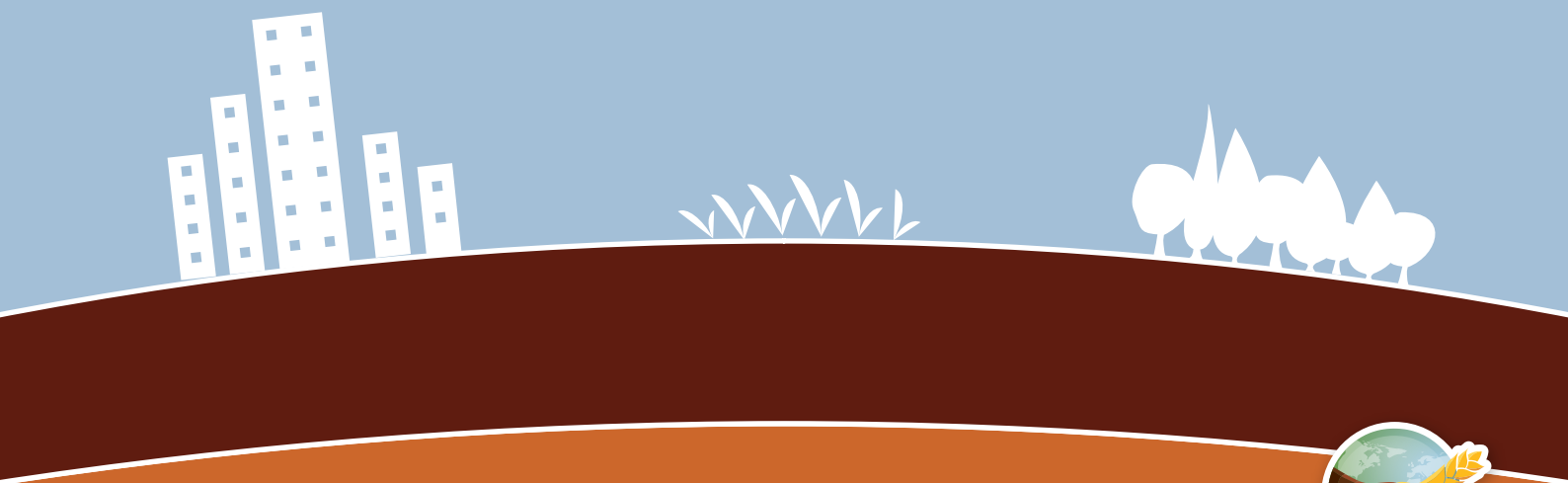
Food and Agriculture Organization of the United Nations

RECARBONIZATION OF GLOBAL SOILS:
A DYNAMIC RESPONSE TO OFFSET GLOBAL EMISSIONS



GLOBAL SOIL PARTNERSHIP

SOIL ORGANIC CARBON – CENTRED SUSTAINABLE SOIL MANAGEMENT – AN AFFORDABLE SOLUTION

As part of a natural process, a healthy soil stores more carbon than the sum of the carbon contained in the atmosphere[1] and vegetation[1] (Figure 1). Based on soil organic matter's stabilization mechanisms (i.e., physical, chemical, biochemical, microbial and ecological), soil carbon can remain stored in the soil for thousands of years[2].

However, the world's cultivated soils have lost[3] between 50 to 70 percent of their original carbon stock, which has been released into the atmosphere in the form of CO_2, mainly due to unsustainable management practices resulting in land degradation and amplifying global warming. Land degradation lowers the soil's ability to maintain and store carbon, contributing to global threats such as climate change, and costing trillions of dollars per year[4].

The implementation of proven Soil Organic Carbon (SOC)-centered Sustainable Soil Management (SSM) practices for maintaining carbon rich soils (peatlands, black soils, permafrost, etc.) and for sequestering more carbon in potential soils (croplands and degraded soils) will address the challenge of compensating aviation emissions (Figure 2). Soil carbon sequestration has been shown to hold the largest sink potential in terrestrial ecosystems and agroecosystems. It is estimated that the sequestration potential is approximately 2.45 Gt C per year[5], which represents much more than the yearly CO_2 emissions by the aviation sector in the atmosphere.

