AUDA-NEPAD
AFRICAN UNION DEVELOPMENT AGENCY

Soil health – critical to addressing climate change and realising Africa's agricultural potential

Guidance note - February 2024

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About AUDA-NEPAD

The African Union (AU) Development Agency-NEPAD (AUDA-NEPAD) is Africa's first-ever continental technical and development agency. The foundation of AUDA-NEPAD is built on the New Partnership for Africa's Development (NEPAD) that was established as Africa's continental renewal and development programme by the AU in 2001 and championed through the then NEPAD Secretariat, based in Midrand, South Africa. The NEPAD vision represented a common pledge by African leaders to eradicate poverty and foster Africa's sustainable economic growth and development through the promotion of regional and continental integration, through the inclusion of Africa in global processes and through the empowerment of socially disadvantaged groups, such as women and children.

About AICCRA

The Accelerating Impacts of CGIAR Climate Research for Africa (AICCRA) project contributes to the construction of an African future that is climate-smart and driven by science and innovation in the agricultural field. It is led by Alliance of Bioversity International and CIAT and supported by a grant from the World Bank's International Development Association (IDA).

AICCRA works to increase access to climate-smart agriculture (CSA) technologies for millions of smallholder farmers across Africa. When farmers have improved access to technology and advisory services they can plan for climate-related events, thereby safeguarding their livelihoods and ensuring food security. However, women farmers and other marginalised groups, do not access the climate information and climate-smart technology and practices to the same extent as men due to entry, structural and systemic barriers. To address this disparity, AICCRA adopts a socially inclusive and gender-transformative approach, working to understand the power dynamics and social contexts that influence the scaling of CSA and climate information services (CIS). Explore AICCRA's work at aiccra.cgiar.org.

The main objective of CA4SH is to improve global soil health by addressing critical implementation, monitoring, policy, and public-private investment barriers that constrain farmers from adopting and scaling out healthy soil practices.

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Key messages

- Land degradation affects more than three quarters of Africa's cultivated land, impacting food production and contributing to climate change.
- Climate change contributes to the degradation of Africa's agricultural soils by intensifying the hydrological cycle and increasing soil erosion.
- Improving soil health by increasing soil organic carbon offers multiple co-benefits at different levels by contributing to climate change mitigation, increasing the resilience of agricultural ecosystems to climate change and enhancing agricultural productivity.
- Sustainable soil management practices promoted in land management approaches such as nature-based solutions, agroecology, climate-smart agriculture and regenerative agriculture offer solutions to Africa's climate-soil health-food crisis.
- Recommendations for scaling up soil health action in Africa include integrating soil into policy, enhancing soil research and monitoring, increasing farmers' adoption of sustainable soil management practices that are inclusive and evidence-based, and increasing finance and investments for soil health.

Africa's soil health challenge

Soil health forms the foundation of food systems providing critical ecosystem services such as land productivity, nutrient cycling, and carbon sequestration. Healthy soils enhance food and nutrition security, improve rural livelihoods, and contribute to climate change mitigation and adaptation goals. Despite these benefits, land degradation affects 46% of Africa's land area, this impacts at least 485 million (65%) people and translates to an annual cost of USD9.3 billion[1]. Further, estimates show that 75% to 80% of the continent's cultivated area is reportedly degraded, with a loss of 30kg to 60 kg of nutrients per hectare per annum.

Unsustainable agricultural practices, urban infrastructure, pollution, erosion, and climate change, amongst other factors, contribute to the rapid degradation of soils and desertification. Adopting sustainable soil management practices and preventing land degradation is key to realising the full potential of Africa's soils to meet the growing demand for food, adequate and clean water supply, carbon sequestration, biodiversity protection and improved resilience to climate change[2].

As healthy soils enhance resilience to climate change, sustainable soil management is a focal area for advancing the 2030 Agenda for Sustainable

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[1] AGNES. 2020. Land degradation and climate change in Africa. Policy brief no. 2.
[2] UNFCCC. 2017. Healthy soils are a key component of climate action. United Nations Framework Convention on Climate Change.

Development and the Paris Climate Change Agreement. Heavily impacted by climate change, African countries are increasingly aware of the urgency to address soil health. Additionally, there is consensus that increasing fertilizer use alone will not close the continent's agricultural productivity gap. To address these challenges, the African Union has called for an African Fertilizer and Soil Health Summit proposed to be held in March 2024. The heightened political attention on restoring soil health as a basis for productive and resilient food systems presents an opportunity to urgently drive policy, innovation, practices, and investments that are required to rebuild Africa's soils.

