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Guest Editors' Introduction

The contribution of farm-scale experiments to the understanding of soil processes and implications for ecosystem services

Soil processes are studied mainly at a small scale (up to a few metres). This can preclude the effect of macroscale variables that modulate these processes and limit our understanding of what occurs at the larger scales. It is the macroscale that is more relevant to those responsible for managing our soil as a key resource.

Farm-scale experiments can be useful because they provide the platform for full biogeochemical nutrient cycling studies: within the soil itself, between soil and water, as well as soil and the atmosphere. In addition, the role of plants and livestock on these nutrient cycles can also be studied. Such studies also enable investigation of the effects of climate and management on water, nutrient and carbon cycling. They provide opportunities for assessing their spatial and temporal variation which, in turn, can provide information for mitigation strategies to avoid excessive nutrient losses. Experimental farm-scale platforms are large investments and by design are intended for monitoring process interactions over the longer term. Longer-term patterns and trends in data help us to understand the effect of changes in the environment and management, and provide unique datasets that can be shared for the validation of models. In reality, we found that there are very few well-instrumented farm-scale experimental platforms, and, despite initial intentions, the longevity of such studies is frequently undermined by the prevailing economic climate and political factors.

The papers in this special section give examples of the quality of data that can be achieved from existing farm-scale platforms, which emphasizes the utility of these kinds of experiments. The papers include research on farm platforms in Australia, France and the United Kingdom that cover a range of spatial scales from the soil and plant to the field scale, and use both measurement and modelling approaches.

The paper by Armas-Herrera *et al.* reports the results of a long-term field experiment initiated in 2005 in Lusignan, France. The authors identified and quantified specific geochemical biomarkers of shoots and roots from three grassland plants, and investigated their dynamics in soil with natural abundance ^{13}C isotope analyses after conversion from grass (C3 plants) to maize (C4 plant). Their results show that source-specific plant-derived molecules can be used to investigate the contribution of above- and below-ground plant inputs to soil organic carbon pools to guide the development of agricultural practices and optimize soil organic carbon stocks.

Three papers describe results from the North Wyke Farm Platform in Devon, UK, a National Capability funded by the Biotechnology and Biological Research Council for research into agricultural productivity and the effects on ecosystems under three different management systems. The paper by Orr *et al.* sets the scene by describing this facility in detail, and in addition it focuses on data recorded on the hydrology, nutrient losses and productivity at high temporal resolution that relies on sensor technologies and surveys to advance research into sustainable pastoral agriculture. The same platform was used by Peukert *et al.* to quantify the spatial variation of soil properties within and between fields under similar management. They found that the oldest permanent pasture supported the largest macronutrient concentrations in the soil, but also produced the largest diffuse nutrient losses. Wu *et al.* also used datasets from this platform to validate the SPACSYS model in its predictions of soil moisture, water losses and sward biomass. The modelled results agree well with the measured data and reveal the effects of different grasses on C and N cycling.

Finally, the paper by Read *et al.* shows the application of a Landscape Function Analysis to assess soil functions from measurable soil characteristics in four different grazing management and landscape rehabilitation schemes in Australia's semi-arid rangelands. The results show that this approach can quantify the outcome of rehabilitation activities and fluctuations in soil functionality because of seasonal effects, different grazing pressures or changed management strategies. They emphasize the need to develop low-cost global research and monitoring tools to evaluate the progress of ecological restoration activities.

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