SOC-centered not only prevents emissions but also provides multiple benefits such as enhancing food security and farm income, reducing poverty and malnutrition, providing essential ecosystem services, contributing to sustainable development and building resilience to shocks and climate change adaptation and mitigation (Figure 3).

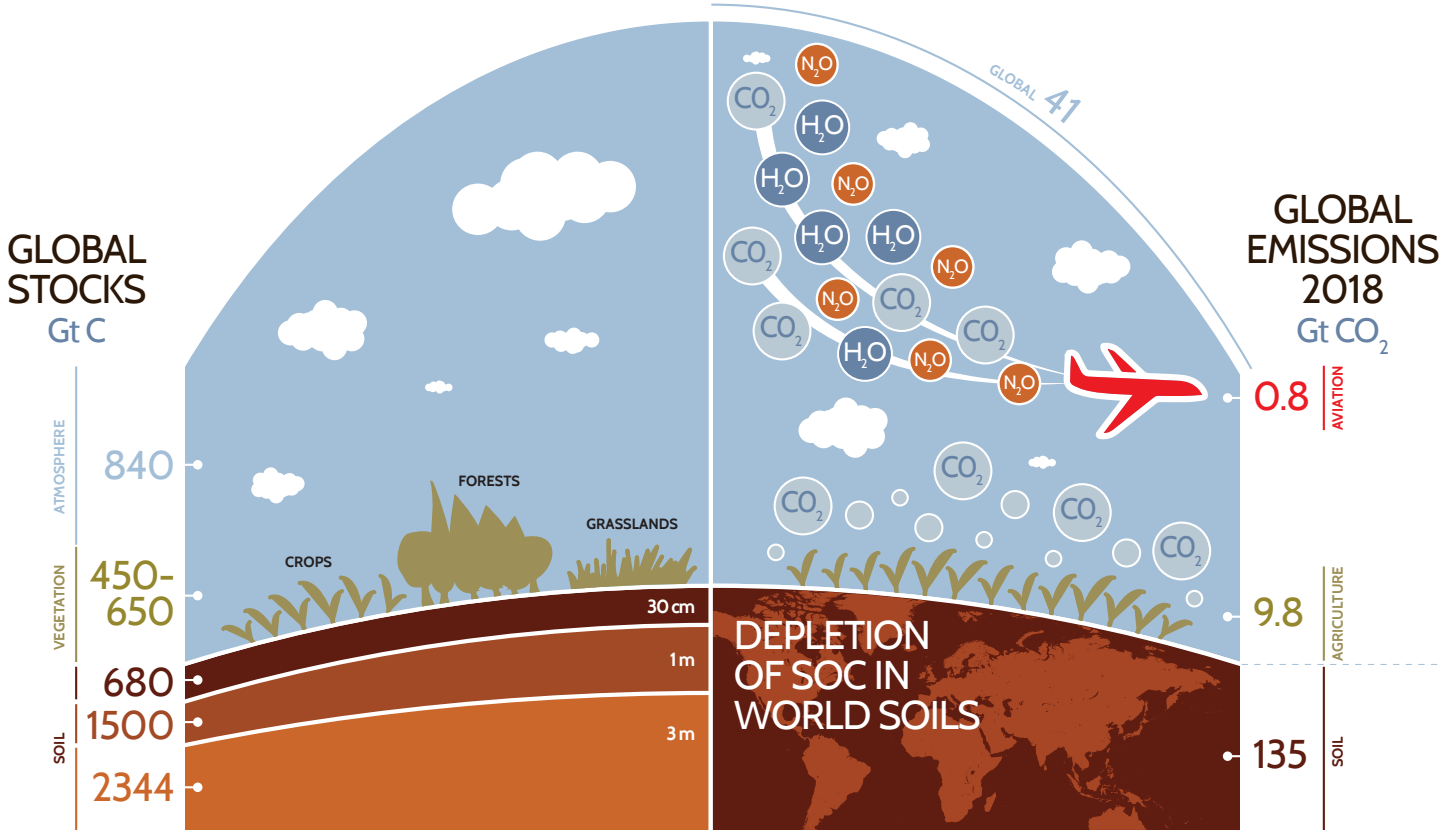


Fig.1 Global carbon stocks and global emissions. Gt = gigatonne = 10^{15} g C = 1 petagram = 1 billion tonnes. 1 Gt C = 3.664 Gt CO_2

