soil biological parameters (nematode abundance, bacterial and fungal biomass) show considerably higher spatial variation under conventional farming than under organic farming. Higher variation in soil chemical and biological parameters coincides with the presence of 'leaky' spots (high nitrate leaching) in conventional farming systems, which shift unpredictably over the course of one season. Although variation in soil physical factors (soil organic matter, soil aggregation, soil moisture) was similar between treatments, but averages were higher under organic farming, indicating more buffered conditions for nutrient cycling. All these changes coincide with pronounced shifts in soil fauna composition (nematodes, earthworms) and an increase in earthworm activity. Hence, more buffered conditions and shifts in soil fauna composition under organic farming may underlie the observed reduction in spatial variation of soil chemical and biological parameters, which in turn correlates positively with a long-term increase in yield. Our study highlights the need for both policymakers and farmers alike to support spatial stability-increasing farming.