BOX 1: Key terms

Soil health – refers to the condition of the soil and its potential to support biological functioning, maintain environmental quality, and sustain plant and animal health. Healthy soils function as a living system, contributing to climate change mitigation by acting as a carbon sink[3].

Land degradation - Land degradation is the result of human-induced actions which exploit land, causing its utility, biodiversity, soil fertility, and overall health to decline[4]. It means a loss of economic productivity of rainfed cropland, irrigated cropland, or range, pasture, forest and woodlands due to human land use activities and associated processes such as soil erosion caused by wind and/or water; deterioration of the physical, chemical and biological or economic properties of soil; and long-term loss of natural vegetation[5].

Desertification - is land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities[5].

Climate change adaptation – is the changes in processes, practices and structures to minimise possible damages or benefit from opportunities associated with climate change[6].

Climate change mitigation – involves attempts to minimise carbon emissions and boost carbon sinks[7].

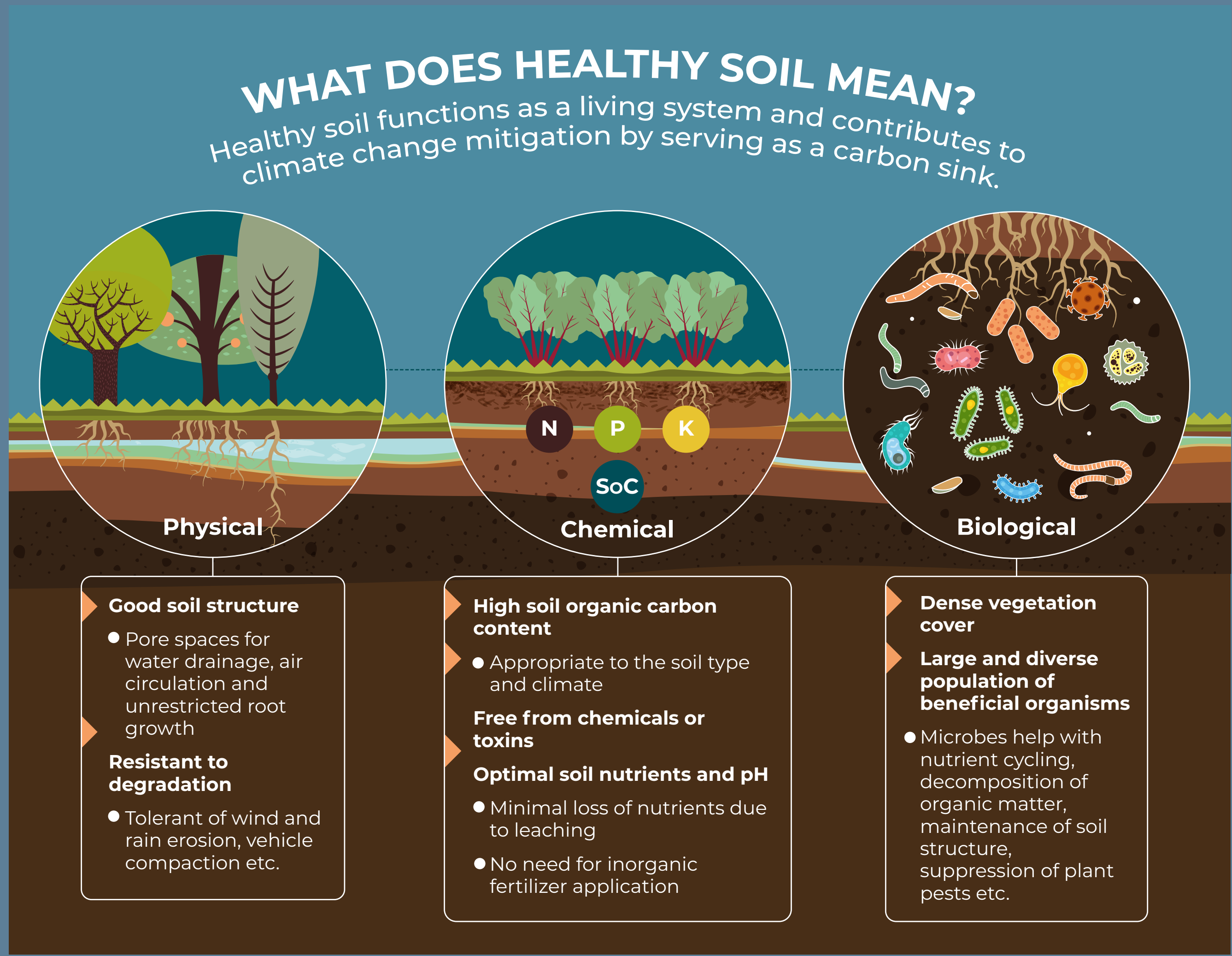
Sustainable soil management – soil management that ensures that the supporting, provisioning, regulating, and cultural services provided by soils are maintained or improved[8].