Agricultural and degraded soils could sequester more than 60 times the emissions generated by aviation in 2018 through the adoption of large-scale SOC-centered SSM practices. Considering that the world's soils have lost[5] around 135 Gt C since the nineteenth century, effective SSM practices that increase soil organic carbon could offset the yearly emissions of aviation when implemented at a large scale.

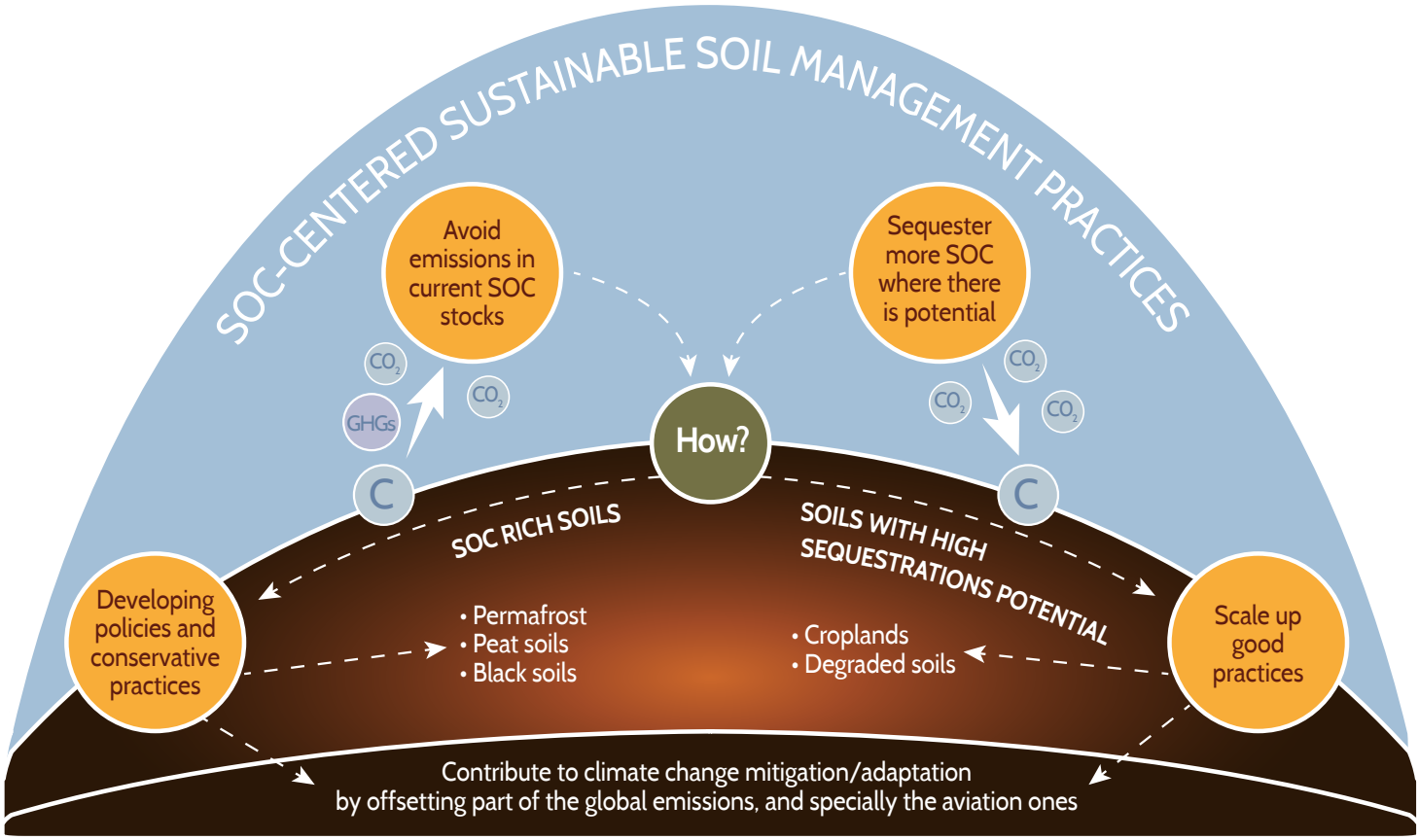


Fig.2 Multiple benefit provided by Sustainable Soil Management based on SOC

AIR TRANSPORT EMISSIONS: SOLUTIONS FOR THE SECTOR

Domestic and international aviation together are responsible for approximately two percent of global anthropogenic CO_2 emissions. In 2010, CO_2 emissions into the atmosphere due to aviation were estimated[6] at about 0.45 Gt CO_2. Furthermore, based on the estimates of the global emissions[7] in 2018, the aviation sector emissions accounted for 0.8 Gt CO_2 (Figure 1). Aviation emissions also include other gases, such as N_2O - a potent greenhouse gas – and H_2O emitted from aircraft contrails which can impact cloud formation thus having an indirect effect on climate forcing[8].

Emissions from domestic aviation, which represent 35 percent of total aviation emissions, are addressed under the United Nations Framework Convention on Climate Change (UNFCCC) agreements, most recently the Paris Agreement, and are included as part of the Nationally Determined Contributions (NDCs). International aviation, on the contrary, is not covered by the UNFCCC agreements, thus currently not bound to emission reduction regulations, although they are responsible for the major part of aviation emissions. Therefore, the International Civil Aviation Organization (ICAO), a UN agency aiming to address all matters related to international civil aviation including environmental protection, has set the goal of "carbon neutral growth from 2020". This goal aims to keep global net CO_2 emissions from international aviation from 2020 at the same level. Since the 1960s, fuel efficiency in the aviation sector has increased by about 80 percent and further improvements are projected to be limited to one to two percent annually[9]. At the same time, air traffic is forecasted to double by 2030, that is, an increase in emissions of up to four percent each year. As a result, a basket of measures has been