Chapter N (please do not write anything in this line. Editors will annotate the chapter number)

The potential of soil carbon sequestration: International and national soil carbon projects

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**Abstract.** Soil organic carbon (SOC) doubles that in the atmospheric pool, and it is three times the carbon in the aboveground biomass of the planet. Despite of that, less importance has been given to the management of SOC than to the carbon in the living soil cover because of the faster recycling of the latter. Soil can be source or sink of carbon, depending on its management. Globally, agriculture, forestry, and land use changes account for ca. 21% of the global emissions, with strong regional differences regarding regions and source sectors. The question is whether it is possible to manage soil so that agricultural practices and land use in general become carbon sinks instead of sources. Scientific evidence indicate that increases of SOC are associated to better soil fertility, biodiversity, more resilience against erosion, droughts and floods besides other positive effects directly related to several SGD. This paper explores different soil carbon projects, carried out both internationally and nationally, to exploit the enormous potential of the soil in mitigating climate change.

**Keywords.** Soil, soil carbon projects, soil carbon sequestration, carbon neutrality, Net zero.

**N.1. Introduction**

Agriculture has great potential in the fight against climate change because it is the only sector that has the capacity to remove GHGs safely and cost-effectively from the atmosphere without reducing productivity. Particularly, improved agricultural practices can help mitigate climate change by reducing emissions and by storing carbon in plant biomass and soils. Moreover, the sequestration of carbon in soils and vegetation can be used to offset greenhouse gas emissions generated by another sector (Acampora et al., 2020). Specifically, in the OECD (2019) report the global technical mitigation potential of the agricultural sector in 2030 has been estimated to be 5500-6000 MtCO2eq yr1 (Smith, 2012), demonstrating that it is technically feasible for agriculture to become close to carbon neutral, relying on supply-side mitigation (low carbon farm practices and practices to remove CO2 from the atmosphere) measures alone, although this depends on optimistic assumptions about the potential of soil carbon sequestration (SCS). The mean global potential for soil carbon sequestration in agricultural soils is 1.5 Gt CO2 yr-1 and 2.6 GtCO2 yr-1, at carbon prices of USD 20/tCO2eq and USD 100/tCO2eq, respectively (Smith, 2016; Smith et al., 2007). Moreover, in the 2019 IPCC report on climate change and land, soil carbon sequestration in croplands and grasslands has been listed as one of the options with largest potential for Carbon Dioxide Removal (0.4–8.6 CO2eq yr–1) together with afforestation/reforestation (0.5–10.1 CO2eq yr–1) and Bioenergy with Carbon Capture and Storage (BECCS) (0.4–11.3 CO2eq yr–1) (Shukla et al., 2020). Different Soil Carbon projects have been developed during the years in order to exploit the enormous potential of the soil in mitigating climate change (DEHSt, 2018). This paper first presents the main international soil carbon sequestration projects internationally, then presents the case study of Barilla S.p.A.

**N.2. Methods**

This research explores the role of soil carbon sequestration in the light of the decarbonization strategy of countries and companies. As sequestering carbon in the soil could contribute to climate mitigation goals, it is critical to develop soil carbon projects that could boost the uptake of the measures. Through a literature review and the analysis of several case studies, this paper analyzes best practices at international and national level. Then the Barilla company has been identified as a solid foundation to develop a case study on the topic. Observational research, and content analysis of communication materials, reports, and website incentives were used to develop the case studies analysis.

**N.3. Results**

**N.3.1. International Carbon Soil Sequestration Projects**

**LABEL BAS CARBON -** The French Label Bas Carbone (French Carbon Standard) is a framework for voluntary carbon reduction project that was adopted by the French Government in November 2018. It provides a transparent framework for guaranteeing the integrity of carbon reduction projects. Environmental integrity is ensured through the utilization of standardized methodologies in line with the overarching rules set in the regulation(Directorate-General for Climate Action -European Commission, 2019). Companies, public organizations or individuals that wish to compensate their emissions can voluntarily acquire the emission reductions determined thanks to these methodologies to offset their emissions. Individuals or sectors can propose methodologies, which the regulator must approve. These methodologies set guidelines for how to do the following: establish eligibility criteria, calculate baseline scenario and demonstrate additionality of the project, demonstrate environmental integrity (i.e., co-benefits), requirements on identifying and managing non-permanence risks, calculate emissions reductions relative to baseline, and MRV requirements and methods (Gabriella Cevallos et al., 2019). Only projects that are additional will be approved (i.e., the carbon credits would shift the Net Present Value of the project from negative to positive and the project would not otherwise occur without credits). To date, it includes approved methodologies for forestry (afforestation, coppicing, and restoration) and for agriculture. For what concerns agriculture methodologies have been approved for: cattle and field crops (CARBON AGRI), sustainable management of hedges and plantation of orchards.

