

Info Note

Evaluating ambition for soil organic carbon sequestration and protection in nationally determined contributions

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Key messages

- Current NDCs demonstrate a range of SOC targets, policies or measures.
- Many countries' NDCs specify practices that sequester or protect SOC under both mitigation and adaptation without explicitly mentioning SOC.
- Only 28 countries have NDCs that specify SOC targets, policies or measures, which can serve as examples for other countries.
- Specifying SOC in future NDCs will support country ambition and clarity, transparency and understanding as well as leverage climate finance, technical support and capacity building.
- Constraints to including SOC include measurement, reporting and verification (MRV) and a need to prioritize food security and flexibility via economy-wide targets.
- Support for exchange among countries is needed to support SOC specification in the NDCs.
- NDCs are not a sufficient indicator of national action on SOC, as some nevertheless have strong domestic programs.

Increased international attention on agricultural soil organic carbon (SOC) has raised expectations of its potential contribution to both climate change mitigation and adaptation. Yet, debate on what is achievable and how to monitor or verify improvement in SOC has challenged progress. Since SOC is the primary terrestrial carbon pool, specification of SOC targets, policies and measures in agriculture may be pivotal to achieving global climate change targets, and thus appropriate to

include in the nationally determined contributions (NDCs) to the 2015 Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC).

To understand how countries are addressing agricultural soil carbon in the NDCs, CCAFS assessed the NDCs in 2019 (184 NDCs submitted by 24 November 2019). We analysed the specification of SOC in adaptation actions and mitigation targets, policies, programs and other measures to be implemented for the agriculture sector based on keyword searches. We considered explicit mention of soil carbon, as well as targets or actions linked to SOC, peatlands and wetlands.

Soil carbon, peatlands and wetlands are currently addressed in only 28 NDCs with varying levels of detail and relation to mitigation targets or actions (Table 1 and Box 1). Only three NDCs quantified indicators for SOC (Burkina Faso, Namibia, Uruguay). Yet, numerous NDCs committed to implementing agricultural practices that would sequester or protect SOC as mitigation or adaptation actions, with or without referring to SOC (Table 2). The large technical potential to sequester or protect carbon in their soils in some countries (Table 3) is not well reflected in NDCs. However, countries that do not address SOC in their NDCs sometimes had significant national policies, targets or actions related to SOC (e.g., Brazil, USA). For many countries, NDCs are, therefore, not good indicators of domestic action and policies related to SOC.



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Table 1. Countries that currently refer to SOC, peatlands and wetlands in their NDCs in relation to the agriculture sector. Columns indicate whether these can be contextually linked to i) unconditional or conditional mitigation targets, ii) national policies/ plans/ assessments/ programs related to climate change, iii) actions or measures to be implemented, or iv) other contexts.

NDC Contents on SOC				NDC Contents on Peatland						
Country	Unconditional target	Conditional target	Policies	Actions	Country	Unconditional target	Conditional target	Policies	Actions	Other
Armenia	✓			✓	Afghanistan		✓		✓	
Bolivia	✓			✓	Belarus	✓			✓	
Burkina Faso				✓	Burundi	✓			✓	
Canada	✓	✓	✓	✓	Indonesia	✓	✓	✓	✓	
China	✓			✓	Malaysia					✓
Japan	✓			✓	Uruguay	✓	✓	✓	✓	
Malawi	✓	✓		✓	Zambia	✓			✓	
Namibia	✓			✓	NDC Specifies Wetlands					
Nepal	✓		✓	✓	Bangladesh					Pakistan
Pakistan		✓	✓	✓	Belize					South Sudan
Palestine		✓		✓	Bolivia					Suriname
Syria				✓	Canada					Uganda
Uruguay	✓	✓	✓	✓	China					United Arab
Zambia	✓			✓	Iceland					Emirates (UAE)
					Indonesia					Uruguay
					Nicaragua					Vietnam

Table 2. Number of countries that identify SOC-related implementation measures under agricultural mitigation or adaptation

Measure(s)	Mitigation	Adaptation
Agroforestry/Silvo-pastoralism	31	36
Conservation agriculture ¹	21	13
Grassland/ Pasture land management	14	16
Organic amendments (manure, compost, biochar)	12	10
Reduced/stopped (crop residue) burning	12	6
Erosion control	9	41
Integrated soil fertility management	6	13
Reduced or no-tillage ¹	5	6
Residue retention (mulching)	3	3
Cover crops	2	1
Fallow	1	1

¹ SOC sequestration resulting from conservation agriculture and reduced or no-tillage, may differ depending on the climatic zone, the sampled soil depth and the calculation method used for SOC change determination.