defined by ICAO to help achieve the carbon neutral goal from 2020. The basket includes efficiency enhancement based on aircraft technologies, operational improvements, enhanced use of sustainable fuels and market-based measures (MBMs). **The issue remains how to offset or mitigate those emissions caused by international aviation so that the sector complies with its social/ environmental responsibility, which is in line with major efforts to reduce emissions and address the issue of global warming and climate change.**

In ICAO's Assembly Resolution AR39 from 2016, it was decided to implement a global Market-Based Measure (MBM) scheme in the form of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) to address any annual increase in total CO_2 emissions above the 2020 levels. Even

accounting for planned technological and operational improvements by 2040, aviation derived CO_2 emissions would increase by 2030 from 0.8 Gt CO_2 to 1.6 Gt CO_2 (which is equivalent to 0.44 Gt C). **If this trend continues, the emissions would have exponential growth by 2050. In defining CORSIA options, due its intrinsic ability to sequester carbon, soils can provide a significant and feasible solution for offsetting CO_2 emissions by avoiding the emission of current SOC stocks and by sequestering additional carbon where a potential exists.**

FARMERS AS THE KEY AGENTS OF CHANGE

While the soil's capacity to sequester carbon is very variable in space and time[10,11] the emission of SOC stocks due to unsustainable management practices is applicable to all, avoiding loss is therefore important and easier to achieve. SOC sequestration is usually a medium-term process and the result as total carbon gain can only be detected after a few years (from one to 20 years depending on the organic matter fraction measured). The speed of soil sequestration greatly depends on local climate conditions, land cover/land use, soil type and adoption of SOC-centered SSM practices as well as its scale of implementation through incentives. Extensive research has shown that sustainable soil management practices can enhance soil carbon stocks in agricultural soils (See Box 1) with practices including minimum tillage, mulching, cover cropping, addition of organic matter and manures, soil fertility management, agroforestry, rotational grazing, and erosion control by water and wind.

