

CIRCASA PROJECT TOWARDS SOIL ORGANIC CARBON SEQUESTRATION IN AGRICULTURAL SOILS

CIRCASA (Coordination of International Research Cooperation on Soil Carbon Sequestration in Agriculture) is a EU H2020 project focused on developing international synergies concerning research and knowledge exchange in the field of carbon sequestration in agricultural soils at European Union and global levels, with the active engagement of all relevant stakeholders.

THE SCIENCE BASE OF A STRATEGIC RESEARCH AGENDA

Why CIRCASA?

Soils are an enormous natural reservoir of carbon; they contain nearly twice as much carbon as the atmosphere (Quèrè et al., 2015). Moreover, agricultural soils represent an important surface and land area, and most significant, they naturally carry a large potential for carbon sequestration in the form of soil organic carbon (SOC), especially in degraded soils (Paustian et al., 2016) that once contained major amounts of carbon. Through stabilization mechanisms in soil organic matter (SOM), the SOC contained can remain stored in the soil for thousands of years. In this sense, enabling and enhancing SOC sequestration appears to be a real nature-based and no-regret solution to mitigate climate change.

Both preserving and enhancing SOC have further benefits for the environment, people, and livelihoods. It contributes to improved soil quality, agricultural productivity, biodiversity, and water protection and thus increased resilience against climate change as shown by the IPCC Special Report (2019) on Climate Change and Land. Furthermore, it is one of the cheapest negative emission option for climate change mitigation.

Policy impact:

By bringing together international expertise and aligning views across countries on knowledge needs for soil carbon sequestration in agriculture, CIRCASA has contributed to the goals of the Paris Agreement on climate and to several strategies (Farm to Fork, Biodiversity) of the EU Green Deal. This H2020 project funded by the European Commission aimed to take stock of the knowledge gaps that prevent farmers, industries, governments and other stakeholders to implement at scale effective soil carbon management while minimizing potential trade-offs between carbon sequestration and other eco-environmental and social dimensions of soil management. The aim of CIRCASA was to enhance international research cooperation on agricultural soil carbon and to prepare an International Research Consortium (IRC) on soil carbon.



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CIRCASA PROJECT RESULTS

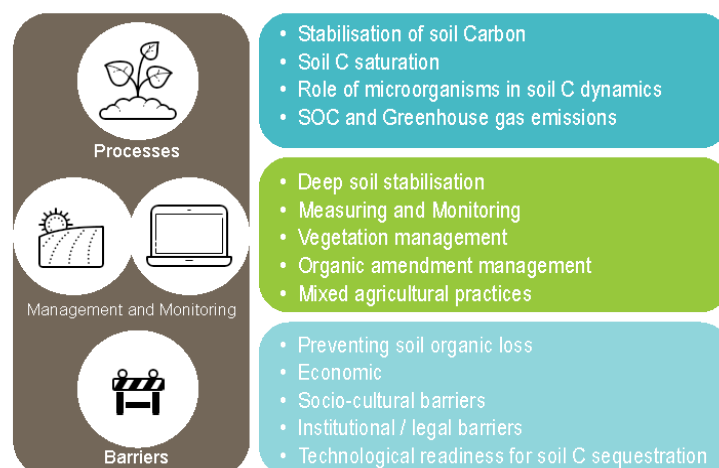
To meet its objectives, CIRCASA reviewed the scientific and technical evidence, structured existing knowledge and gathered stakeholders' views on solutions, barriers, knowledge, and research needs. These results served as inputs for the co-design of a strategic research agenda (SRA) by all partners in the project. This SRA, as well as recommendations on membership, governance and funding, will facilitate the establishment of an International Research Consortium (IRC) on soil carbon.

1. Reviewing the scientific and technical evidence

What are the scientific uncertainties and gaps in the processes, in the management and monitoring of soils, and what are the barriers and adoption?

CIRCASA prepared a survey for the scientific community involved in agricultural systems, soil sciences and land management. Through this survey, fourteen research challenges were identified and categorized in three themes: Processes, Management and Monitoring, and Barriers

The survey had more than 200 responses from different science disciplines and from all continents.