Country SOC sequestration and protection potentials

Large variation exists in global estimates of technical SOC sequestration and protection potentials. A number of

countries, however, are consistently identified as having large SOC potentials across studies. Ten countries store more than 60% of the total global SOC stock in the upper 30 cm of soil, with the top five countries (Russia, Canada, USA, China, Brazil) holding more than 50% of this stock (FAO and ITPS 2018). These five countries were also among the ten countries with the highest technical potential to sequester total SOC in croplands over 20 years (Zomer et al. 2017) and the ten countries with the largest peat carbon stocks (Crump 2017).

Table 3. Countries with the largest technical potential to sequester SOC in croplands per country over 20 years (Zomer et al. 2017) and the largest peat carbon stocks per country (Crump 2017). Countries in bold text appear in both categories.

Country	SOC sequestration potential (Mt C yr ⁻¹)	Country	Peat C stock (Mt C)
1 USA	124.7	Canada	139,819
2 India	103.8	Russia	124,762
3 China	65.4	Indonesia	48,993
4 Russia	62.6	USA	26,454
5 Australia	36.2	Papua New Guinea	5,427
6 Brazil	35.9	Brazil	4,934
7 Canada	26.8	Malaysia	4,926
8 Mexico	21.1	Finland	4,802
9 Nigeria	19.8	Sweden	4,535
10 Ukraine	17.3	China	2,924

What challenges do countries face?

Due to the voluntary nature of NDCs and associated targets under the Paris Agreement, countries may choose whether and how to address SOC in their NDCs. Countries electing not to include SOC and associated targets in their NDCs may do so for various reasons, including:

- the goal of NDCs is to express a commitment to sustainable development and climate change as a central issue, and countries need to reflect that understanding as a nation through an economy-wide commitment instead of focusing on particular (natural) carbon pools;
- the objective of enhancing agricultural production for food security is seen as a higher priority than SOC protection or sequestration; and
- countries experience multiple challenges related to MRV of SOC, monitoring SOC changes over time and linking changes to management practices, identifying and tracking relevant measures at the national level, and ensuring that national GHG inventories can accommodate selected data and indicators.

Box 1: Existing mitigation targets linked to SOC

Thirteen countries' NDC commitments included mitigation targets linked to SOC. Eight of these NDCs included SOC in relation to quantitative targets, demonstrating a wide range of possible approaches and indicators (Bolivia, Burkina Faso, Canada, Japan, Malawi, Namibia, Nepal, Uruguay).

Of these eight NDCs, only Burkina Faso, Namibia, and Uruguay provide quantified indicators specifically for SOC. In the other five NDCs, SOC is a component in a broader target or indicator to be achieved from the implementation of measures which fall under the same sector (Bolivia, Japan, Malawi, Nepal) or multiple sectors (Canada).

Examples of indicators related to SOC in NDCs:

■ *Net GHG emissions and removals:*

- Canada sets a GHG emission reduction target of 44 Mt CO₂eq by 2030 to be achieved from the implementation of measures under different sectors, including stored carbon in forests, soil and wetlands.
- Japan sets a GHG removal target of 7.9 Mt CO₂ by 2030 to be achieved through cropland and grazing land management which includes the promotion of soil management that will lead to increased carbon stock in cropland.
- Under the agriculture, forestry and other land use (AFOLU) sector, Namibia estimates a GHG reduction/removal target for soil carbon of 0.18 Mt CO₂eq by 2030.

■ *Quantitative indicators for a specific measure/s:*

- Malawi estimated that mitigation measures suggested under agriculture, including soil carbon sequestration resulting from agroforestry, will contribute about 0.4 Mt CO₂eq yr⁻¹ by 2040 from the extensive implementation of climate-smart agriculture.