Through sustainable farming, the loss of this important stock can be curbed, while taking advantage of soil's enormous storage capacity. **More importantly, sustainable farming practices have multiple benefits for the environment, producers and consumers. Furthermore, investing in sustainable soil management (centred on the maintenance of current SOC stocks and further sequestration) entails multiple benefits in terms of food security and nutrition, poverty reduction, provision of ecosystem services and sustainable development.**

Indeed, SSM practices can effectively store more carbon in the soil over the short to medium term, thus improving food production and livelihoods, and contribute to the achievement of the Sustainable Development Goals (SDGs) by 2030 (Figure 3).

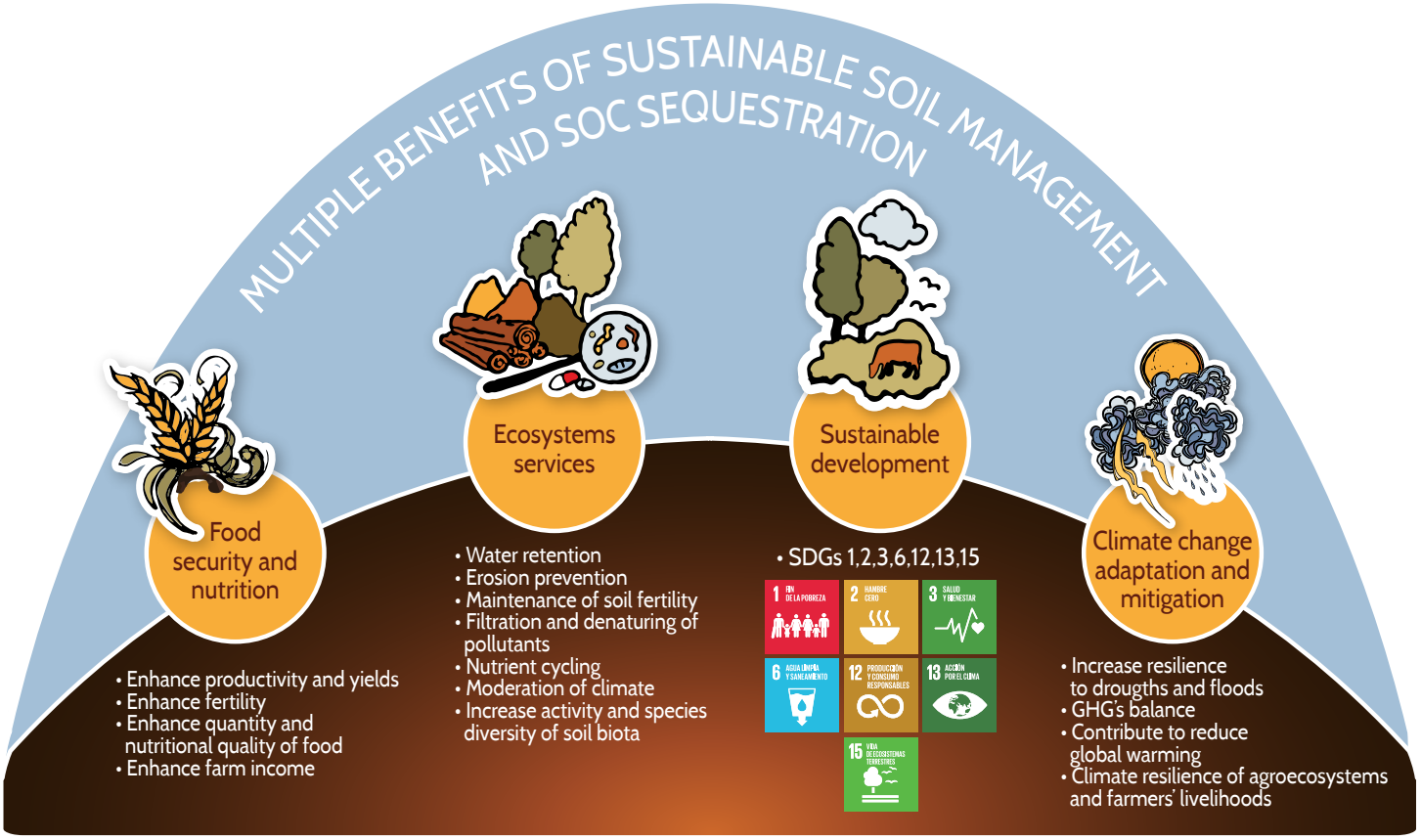


Fig.3 The challenge behind SOC

BOX 1. EVIDENCE FROM HONDURAS

The Quesungual system involves an integration of cropping and preservation of trees, shrubs and grasses (agroforestry); maintenance of vegetation cover, as well as clearing of vegetation by hand instead of with fire; incorporation of organic matter into the soils, and minimum soil tillage. As a result of the adoption of this sustainable soil management practice, yields almost doubled and soil organic matter content increased from 2% to 3.3% over 20 years[12,13]. This is equivalent to an increase from 15 to 25 tonnes of carbon per hectare in the first 10 cm of the soil (assuming a bulk density of 1.3 g per cm^3).

Overall, soil health and management were improved through this new low-cost system, which replaced the previous unsustainable form of slash and burn agriculture. Simultaneously, soil moisture was increased by 20% and resistance towards erosion and landslides was improved, thus enhancing resilience of the rural communities against extreme weather events such as droughts and intense rainfall, which are expected to become more frequent with the impact of climate change.