Where are the research gaps within CIRCASA themes?

From the 14 000 journal articles that were reviewed to map the major institutions that publish soil sciences papers at a global scale (soil organic carbon related to GHG and carbon sequestration), the following conclusions were drawn:

- There are a limited number of publications (9.4% on processes, 8.7% on soil monitoring, 8% on soil management, and only 2.4% in barriers) related to the three themes identified, which shows there are gaps to be filled with the SRA. . “Barriers” is an area where increased capacity is needed, being the last published theme in global literature.
- Research is not widely aimed at farmers, the private sector, and even less to policymakers (only 1.1% of publications).

Those results are different if we observe only literature from CIRCASA Network, which shows that the consortium is clearly studying the management aspects and targets specifically policymakers and farmers.

Which existing networks contribute to this research?

CIRCASA reviewed international, regional and national research projects and programs on agricultural SOC sequestration showing strong imbalance across world regions and topics. This review underlined the need to strengthen international research partnerships, to allow for cross projects linkages and provide mission oriented research and innovation better connected with stakeholders needs and public policies.

“Countries that are active in projects are assumed to be also better equipped to serve local and regional policymakers and private sector partners.”

What is the potential of soil carbon and how cost-effective are management practices?

By coupling a crop model and a soil carbon model, the project studied the balance under current practices between crop residues and soil organic matter decomposition in arable cropping systems. Results show differences across regions with more likely losses of soil organic carbon in tropical compared to temperate conditions. Moreover, part of the temperate cropping systems would produce enough crop residues to build-up soil organic carbon at a relative rate of 0.4 % (i.e. the aspirational 4 per 1000 target) or more.

Moreover, the project reviewed cost changes from conventional tillage to no-till in croplands around the world. Contrasts across regions and crop types were found in the cost-effectiveness of implementing no-till, in part due to crop yield effects. These are examples of important questions to address in the future IRC.

CIRCASA contributions to International Knowledge Synthesis

In collaboration with the Soil Carbon Sequestration (SCS) Network of the Integrative Research Group of the Global Research Alliance (GRA), CIRCASA scientists produced a review on how do we measure, report and verify soil carbon change, published in Global Change Biology (Smith et al., 2020¹). The research review examined the methods used to report changes in SOC in national inventories of GRA countries, and proposed how existing components (long- and short-term experiments, models, spatial databases, repeat sampling campaigns, activity data and remote sensing) can be brought together into an integrated MRV platform for soil carbon sequestration. In addition, CIRCASA built the knowledge collated in the project on the Dataverse

¹ Smith, P., Soussana, J.-F., Angers, D., Schipper, L., Chenu, C., Rasse, D.P., Batjes, N.H., van Egmond, F., McNeill, S., Kuhnert, M., Arias-Navarro, C., Olesen, J.E., Chirinda, N., Fornara, D., Wollenberg, E., Alvaro-Fuentes, J., Sanz-Cobena, A. & Klumpp, K. 2020. How to measure, report and verify soil carbon change to realize the potential of soil carbon sequestration for atmospheric greenhouse gas removal. Global Change Biology, 26, 219-241. doi: 10.1111/gcb.14815.

repository of the Open Collaborative platform (www.ocp.circasa-project.eu), which is an open source web application for sharing, citing, analyzing, and preserving research data.

2. Stakeholders views

A second survey with more than 3,000 respondents gathered stakeholders' views on solutions and barriers for agricultural soil carbon sequestration and associated knowledge needs. The consultation in seven languages has been complemented by workshops in 10 world regions.

What are the knowledge and research needs of stakeholders?

Stakeholders perceived the lack of accessible knowledge to be a key barrier in scaling up beneficial practices. Sharing, availability, transfer, and exchange of knowledge were pointed out as the main needs by farmers. The gaps mentioned related to better understanding costs and benefits of SOC management practices in terms of productivity yields, financial returns, income impact, and risks. Farmers also pointed out the need for guidance on how to manage crop rotations, how to combine practices, and to better understand the role of soil biology and microorganisms.

