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The Known Knowns, and Known Unknowns of Soil Organic Carbon: Establishing Testable Hypotheses for Soil Organic Carbon Research

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Soil organic carbon is integral to the control of soil moisture, soil structure, and soil nutrient cycling and is thus vital for a functional soil. The types of organic carbon in soils are, however, complex and dynamic, and the processes that control organic carbon reactivity and cycling are only poorly understood.

International attention on the importance of soil organic carbon is growing, and new interdisciplinary research initiatives such as 4per1000, CIRCASA, FACCE-JPI, and Global Research Alliance on Agricultural Greenhouse Gases have been established to investigate the relationships between soil, organic carbon, and climate. To maximise the effectiveness of these and future consortia, we propose that a concerted approach to close our knowledge gaps on soil organic carbon processes is needed.

Approximately 200 researchers assessed 14 research challenges identified from literature. The research challenges were divided into 3 themes: (1) Understanding how soil organic carbon is created, processed, and stored; (2) Monitoring soil organic carbon and managing for increases; and (3) The implementation of soil and land and soil management practices to improve soil carbon stocks. Researchers across scales, locations, and disciplines were asked to rate our community's understanding of each challenge, and rank them in order of importance. The responses demonstrate consensus across disciplines for the identified research challenges and provide clear prioritisation for future research targets.

As a result, we have formed a series of testable hypotheses to tackle these research challenges, which will help us to refine the tools we use to prescribe land management practices, predict soil organic carbon responses to changing climate, and give us vital information on the capacity of soils as a sink for atmospheric carbon sequestration.