WHAT IS THE RECARBONIZATION OF GLOBAL SOILS (RECSOIL) FACILITY AND HOW IT CAN HELP THE AVIATION SECTOR?

A promising offsetting option in the framework of CORSIA could be achieved by supporting the implementation of such actions through the **RECSOIL facility**, which constitutes an implementing facility for scaling up SOC-centered SSM, based on collaborative efforts under the Global Soil Partnership (Figure 4). **The main priorities of RECSOIL and associated multiple benefits are: a) to prevent further SOC losses from carbon-rich soils (peatlands, black soils and permafrost) and, where feasible (agricultural and degraded soils), to increase SOC stocks; b) to enhance farmer income through by increasing soil productivity; and c) to contribute to improved food security and nutrition. RECSOIL will also contribute to the growth of Corporate Social Responsibility (CSR) in the aviation sector.**

RECSOIL will be implemented following an inclusive approach involving multiple stakeholders, who will all have a role to play. Various components (global SOC monitoring system, guidelines for measuring, mapping, reporting and monitoring SOC, etc.) will work at global, regional and national levels (Figure 4). Governments, in particular, will be involved in the implementation of RECSOIL as a delivery mechanism of commitments in their NDCs and the development of normative and measuring tools. However, farmers are the key actors and beneficiaries who will implement RECSOIL on the ground. They will receive technical support for adopting effective SOC-centered SSM practices as well incentives for its operationalization.

Despite the potential of SOC sequestration, lacking investment in SSM is still a major constraint to scale up action. In order to address this challenge, RECSOIL will establish an incentives scheme to mobilize voluntary contributions, especially private funding from voluntary carbon offsets and blended investments in climate change adaptation and mitigation.