■ *Percentage or hectares of croplands/forests where SOC will be preserved or sequestered:*

- Bolivia sets a target to strengthen environmental functions (carbon sequestration, organic matter, soil fertility, biodiversity conservation and water availability) in about 29 million hectares by 2030.
- Nepal sets an unconditional target to maintain at least 40% of the total area of the country under forests. Under this target it is indicated that in the Chure (Siwalik) area the implementation of forests, soil and water conservation activities is expected to greatly sequester carbon and could function as a carbon sink.
- Uruguay sets an unconditional target to preserve SOC in 75% of the cropland area and sequester SOC in the remaining 25% of cropland by 2025.

■ *Quantitative mitigation co-benefits of adaptation actions:*

- Burkina Faso identifies that proposed adaptation actions would sequester carbon in the soil in excess of 0.515 Mt CO₂eq by 2030.

How can countries include SOC in future NDCs?

Countries may opt to include SOC in NDCs for two reasons. First, to provide necessary clarity, transparency, and understanding to enable the tracking of NDC commitments and progress to achieve the 2°C and pursue the 1.5 °C policy target of the Paris Agreement. Second, to leverage climate finance, technical support and capacity building for SOC related policies and actions. Toward both aims, we provide examples of how countries can address SOC in future NDCs (Boxes 1, 2 and 3), considering the guidelines for NDC enhancement, countries' perspectives on agriculture and SOC in NDCs, and challenges associated with the quantification, target setting and monitoring of SOC and associated measures.

These examples may be applied for countries to:

1. Increase NDC ambition by:
 - a. Quantifying the contribution of existing or future long-term national actions for SOC protection or sequestration to reduce GHG emissions or serve as negative emissions technologies.
 - b. Quantifying mitigation co-benefits of existing or future adaptation actions that would protect or sequester SOC long-term. (Example: Burkina Faso, Box 2)
2. Increase transparency for global SOC accounting by:
 - a. Breaking down economy-wide targets into sectoral or multi-sectoral sub-targets that specify SOC. (Example: Canada)

- b. Breaking down sectoral targets into sectoral sub-targets. (Examples: Japan; Namibia; Uruguay, Box 3)
3. Leverage support for relevant national policies and technical capacity development, and leverage access to climate finance:
 - a. Specifying SOC in relation to measures already included in NDCs that would support the sequestration or protection of SOC under agricultural mitigation or adaptation (Table 2).
 - b. Setting conditional mitigation targets for developing countries, which may be dependent on financial, technical or capacity development support. (Examples: Palestine; Uruguay, Box 3)

Box 2: Burkina Faso's first NDC (2015) – Excerpts relevant to SOC

Burkina Faso's adaptation component of the NDC consists of projects with the primary objective of enhancing environmental services; the below tables are sections from the adaptation section of its NDC. The NDC notes that agricultural adaptation actions are also expected to provide mitigation co-benefits.

Table 12. Investment and implementation costs of conditional projects within the INDC (in US\$)

Sectors	Investment costs of the sectoral projects	Implementation costs	Co-benefits associated with implementation of the sectoral projects
Agriculture & water	1,233,470,000	493,388,000	<ul style="list-style-type: none"> > Annual growth in agricultural production, more specifically the amounts of cereals produced, leading in turn to an improvement in the levels of food security and the levels of farmer income, which reduces the incidence of poverty. > The proposed actions make it possible to sequester carbon in the soil (more than 5,150 Gg eq CO₂ sequestered at the 2030 horizon), contributing to the restoration of degraded land and mitigation of the effects of climate warming, with the end result of preserving ecosystems and water resources.

Table 8. Priority actions within the framework of adaptation projects.

Sector	Suggested adaptation measures	Applicability over the short, medium or long term	% of participants giving priority to this action
1. SLM – Sustainable Land Management			
A3	Promotion of sustainable land management (SLM) – Improving access to climate information	M	88%
	Includes:		
A1	Cultivation of early or drought-resistant varieties	S	50%
A2	Implementation of water and soil conservation techniques (stone barriers, levees, filtering levees, terraces, half-moons, agroforestry, dune stabilisation, etc.)	S	50%
A4	Practice of integrated soil fertility management	M	50%

