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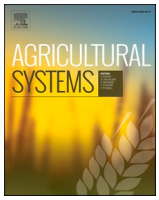

Editorial

Agricultural Systems Editors' Picks for World Soil Day 2020

Soil is fundamental to the functioning of agricultural systems. Every year the Food and Agriculture Organization highlights the importance of soils on "World Soil Day". In 2020 this day falls on 5 December with the charge to action "Keep soil alive, protect soil biodiversity". We honour the day and the importance of soils in sustaining agricultural systems with a selection of articles from *Agricultural Systems*.

Agricultural Systems publishes articles on a wide range of aspects of soils in relation to agricultural production: from soil carbon, to soil biodiversity, to aspects of soil health and to key social drivers that determine adoption of soil restoration interventions. These are all in the context of the centrality soil within agricultural systems and are primarily concerned with the interactions within the systems. The articles have been published relatively recently, have cited well for their age, and have been selected as aligning with the "drivers of soil biodiversity loss" or "benefits of soil biodiversity" sub-themes of World Soil Day with an *Agricultural Systems* slant that emphasises interactions within and between agricultural systems.

Within the context of land sharing, Hall et al. (2020) undertook a study on the relationships between management intensity, vegetation in the inter-rows of European vineyards and biodiversity. Their sub-themes of ecosystem services, reduction of erosion and increases in soil carbon relate this work to the goals of World Soil Day. They documented relationships between extensive management of the vegetation and the attributes of high vegetation cover with its associated benefits of erosion reduction and carbon sequestration. The authors also noted some conflict between environmentally-focussed regulations requiring the sowing of cover crops and the biodiversity that emerged in less-managed or permanent inter-row covers.

A recent review, Aguilera et al. (2020) discussed the role of systemic agroecological thinking for enabling adaptation to the twin challenges of climate change and resource depletion and demonstrated the importance of local food systems for reconnecting the cycling of carbon back to the land and maintaining both soil quality and carbon storage. These challenges feed directly into the benefits and drivers of soil biodiversity and highlight the systemic thinking needed if agricultural systems are going to preserve and protect soil biodiversity.

The importance of maintenance and improvement of soil organic matter and soil fauna is a key message featured in World Soil Day. One publication in *Agricultural Systems* that highlights this is Perego et al. (2019) which examines changes in soil carbon and fauna in a chronosequence of farms managed conventionally or with conservation agriculture (CA) practices. They found a greater variation in yields under CA compared to that in the conventional farms. They also found that there were general reductions in yield, but these reductions were minimised for the older cohort. The mechanisms used for weed management were different between the two systems but the costs were unchanged. Their data showed the duration needed for the full value of CA to manifest as improvements in soil quality but that these improvements offset some of the yield losses.

Berti et al. (2017) studied the effects of many different crop rotations including the oilseed crop camelina on a wide range of output effects including soil erosion potential and biodiversity. More complex rotations necessarily involve some compromises in sowing dates and other management activities. While those compromises reduced the primary productivity of camelina, the seed yield was largely unaffected, and they found that the more complex rotations resulted in both increased areal primary productivity (albeit with a reduced oil yield) and biodiversity and reduced soil erosion potential.

The review by Kanter et al. (2018) evaluates trade-offs between crop yields, biodiversity, and human nutrition as we strive towards achieving the Sustainable Development Goals (SDGs). Soil is at the centre of agriculture, and agriculture is central to many aspects of the SDGs. Thus, it is important to robustly assess, anticipate, and visualise the trade-offs and win-wins between the SDGs more immediately aimed at the human population of this planet (e.g. human nutrition) against those that will sustain the soil and so underpin the continuing ability of that soil to support all SDGs. A more recent article Lairez et al. (2020) highlights the importance of selecting sustainability criteria that are locally-relevant and how this relevance is important in farmer acceptance and uptake of sustainable practices.

Legacy effects of past cropping practices on soils, their carbon storage and biodiversity remain largely unknown. To begin to address this gap, Jernigan et al. (2020) studied legacy effects of four contrasting organic grain cropping systems that varied in fertilizer inputs, tillage practices, and weed control on soil health indicators, soil invertebrates, weeds, and crop yield. Legacy effects of past cropping practices varied according to differences in preceding crop, nutrient inputs and soil disturbance. Overall findings showed that crop productivity was mainly related to soil aggregate stability, a soil invertebrate group, and microbial respiration through soil invertebrates confirming the key role of soil biodiversity in ensuring tomorrow's food security.

Soil health has become an important topic of multiple innovation programmes, for example the European Union has "Soil health and Food" as one of its research and innovation mission areas. Enacting such research and innovation missions requires knowledge exchange and learning at different scales in agricultural systems. Skaalsveen et al. (2020) have investigated the role of farmers' social networks in the implementation of no-till farming practices. Their findings suggest that intermediary farmers had an important role in increasing the information flow and knowledge exchange between the different clusters of the

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no-till farmer network. These intermediaries acted as influencers with a high level of experiential knowledge and viewed as important sources of information by other farmers, using social media to discuss farming practices with similar minded no-till farmers who were geographically distributed. It is suggested that formal advisors should strive to improve their understanding of these well-developed farmer information networks, to enable a more streamlined and efficient information diffusion on no-till.

Soil biodiversity is tightly linked with the natural capital of a soil. Cong et al. (2014) hypothesized that soil natural capital, i.e., the capacity of soil biodiversity to generate soil ecosystem services as a component of farm capital, could be important for the stability and resilience of arable production systems. Their results demonstrated that higher soil natural capital buffers yield variance against adverse weather and reduces reliance on chemical fertilizers, and thus its management has potential to mitigate agricultural risks due to energy price shocks and adverse weather events. Based on a literature review of soil ecosystem services and their functions, Jónsson and Davíðsdóttir (2016) also demonstrated that soil ecosystem services provide multiple benefits to humans and hence there is a need to develop a comprehensive framework for their economic assessment to better inform decision-making at various levels of governance regarding land use and management. They also showed how the concept of soil ecosystem services ties together with the emerging concept of the Critical Zone (NRC 2001) and need of properly accounting for the value of soil ecosystem services in decision making. They recommended that a holistic framework and a methodology is required to tie together soil natural capital, soil ecosystem services and economic valuation.

Crop-tree-livestock interactions are core discipline areas for *Agricultural Systems* and these interactions are also key in preserving and protecting soil carbon and biodiversity. We recommend recent articles in this area that are of relevance to World Soil Day. Trees and tree-pasture-crop systems provide many ecosystem services (Garrett et al. 2017) but Sarto et al. (2020) found that integrated crop–livestock–forest systems had lower fine root density than grazed pasture and this might affect some ecosystem services. In a similar vein, Pravia et al. (2019) noted that the inclusion of pastures in crop-pasture rotations was key to improving the carbon content of soils. Soils, and their biodiversity, are complex systems and are difficult to understand without underpinning conceptual and mathematical models. Keating (2020) commented on the importance of simulation models as evolving hypotheses of interactions in the soil-plant environment and we look forward to seeing future submissions that assist us to better understand the complex functioning of soil and its biodiversity in the agricultural systems of the world.

With these publications, *Agricultural Systems* honours FAO's 2020 World Soil Day. From the articles cited here, we have selected two articles, Hall et al. (2020) and Jernigan et al. (2020), as being particularly relevant to World Soil Day 2020. Elsevier will make these articles freely-available and has collected them at "World Soil Day 2020" https://www.elsevier.com/physical-sciences-and-engineering/environmental-science/journals/world-soil-day.

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