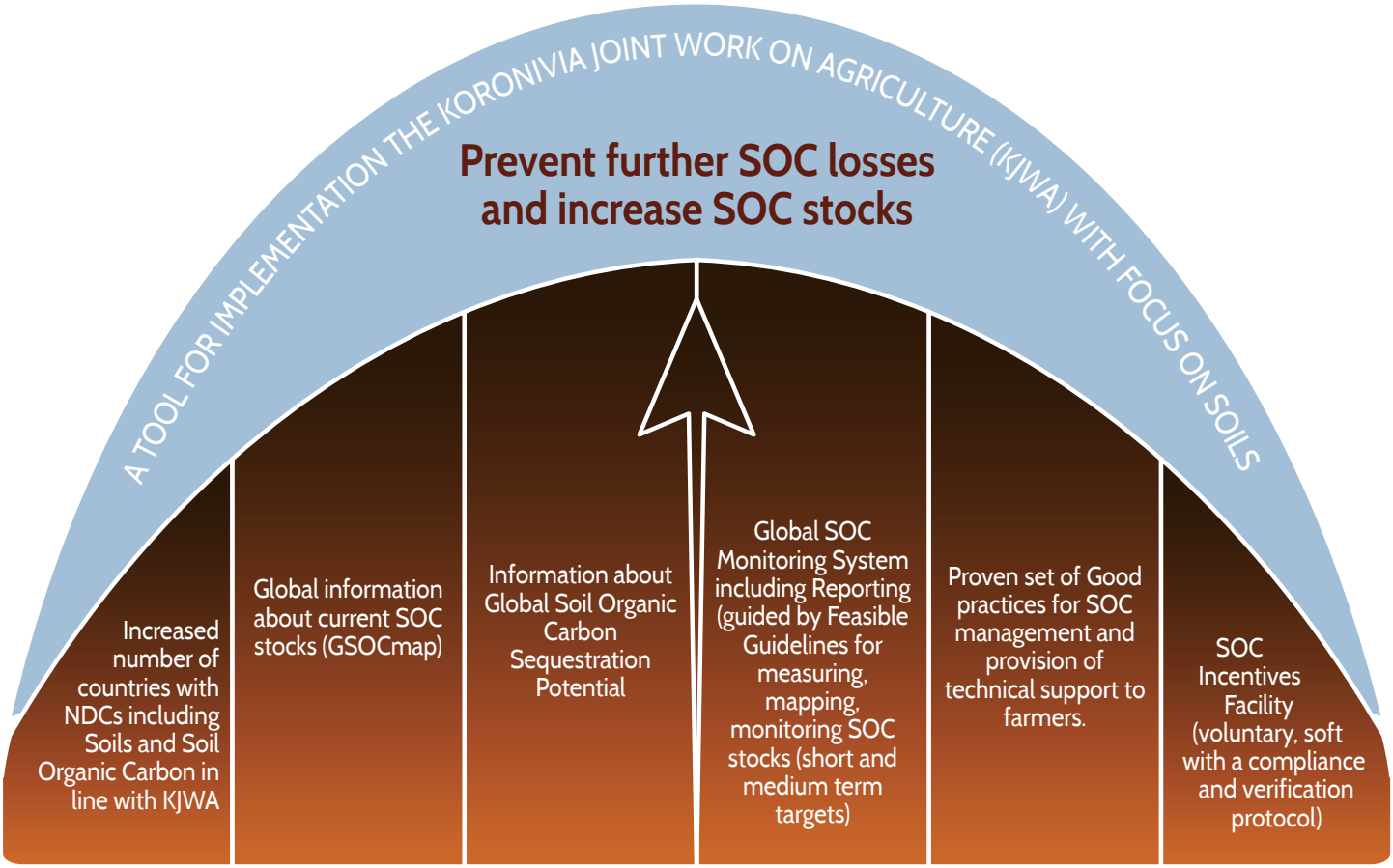


Fig.4 RECSOIL: Recarbonization of Global Soils

In order to avoid the bureaucracy observed in many other existing finance schemes, the RECSOIL facility will provide access to a friendly incentives scheme for farmers to implement the SOC-centered SSM for climate change mitigation and adaptation, and associated multiple benefits.

- It is estimated that 33% of global soils are degraded[14], thus recarbonization offers a great opportunity for sequestering SOC and providing multiple benefits to achieve the SDGs and offset the emissions of the international aviation industry, which are projected to increase.
- Ecosystems where SOC sequestration is feasible include 4 900 Mha of agricultural land (including 332 Mha equipped for irrigation) and 2 000 Mha of degraded soils[14].
- RECSOIL will contribute not only to offsetting emissions from the aviation sector, but will also provide multiple benefits to offsetting the emissions generated by land use change that account for 30% of global cumulative emissions since 19th century.

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The Global Soil Partnership (GSP) is a globally recognized mechanism established in 2012. Our mission is to position soils in the Global Agenda through collective action. Our key objectives are to promote Sustainable Soil Management (SSM) and improve soil governance to guarantee healthy and productive soils, and support the provision of essential ecosystem services towards food security and improved nutrition, climate change adaptation and mitigation, and sustainable development.