Box 3: Uruguay's first NDC (2017) – Excerpts relevant to SOC

1. Climate change objective for the LULUCF sector

GHG	Carbon pool/ Land use categories	2030 Intended Mitigation Objectives: Carbon stock maintenance	
		Unconditional	Conditional on additional specific means of implementation
CO ₂	Soil Organic Carbon (SOC) in Grasslands, Peatlands and Croplands	Avoid CO ₂ emissions from SOC in 10% of the grasslands area	Avoid CO ₂ emissions from CO ₂ in 45% of the grasslands area
		Avoid CO ₂ emissions from SOC in 50% of the peatlands area of year 2016	Avoid CO ₂ emissions from SOC in 100% of the peatlands area of year 2016
		Avoid CO ₂ emissions from SOC in 75% of the cropland area under Plans of Soil Use and Management of year 2016, as well as CO ₂ sequestration in the remaining 25% of area	---

2. Conditional Mitigation Targets

LULUCF Sector (relative to paragraphs 12 and 16 of the PNCC)

- Protection of 100% of the peatland area by 2025 (8,366 ha).
- Adoption of good practices of natural grasslands management in livestock production in 3,000,000 ha (30% of grasslands), thus avoiding the loss of soil organic carbon, and favoring carbon sequestration towards 2025.*

Croplands: An objective is presented for soil organic carbon: virtually all (98%) the agricultural area of cereals and oilseeds in the country is under Land-Use and Management Plans, required by law from 2013. These plans are based on the use of soil by its capacity for use. In average terms, this resulted in 90% of agriculture activities being performed through no-till farming, no bare soils remaining (without stubble), mainly in winter, as winter, cover and services crops cover 98% of the soybean area. There has been an estimated 30% increase in the yearly area planted with summer C4 grasses (sorghum and maize) or that goes to the pastures cycle. These management practices minimize losses and/or increase soil organic carbon stocks. In this sense, it is set that soil organic carbon is to be preserved in 75% of the croplands area and, conservatively, that organic carbon in the soil will be sequestered in 25% of the area under crop – sown pastures rotations at an estimated rate of 0.2 ton/ha/year in the soils.

3. Unconditional Mitigation Targets

Main mitigation measures being implemented and to be implemented to contribute to achieving the unconditional mitigation objectives included in Uruguay's NDC.

Agriculture Sector: other activities

- Introduction of intermittent irrigation technology with alternate wetting and drying (AWD) of soils in at least 10% of the rice crop area (16,000 ha) by 2025.

LULUCF Sector (relative to paragraphs 12 and 16 of the PNCC)

- Protection of at least 50% of the peatland area by 2025 (4,183 ha).
- Implementation of no-till farming, with grain crop rotations, cover crops, and inclusion of C4 grasses, under Plans for Soil Use and Management, in 95% of the agricultural area by 2025.*
- Implementation of service crops (covers) installed in soybean pre-harvest in 600,000 ha by 2025.*
- Adoption of good practices of natural grassland management in livestock production in 1,000,000 ha (10% of grasslands), thus avoiding the loss of soil organic carbon, and favouring carbon sequestration towards 2025.*

* also have effects on adaptation

Addressing SOC in future NDCs, along with associated targets would require:

- Practical MRV systems that are cost-effective to better quantify and monitor changes in SOC.
- Identification of measures and practices that:
 - Are scientifically documented to protect or sequester SOC within the national context.
 - Provide economic benefits that would be more attractive to farmers and other land users.
- Developing indicators for the assessment and reporting progress of mitigation and adaptation efforts related to SOC.
- Ensuring that the national GHG inventory has the capacity to incorporate and recognize SOC activity data and indicators.
- Improving national and sub-national statistical systems and ensuring targeted investigation of SOC-relevant indicators.
- Considering sectors and practices that can be controlled or regulated to ensure implementation of measures to reach SOC targets.
- Supporting farmers through financial, technological and other support mechanisms.
- Identifying barriers to implementation to adjust targets accordingly and find appropriate solutions.

Increased collaboration between experienced countries and those requesting support is needed to rapidly enhance capacities for specification of SOC in the NDCs. Countries opting to include SOC in their second NDCs will support the goals of increased ambition and clarity of the Paris Agreement. In doing so, they may also unlock opportunities through platforms like the UNFCCC's "Koronivia Joint Work on Agriculture," for mutual learning to enhance technical support, build relevant national capacities and enhance national actions on SOC.

Further reading

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