[3] CA4SH. 2023a. Why achieving soil health is so critical. Flyer. Coalition of Action for Soil Health.
[4] UNCCD. n.d. Land degradation neutrality. United Nations Convention to Combat Desertification.
[5] UNCCD. 1994. United Nations Convention to Combat Desertification in Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa. United Nations Convention to Combat Desertification.
[6] UNFCCC. n.d. Adaptation and resilience. United Nations Framework Convention on Climate Change.
[7] UNFCCC. n.d. Introduction to mitigation. United Nations Framework Convention on Climate Change.
[8] FAO. 2015. Revised World Soil Charter. Food and Agriculture Organization of the United Nations. Rome, Italy.

What is 'healthy soil'?

Soil health is the ability of soil to sustain the productivity, diversity, and environmental services of terrestrial ecosystems[9]. Healthy soil functions as a living system and contributes to climate change mitigation by acting as a carbon sink[10].

Soil health encompasses the physical, biological, and chemical properties of soil. The chemical properties of soil can be improved by reducing nutrient deficiencies, the accumulation of pesticide residues, and by increasing the soil organic carbon (SOC) content[11]. Organic carbon content is a key criterion for evaluating soil health. The physical health of soils, its structure and resistance to erosion or compaction, is determined by meteorological factors (e.g. precipitation and wind), the state of soil moisture, and activities such as tillage, the type of cropping system, the application of organic fertilizers and vegetation cover[11]. Healthy soil contains a large and diverse population of soil fauna comprising bacteria, fungi, and invertebrates such as earthworms, mites, collembolans, and nematodes. These organisms assist with nutrient cycling, the decomposition of organic matter and the maintenance of soil structure, amongst other benefits.



[9] ITPS. 2020. Towards a definition of soil health. Intergovernmental Technical Panel on Soils. Soil Letters.
[10] CA4SH. 2022. What does healthy soil mean? Coalition of Action for Soil Health.
[11] Radulov I. and Berbecea A. 2023. Role of soil health in mitigating climate change. In. Kumar V. 2023. Global Warming - A Concerning Component of Climate Change.

The soil health – climate – agriculture nexus

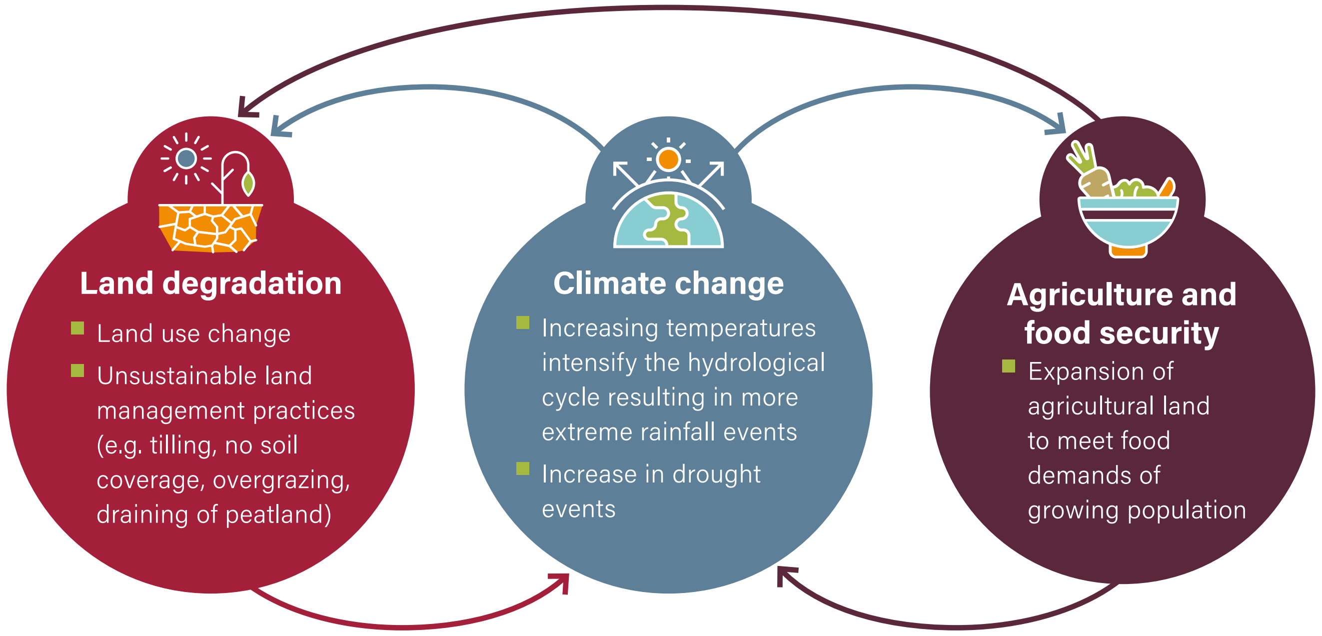
The world's soils contain approximately 2,400 - 2,500 Gt of carbon[12,13]. This is more than three-fold the amount of carbon in the atmosphere, and four times the quantity stored in all living plants and animals. Africa's SOC stocks are estimated between 133 - 184 Gt for the 0–100 cm soil layer (5% to 7% of the global SOC stock) but vary considerably according to the ecoregion[13].

