Annex 2. EJP SOIL call topics

Topic: Climate change Mitigation (CM)

CM1 - Plant below-ground inputs to enhance soil carbon sequestration in agricultural soils

Rationale/Specific challenge: Soil organic carbon sequestration qualifies as a significant GHG removal technology, at low cost compared to other negative emission technologies (IPCC 2019). The Green Deal increased Europe's ambitions regarding climate change mitigation with an objective of zero net GHG emissions by 2050 (European Commission, 2019)[1]. There will be the need to use the full potential of European soils for mitigation and adaptation strategies, in particular by increasing the soil organic carbon pool in agricultural soils by implementing sustainable soil management practices (Montanarella and Panagos, 2021)[2]. Agricultural soils have indeed a key role as they have lost huge amounts of soil organic C since the advent of agriculture (Sanderman et al. 2017)[3], and have thereby a large potential to store additional carbon and sequester CO2 from the atmosphere, through appropriate soil and crop management options (e.g. Smith et al. 2008)[4]. There is an increasing agreement that crop root systems are major determinants of increasing topsoil and subsoil SOC stocks. Increasing below ground C inputs to soil may be achieved by a variety of management options, from the selection of varieties of annual crops with deep rooting and large allocation to their belowground parts, to the implementation of cover crops, of multispecies cropping systems, of high diversity grasslands, or of silvo-arable or silvo-grassland agroforestry systems. The present knowledge does not allow, however, to predict root derived SOC storage nor its persistence in agricultural soils as related to root traits or functions, or to soil and climate characteristics in the different soil cover and management systems.

Scope: The project will aim to assess the contribution of belowground parts of plants to soil C and its persistence for a diversity of agricultural systems and management practices. Proposing relevant descriptors/root traits (e.g. root biomass, root architecture, rhizodeposition) is necessary to predict the effect of root systems on SOC stocks. Both experimental and modelling efforts are required to make progress in the understanding of the effects of the diversity of systems (e.g. intercrops, cover crops, diverse grassland plants, agroforestry) on C allocation to belowground parts of plants (shallow or deep roots, mycorrhizas and rhizomes) and their residues and rhizodeposits, as well as their control by soil type and climate. Combining syntheses and meta-analyses of field experiments with modeling approaches will be particularly useful to assess the C sequestration potential of the different rooting systems. The project should contribute to the root/shoot database for C-input data to the soil developed by the EJP SOIL CarboSeq project, and, to identify the co-benefits of deep rooting systems. The latter should consider adaptation to drought events and climate

[1] European Commission, 2019. The European Green Deal. =COM (2019) 640 final

[2] Montanarella, L., Panagos, P., 2021. The relevance of sustainable soil management within the European Green Deal. Land Use Policy 100.

[3] Sanderman, J., Hengl, T., Fiske, G.J., 2017. Soil carbon debt of 12,000 years of human land use. Proc Natl Acad Sci U S A 114(36), 9575-9580.

[4] Smith, P., Martino, D., Cai, Z., Gwary, D., Janzen, H., Kumar, P., McCarl, B., Ogle, S., O'Mara, F., Rice, C., Scholes, B., Sirotenko, O., Howden, M., McAllister, T., Pan, G., Romanenkov, V., Schneider, U., Towprayoon, S., Wattenbach, M., Smith, J., 2008. Greenhouse gas mitigation in agriculture. Phil. Trans. R. Soc. B 363, 789-813.

change, reduction of N leaching, promotion of habitats for soil biota, protection from erosion and evaluation of trade-offs with yield maintenance and potential additional GHG emissions.

Expected outcomes:

- Sound scientific evaluation of the C sequestration potential, co-benefits and trade-offs of selected management options and agricultural systems (e.g., annual crops or perennial systems) resulting in increased and deeper OC belowground inputs.
- Improved knowledge on root traits for annual and perennial plants usable by plant breeders.

Expected impacts:

- EJP SOIL EI1: Fostering understanding of soil management and its influence on climate mitigation and adaptation, sustainable agricultural production and environment.
- EJP SOIL EI2: Understanding how soil carbon sequestration can contribute to climate change mitigation at regional level including accounting for carbon.

Project Type: Medium size research project (up to 2M€).