Societal and environmental benefits of SOC sequestration seem to be not well known or apprehended by stakeholders, policy-makers, and civil society. Actions and research are needed on how to design policy mechanisms to better incentivize SOC management, their effectiveness in terms of public investments.

“The issue is not merely a lack of available knowledge and the need for more research.”

Moreover, a clear research and information need was indicated by part of the policy-makers to improve the reliability and standardization of monitoring, reporting and verification (MRV) at a reasonable cost and to support agri-food transformations.

While more research is certainly required in some areas (e.g. MRV), the report finds that the accessibility and applicability of existing knowledge is a key area of concern in other areas (e.g. farm-level management). To create an enabling environment for farmers and

other stakeholders, innovative forms of knowledge creation and exchange need to complement traditional top-down research and dissemination. Here, participatory forms of knowledge (co-)creation and exchange, which involve farmers in the research process, and therefore in defining the research question and in the collection of data, are promising. Examples are

Need of research improvement

To make research effective as a trigger to scaling up improved SOC management, a strategy is needed, which include:

- Continuous alignment of research with the knowledge needs
- Ensure that research delivers context-specific and place-based knowledge and produce tailored guidance for stakeholders.
- Ensure participative co-creation of knowledge to ensure its usability and utility by stakeholders.
- Enable access to the existing and newly created knowledge.

STRATEGIC RESEARCH AGENDA

**PILLAR 1:
Frontier Science**

Unlocking the potential of soil carbon.

Research collaboration across disciplines have the potential to deliver a renewed understanding of soil functions, dynamics, and biodiversity, which together govern soil carbon, soil health, and ecosystem services.

**PILLAR 2:
Monitoring
Reporting and
Verification
(MRV) system**

Develop and scale up rapid cost-effective assessment methods for soil organic carbon change monitoring, reporting and verification. This may involve remote and proximal sensing technologies, but equally important in this context are farm level monitoring tools and mechanisms, and the potential of crowdsourcing farm level data.

**PILLAR 3:
Agro-ecological
&
technological
innovations**

Fostering technological innovation through public-private cooperation for example in plant breeding, biochar, organic amendments and, precision agriculture and machinery.

**PILLAR 4:
Enabling
environmental and
knowledge
co-creation**

Understanding financial, policy, and capacity-building mechanisms that are effective and equitable is a key open research gap from various levels, bottom-up to national to international. An international SRA can stimulate the setting up of these infrastructures; provide an impulse for different ways of working through co-creation methods or more transdisciplinary approaches that involve different stakeholders.

CIRCASA project D3.1 - “Strategic Research Agenda (SRA) on soil carbon”, Research priorities for the alignment of International Research on SOC sequestration in agriculture. This agenda has received feedbacks from CIRCASA partners, members of the 4p1000 initiative Scientific and Technical Committee, the international Technical Panel of soils of the Global Soil Partnership,

so-called living labs and the crowdsourcing of information.

To take these insights forward, the CIRCASA project developed a strategic international research agenda to encourage further research on soil carbon sequestration and to pursue the question of how to facilitate regionally applicable knowledge.

THE STRATEGIC RESEARCH AGENDA

A 2020-2025 Strategic Research Agenda (SRA) has been co-designed between different stakeholders and it is based on scientific evidence and stakeholder's knowledge demands previously identified. This SRA will support the alignment of research into an International Research Consortium (IRC) that will have large benefits to stakeholders in both EU and worldwide through international research and innovative co-creation. The alignment of activities will help create breakthroughs; avoid duplication and develop innovation at a large scale. For this, the future IRC needs to be highly interdisciplinary and guided by stakeholder's demands. This action requires a dedicated tool to carry ambitious international research and innovation programs.

CIRCASA proposition of the IRC is built upon the 4 pillars of the SRA corresponding to the main research priorities (Figure 2) to develop Research and Innovation activities through a portfolio of projects and programs that could be coordinated across regions and across pillars. This implies sharing and develop collaborative knowledge, having the capacity-building, create coordination across institutions and organizations, and have therefore governance.

To implement this IRC, a formal dialog with each partner (research founders, program owners, foundations, private sector) is needed for institutional and financial arrangements in the IRC.

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