Poor land management practices such as unsustainable agricultural activities release soil carbon into the atmosphere in the form of carbon dioxide, thereby contributing to climate change[14]. In addition to carbon dioxide, crop cultivation and animal husbandry are a key source of nitrous oxide, contributing around 25% of global nitrous oxide emissions[11]. Examples of unsustainable agricultural practices which release soil carbon include tilling, removing crop residue, land clearing/deforestation, overgrazing, and the draining of peatland.

Climate change is also a driver of land degradation through changes in temperature, increases in rainfall intensity and windstorms and an increase in extreme weather events such as droughts. Changes in the hydrological cycle affect vegetation cover and composition and can lead to the erosion of agricultural soils[1].

Due to Africa's increasing demographic pressure and an associated rising demand for food, large areas of grassland and forest have been cleared for cultivation. This has led to a decline in SOC, mainly due to topsoil erosion and low carbon inputs. For example, it is estimated that SOC in croplands in Southern Africa has declined by 25% to 53%[15]. As land management practices can enhance the emission or storage of carbon in soils, they present both a climate-related challenge and opportunity.

Figure 1: Relationships between land degradation, climate change and agriculture[1]



[12] Cho R. 2018. Can soil help combat climate change? Columbia Climate School.

[13] Corbeels M, Cardinael R, Naudin K, Guibert H, Torquebiau E. 2019. The 4 per 1000 goal and soil carbon storage under agroforestry and conservation agriculture systems in sub-Saharan Africa. Soil and Tillage Research, Vol. 188, Pages 16-26, ISSN 0167-1987.

[14] FAO. 2016. Soils, land and water for climate change adaptation and mitigation. Food and Agriculture Organization of the United Nations. Rome, Italy.

[15] Swanepoel CM, van der Laan M. Weepener HL. Du Preez CC. Annandale JG. 2016. Review and meta-analysis of organic matter dynamics in cultivated soils in southern Africa.

Healthy soils are therefore essential to reducing greenhouse gas (GHG) emissions and building resilience to climate change by maintaining or increasing their carbon content[2]. Sustainable soil management practices that increase SOC deliver co-benefits at multiple levels by contributing to climate change mitigation whilst also maintaining soil-supported ecosystem services, and thereby increasing the resilience of agricultural ecosystems to climate change and other stressors[16]. Healthy soils also contribute to increased agricultural production and more nutritious foods through the supply of essential nutrients, water, oxygen and root support. Further, healthy soils protect plant roots from extreme changes in temperature and enable water drainage thereby reducing the potential for waterlogging.

BOX 2: Benefits of SOC in enhancing farmers' resilience to climate change

Carbon sequestration takes place when plants absorb carbon dioxide during photosynthesis and convert it into organic carbon compounds. These compounds are then released into the soil through the plants' roots and decaying plant material. The soil organic matter provides a carbon sink, retaining the carbon for lengthy periods. Soil microorganisms break down the organic matter and convert it into more stable forms of carbon.

High levels of SOC increase farmers' resilience to climate change as the soils[11]:

- Can store up to 10 times their weight in water;
- Provide a good food source for soil microorganisms (e.g. bacteria and fungi) that improve soil structure;
- Provide habitat for macrofauna (e.g. earthworms), which increase the porosity of soil and thereby enhance water drainage into the soil profile; and
- Have good drainage and so are less susceptible to soil erosion.

