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Subject: Cooperative sectoral approaches and sector-specific actions, in order to enhance implementation of Article 4, paragraph 1(c), of the Convention

Information note: **The carbon sequestration potential in agricultural soils**

1. Introduction

The major natural sinks of carbon dioxide are oceans, soils and living and dead biomass, mainly plants – including forests. This short information note provides an overview of the potential of soil as a carbon sequestration option.

Currently the Clean Development Mechanism, established under the Kyoto protocol, considers only afforestation and reforestation as acceptable sequestration activities. It is suggested that the post-2012 regime would benefit if soil carbon storage could be recognized as an eligible carbon sink in all land use systems, in particular agricultural soils. Indeed, the IPCC (2007) noted that soil carbon sequestration is the mechanism that holds the greatest global mitigation potential.

The negotiations initiated at COP-13 of UNFCCC, on strategies and incentives for Reduced Emissions from Deforestation and Degradation (REDD) were focusing on developing countries and forest lands. However there are opportunities for soil carbon sequestration across all climatic zones and a wide range of cropping, grazing and forestry land use systems. Moreover, there are multiple benefits of management practices that restore soil carbon including reversing degradation and desertification, enhancing productivity and the provision of a range of ecosystem services and increasing resilience to climate change. If recognised as an eligible carbon sink, as well as mobilising the adoption of good practice by the large scale commercial farming sector, multiple benefits could accrue to smallholders and the millions of poor farmers and herders who have currently no access to the Kyoto mechanisms.

As agriculture including grasslands cover such a vast land area, although the amount of carbon stored in their soils and vegetation per unit area is lower than in forests, the potential carbon storage is significant. The total agricultural area in the world amounts to 5.0 billion ha. Of this, about 1.5 billion ha (30.4%) is arable land and land under permanent crops and the remaining 3.5 billion ha under permanent pastures and another 1.7-2.5 billion ha is rangelands. Agricultural activities and land-use change such as deforestation contribute about one third of the total greenhouse gas (GHG) emissions and are the largest sources of methane and nitrous oxide emissions.

In view of the above facts, it is only natural that the sectoral approaches that will be discussed in one of the AWG-LCA3 workshops should not overlook the importance of the agriculture sector, including rainfed and irrigated croplands, pasture and rangelands and agroforestry.

2. Order of magnitude of soil carbon sequestration

The global soil carbon pool amounts to 2500 Gt (gigatons), whereas the biotic pool is 560 Gt (Lal, 2004). Most agricultural soils have lost 30% to 75% of their antecedent soil organic carbon (SOC) pool or 30 to 40 t C ha-1. On a global scale, carbon loss from soils is mainly associated with soil degradation, including accelerated erosion and mineralization, and land use change, and has amounted to 78+/- 12 Gt since 1850. Consequently, the present organic carbon pool in agricultural soils is much lower than their potential capacity (Lal et al, 2007). The restoration of wastelands, degraded/desertified soils and ecosystems (e.g., afforestation, improved pastures) and adoption of improved farm management practices can enhance soil organic carbon and improve soil quality and soil health. Such management practices include organic agriculture, conservation tillage, mulching, cover crops, integrated nutrient management including use of manure and compost, and agroforestry, as well as improved management of pastures and rangelands (FAO, 2007).

Considering all greenhouse gases, the global technical mitigation potential[1] from agriculture (excluding fossil fuel offsets from biomass) will be between 1.5 and 1.64 Gt C-eq per year by 2030 (Smith et al., 2008). Soil carbon sequestration (enhanced sinks) is estimated to contribute about 89 percent to this mitigation potential (Smith et al., 2007).

Management-related factors that can prevent or reduce soil carbon losses and restore soil carbon content include: conservation practices that reduce loss of soil matter through erosion; conservation tillage and protective vegetation cover to reduce oxidation by tillage or high soil temperature; maintenance of organic residues to provide cover and carbon inputs; restoration of soil biota and their ecological processes that breakdown organic inputs to soil organic carbon fractions and stable organo-mineral complexes. In addition, such practices contribute to improved soil fertility and productivity, enhanced above-ground biodiversity, and increased infiltration, reduced runoff and enhanced soil moisture retention, thereby reducing risk of drought and desertification. If such management practices are maintained over several years or decades the total amount of carbon sequestered will be substantial, though in some years the attainable level may be lower than the potential due to climatic vagaries and human management factors.

The global potential of soil organic carbon sequestration is estimated at 0.6 to 1.2 Gt C year, comprising 0.4 to 0.8 Gt C year through adoption of recommended management practices on cropland soils, 0.01 to 0.03 Gt C year on irrigated soils, and 0.01 to 0.3 Gt C year through improvements of rangelands and grasslands (Lal et al., 2007). This adds to the potential of C sequestration in biomass in forest plantations and short rotation woody perennials.

3. Benefits associated with higher soil carbon

Increasing carbon content in the soil, through better management practices, produce a number of benefits in terms of soil biodiversity, soil fertility and soil water storage capacity and hence productivity. Soil carbon sequestration through the restoration of soil organic matter can further reverse land degradation and restore soil "health" through restoring soil biota and the array of associated ecological processes. In particular, through improved soil water storage and nutrient cycling, land use practices that sequester carbon will also contribute to stabilising or enhancing food production and optimizing the use of synthetic fertilizer inputs, thereby reducing emissions of nitrous oxides from agricultural land. Conservation tillage practices also reduce significantly the use of fuel and hence gaseous emissions.

[1] The technical mitigation potential includes all greenhouse gases. Nitrous oxides and methane are converted to CO_2 and C equivalent using their global warming potentials.

Soil carbon sequestration is thus very cost effective and could take effect very quickly (FAO, 2008). It also constitutes a valuable win-win approach combining mitigation (CO_2 is removed from the atmosphere) and adaptation, through both increased agroecosystem resilience to climate variability and more reliable and better yields (production and income generation).

Under climate change scenarios, increased temperature may enhance soil organic matter mineralization in colder regions of the world, releasing carbon dioxide from soils (FAO, 2001). Improved soil management will mitigate the effects of global warming by improved and permanent soil cover.

Soil carbon storage was hitherto left out of international negotiations because of envisaged difficulties of validation of amounts and duration/permanency of sequestration. However, in addition to the undisputable multiple benefits of soil carbon storage, soil sampling for verification purposes is less expensive and more accurate than the indirect estimation of carbon stored in living biomass.

4. Conclusions

FAO has been advocating sustainable soil management practices through promoting agricultural technologies that restore carbon pools and soil quality (e.g. soil conservation techniques, organic matter management and conservation agriculture, biodiverse farming systems improved pasture and rangeland management, etc.). FAO has prepared a Global Carbon Gap Map that identifies areas of high carbon sequestration potentials and is developing local land degradation assessment tools that includes a simple field measurement of soil carbon. FAO is also working with partners that are developing tools to measure, monitor and verify soil carbon pools and fluxes of greenhouse gas emissions from agricultural soils, including cropland, degraded land and pastures. Incentives for sequestering carbon and for reducing greenhouse gas emissions (GHG) from agricultural soils, and support by Governments and development partners, would encourage smallholders at subsistence level as well as larger commercial farmers and herders to adopt improved management practices and by so doing enhance their productivity while contributing to reversing degradation and desertification, conserving biodiversity, and mitigating and adapting to climate change. The soil carbon sequestration potential is large and deserves to be incorporated into the post-Kyoto regime.

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