**CARBON AGRI and CAP2’ER®** - CARBON AGRI provides a method for project developers (i.e., person/organization/company) to account for emissions reductions on cattle (beef and dairy) or field crop farms in France thanks to actions that mitigate GHG or increase carbon storage. These validated emissions reductions can then be traded for payment from an external party voluntarily offsetting their emissions. The method includes six types of actions: herd management and feeding, animal manure management, crop & grassland management, consumption of fertilizers and energy, and carbon storage (in total 40 low carbon practices). It quantifies both reductions on farm as well as associated upstream emissions, applying life cycle assessment. Emissions change is calculated using the national tool CAP2’ER®, a whole farm calculator.

**The 4x1000 Initiative** The mitigation potential of carbon sequestration in agricultural soils is large and has consequently been the focus of recent international attention such as the “4 per 1000” initiative launched at the 21st Conference of the Parties (COP 21)(4 per 1000 Initiative: Soils for Food Security and Climate, 2017). The 4 per 1000 initiative is an international, voluntary collaboration to increase soil organic carbon (SOC) stocks by 0.4 per cent annually, enough to halt the increase in the CO2 concentration in the atmosphere related to human activities (Minasny et al., 2017; Soussana et al., 2019). The initiative aims to reduce deforestation and encourage agro-ecological practices that increase the quantity of organic matter in soils and meet the 4 target per year (French ministry for agriculture & food, 2015).

**N.3.2. The Barilla S.p.A. case study:** **Soil health as new business model**

Nowadays many actions were undertaken by global food companies towards agro-food sustainability involving third parties beyond raw materials suppliers and their customers. Barilla is one of these firms, it reframes its strategy including sustainability inside the “Good for You Good For the Planet” vision, put it as an essential milestone to engage people on Sustainable Development Goals challenges.

The company have internalized the sustainability concepts, where environmental objectives are expressed as explicit targets for each raw material used in food production. Nowadays Barilla employees are focused to improve the raw material sustainability’s performances, by engaging new relationships with the up-stream value chains actors, mainly raw materials producers, farmers’ cooperative, mills and processors and looking at these interactions as a potential source of new information and data useful to monitor tools and strategies efficiency.

**N.3.2.1. The DIVERFARMING project**

Barilla have tested a sustainable agriculture practice by establishing horizontal agreements between three of its main input suppliers: Co.Pro.B. for sugar beet, Cereal Docks for oilseeds, and Casalasco Farmers Cooperative for tomato. Today these horizontal agreements are bilateral, which means that the Barilla Group has a specific agreement with each of the suppliers, but thanks to the research activities in the H2020 Diverfarming project, new approaches are being tested to define multilateral agreements.

In DIVERFARMING project a first multi-years and multi-crop agreement was set up and evaluated by field experiment in three farms of Po valley. In all farms the cropping systems are planned to supply raw material to agroindustry requests (Durum wheat and Tomato), which in turn, sets the quality requirements for acceptance and provides farmers with technical advisory. Having in mind both the sustainable intensification and agroecology principles, the case studies were co-designed with active engagement of the farmers and agronomist, and researchers with a view to the overall farming systems sustainability. Looking at the first two years of experiment, researchers can affirm that co-defined and multidimensional diversifications options mitigated the effect of climatic and market instability on farm gross margin, compared to current crop management in the area, as well as a positive impact was recorder for soil biodiversity, organic carbon content and GHGs emissions reduction.

To pull farmers in this new technical-managerial path, it is necessary to increase the relationships between farmers&farmers as well as between farmers and other value chain actors and advisors. Thanks to BSF concept, for the first time, while still putting the farmer at the centre, a new logic of ‘cooperating to compete’ is adopted, by offering concrete business opportunities in a ‘win-win’ situation for all parties to reduce the agricultural impact and contribute spreading a new thinking regarding sustainability.

**N.3.2.2. The ICAFRUD project**

The pilot project ICAFRUD (Impronta CArbonica della coltivazione di FRUmento Duro - the Carbon Footprint of the cultivation of durum wheat) - edited by CREA-PB in collaboration with Barilla, Horta, Lyfe Cycle Engineering and CCPB - has allowed to evaluate the results achieved by the cereal growers who have adopted the "Decalogue for the sustainable cultivation of quality durum wheat", using an advanced decision support system regarding different cultivation techniques (GranoDuro.net® developed by Horta). The carbon footprint of durum wheat has been developed within an approach based on the tools of Life Cycle Analysis. This project has a dual purpose: 1. To demonstrate that sustainable production protocols lead to lower emissions and greater environmental benefit 2. Account for any carbon credits generated as part of the development of sustainable durum wheat cultivation.

**N.4. Conclusions**

Soils store large quantities of carbon as soil organic carbon (SOC). This has tremendous potential in the fight against climate change, as stabilization mechanisms in organic matter stores carbon over decades to millennia. Indeed, soil carbon sequestration and related soil carbon projects have gained popular and political attention as a possible net-negative emissions technology and as decarbonization strategy in the agricultural sector. Whilst the benefits of soil carbon are well known, the adoption of soil-enhancing agricultural practices remains slow and surrounded by widespread skepticism. Major uncertainties are related to how long carbon can be stored in the soil, how much carbon can be sequestered by different practices, and how to effectively measure and track the carbon that is sequestered. Indeed, for these projects to become an important mitigation strategy a credible, cost-effective, and consistent MRV system is essential for building trust and confidence in the results (and eventually carbon credits) generated.

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