Sustainable soil management practices

Climate change will further increase the vulnerability of African agricultural systems, challenging farmers to adopt strategies to reduce climate and weather-related risks. There are a suite of agricultural land management approaches that promote sustainable soil management practices which farmers and other land users can adopt to enhance their resilience.

These practices typically involve action in one or more of the following areas[17]:

- Minimising soil disturbance;
- Maximising soil cover;
- Enhancing biodiversity; and
- Ensuring the continuous presence of living roots.

[16] FAO. 2017. Climate-smart agriculture sourcebook summary. Second edition. Food and Agriculture Organization of the United Nations. Rome, Italy.

[17] USDA. 2019. Applying soil health management systems to reduce climate and weather risks in the Northwest. FactSheet. United States Department of Agriculture.

Some examples of land management approaches which integrate sustainable soil management practices include:

- **Nature-based solutions** – refer to a set of actions or policies that harness the power of nature to tackle societal challenges such as soil degradation and climate change[18]. Examples of nature-based solutions for soil health in the agricultural sector include the efficient use and re-use of organic matter, nutrients and water; reduced use of chemicals and integrated pest management; the protection of soil structure through reduced tillage and animal management; improved soil coverage; and crop diversification.
- **Ecosystem-based adaptation (EbA)** – is a type of nature-based solution. It is the "sustainable management, conservation and restoration of ecosystems, as part of an overall adaptation strategy that takes into account the multiple social, economic, and cultural co-benefits for local communities"[19]. EbA practices in agriculture involve the conservation of biodiversity and enhancement of ecosystem processes and services, such as nutrient cycling, soil formation, water infiltration and carbon sequestration. Examples of practices include agroforestry or silvopastoral systems, mulching, and cover crops[20].

Table 1: Ecosystem-based adaptation practices for enhanced soil health and climate resilience[21]

Climate change impacts	EbA practices for healthy soils
Water stress, drought, higher temperatures, increased evapotranspiration	Improve the water storage capacity of soils through enhancing soil organic matter.
	Integrate trees and shrubs for nitrogen fixation and green fertilizer cuttings (e.g. agroforestry and agrosilvopastoralism).
Intense storms and flooding	Enhance species diversity for resilience (e.g. intercropping and agroforestry).
	Maintain organic matter, use cover crops and avoid the use of heavy machinery to prevent soil compaction, thereby ensuring infiltration and water-storage capacity.
Erosion and landslides	Maintain vegetation on slopes, ensuring deep and shallow root systems to hold soil in place.
	Practice contour planting with planted strips.
	Avoid disturbing soil in unstable areas with equipment or livestock.
	Practice no-till farming and use cover crops to prevent erosion or hardpans and restore soil biodiversity.
	Use rotational grazing and farming for root development and more resilient foliage and soils.
Pests and disease outbreaks	Use integrated pest management.
	Diversify and integrate crops, trees and livestock (e.g. agrosilvopastoral systems) to reduce the likelihood of outbreaks.

[18] WWF. 2020. What are nature-based solutions and how can they help address the climate crisis? World Wildlife Fund.

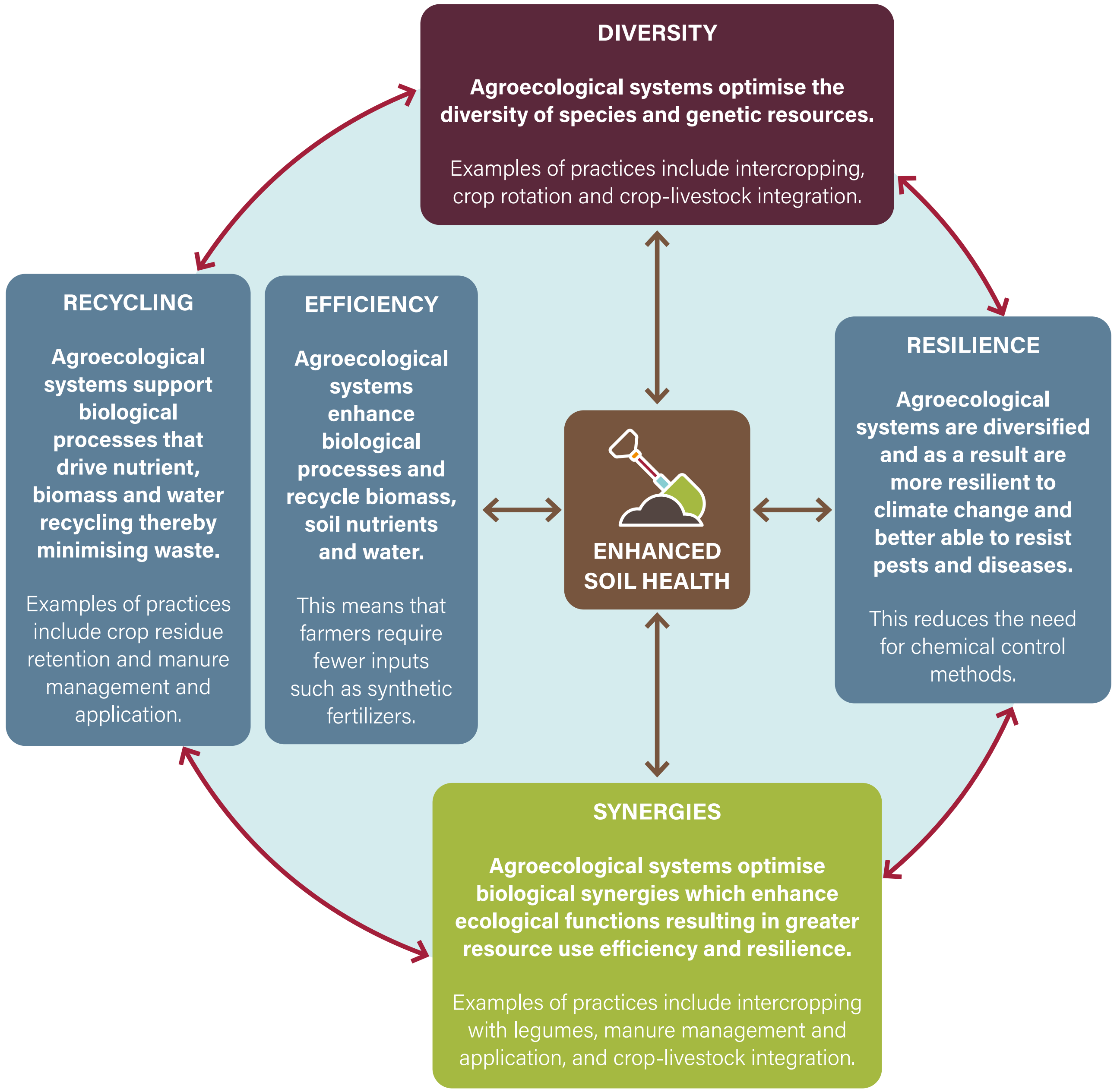
[19] CBD. 2010. Conference of the Parties to the Convention on Biological Diversity, Tenth meeting Nagoya, Japan, 18–19 October 2010. Agenda item 5.4. Secretariat of the Convention on Biological Diversity. Montreal, Canada.

[20] Vignola R, Harvey CA, Bautista-Solis P, Avelino J, Rapidel B, Donatti C, Martinez R. 2015. Ecosystem-based adaptation for smallholder farmers: Definitions, opportunities and constraints. Agriculture, Ecosystems and Environment. 211: 126-132.

[21] SUNEP. 2022. Ecosystem-based Adaptation in Agriculture: A Path to Climate-resilient Food Systems. Nairobi. United Nations Environment Programme.

Agroecology – involves understanding ecological processes and applying the concepts to the design and management of agricultural production systems. System diversity, recycling, efficiency, synergies and resilience are core elements of the approach that relate to soil health[22]. A key principle of the practice is to maintain or improve soil health and functioning for plant growth, with a focus on managing organic matter and soil biodiversity[23]. Examples of practices include agroforestry, intercropping, crop rotations, crop-livestock integration and crop residue retention.

Figure 2: Agroecology elements and practices which contribute to enhanced soil health[22]

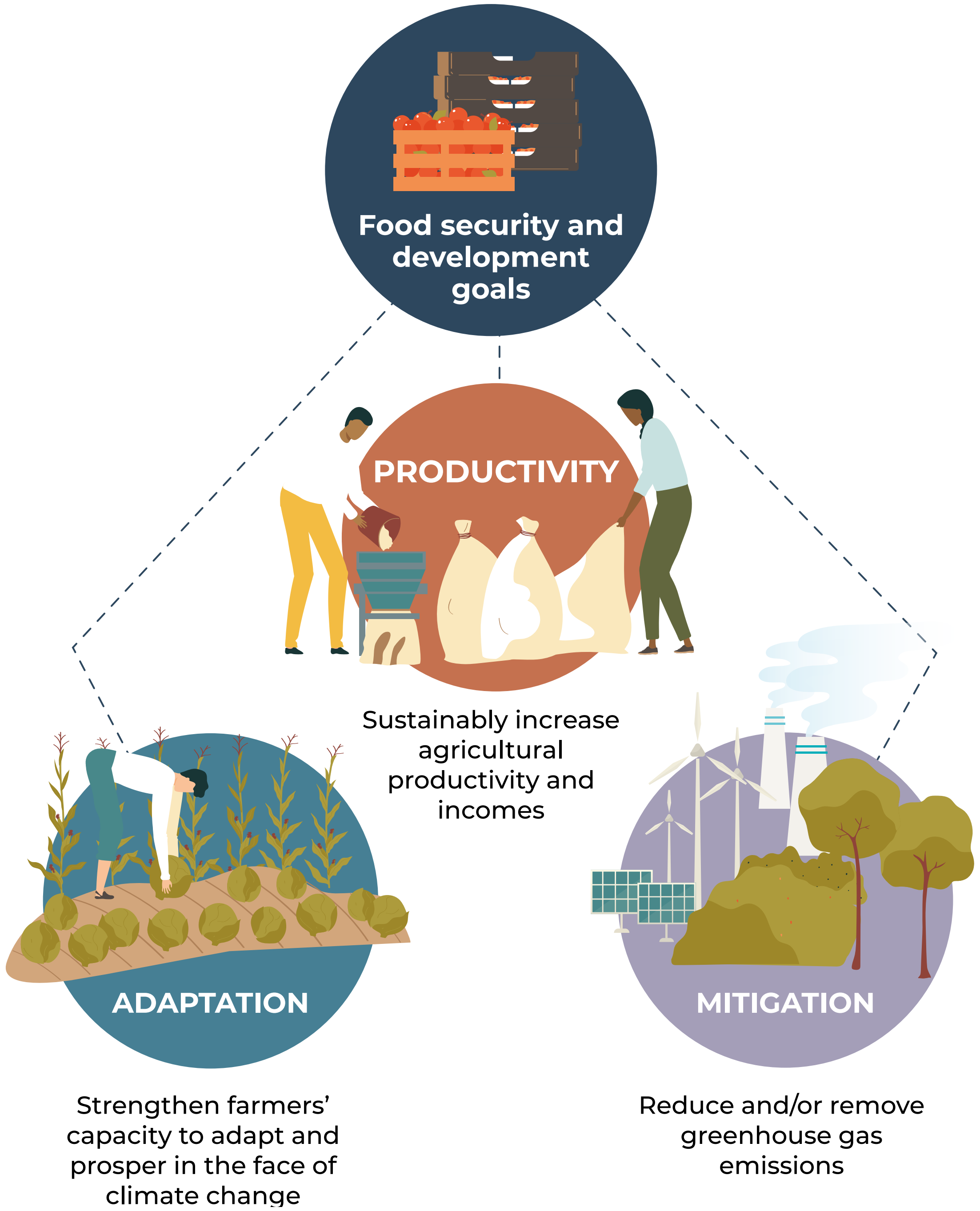


[22] FAO. 2018. The 10 elements of agroecology. Guiding the transition to sustainable food and agricultural systems. Food and Agriculture Organization of the United Nations. Rome, Italy.

[23] European Commission. 2019. Agroecology. Information brief. The European Commission's Knowledge Centre for Global Food and Nutrition Security.

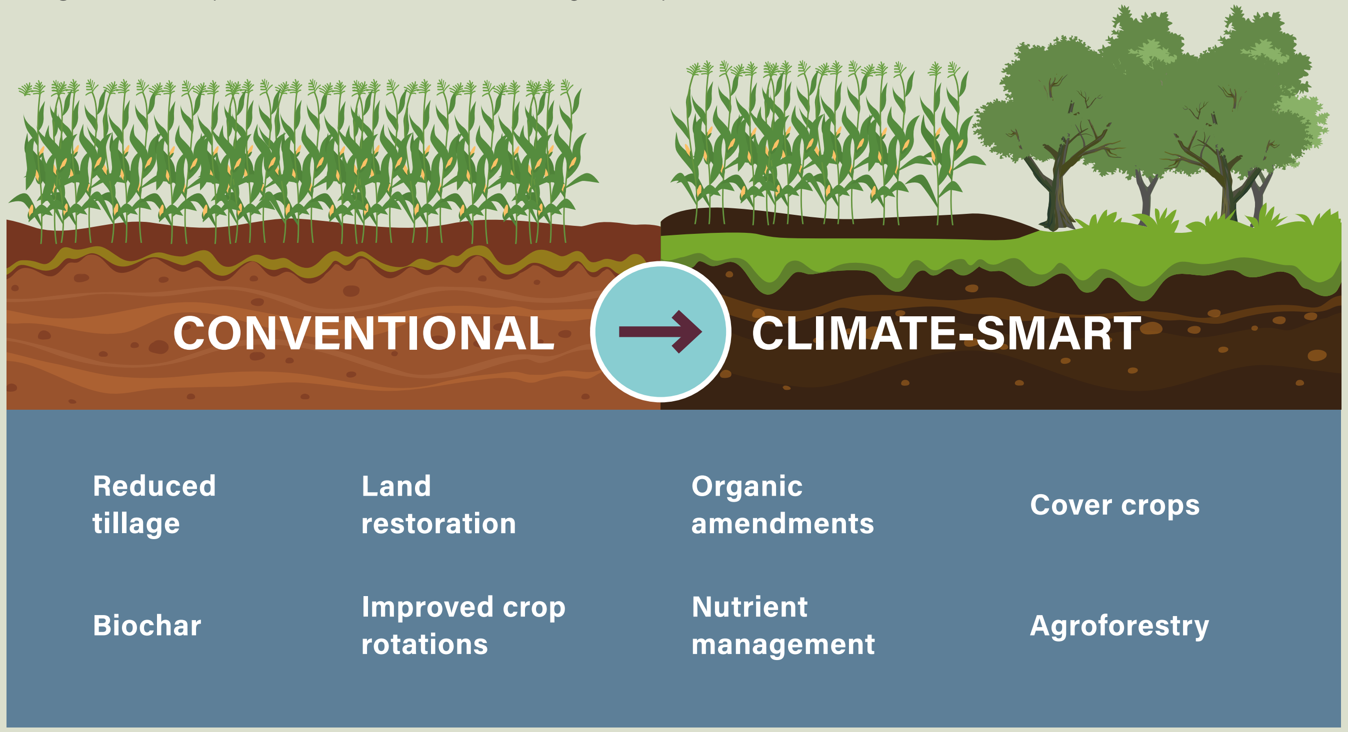
Climate-smart agriculture (CSA) – refers to agricultural land management strategies with the triple objectives of sustainably increasing agricultural productivity, enhancing resilience to climate change and reducing GHG emissions. Examples of CSA practices promoted in Africa include conservation agriculture (reduced tillage, cover cropping/mulching, and crop rotation/intercropping), soil and water conservation (contour planting, terraces and bunds, planting pits, and irrigation), agroforestry, application of organic and inorganic fertilizers, and the use of improved seeds[24]. Many of the CSA interventions are aimed at improving soil water retention through increasing SOC.

Figure 3: Three pillars of Climate-Smart Agriculture



[24] Dougill A. 2022. Starting from the soil: Climate-Smart Agriculture as Route to Building Climate Resilience in African Food Systems. GCRF AFRICAP.

Figure 4: Examples of climate-smart soil management practices



BUILDING SOIL HEALTH IS A KEY OUTCOME OF CLIMATE-SMART AGRICULTURE[25]

Many climate-smart agriculture practices contribute to improved soil health. Maintaining or enhancing soil health is essential for sustainable and productive agriculture.

Agroforestry is the interaction of agriculture and trees, including the agricultural use of trees. It involves the planting of trees or shrubs in or around farmland or pastureland.

- Increases soil organic carbon
- Improves soil nutrient availability and fertility
- Enhances soil microbial dynamics
- Reduces soil erosion

Limits mechanical soil disturbance (i.e. no/zero tillage), maintains permanent soil organic cover (at least 30%) with crop residues and/or cover crops, and encourages the establishment of diverse plant species through varied crop sequences and associations involving at least three different crop species.

- Increases soil organic carbon
- Reduces soil erosion
- Conserves in-soil water
- Improves soil structure, and thus the rooting zone
- Suppresses weed growth
- Protects soil from extreme weather damage

Is the successive alternation of subsistence, cash or green manure/cover crops on the same field following a set sequence.

- Restores soil fertility
- Reduces soil erosion
- Recycles plant nutrients in the soil
- Prevents soil crusting
- Conserves in-soil water

Includes the optimal handling of livestock manure involving its collection, storage, treatment and application.

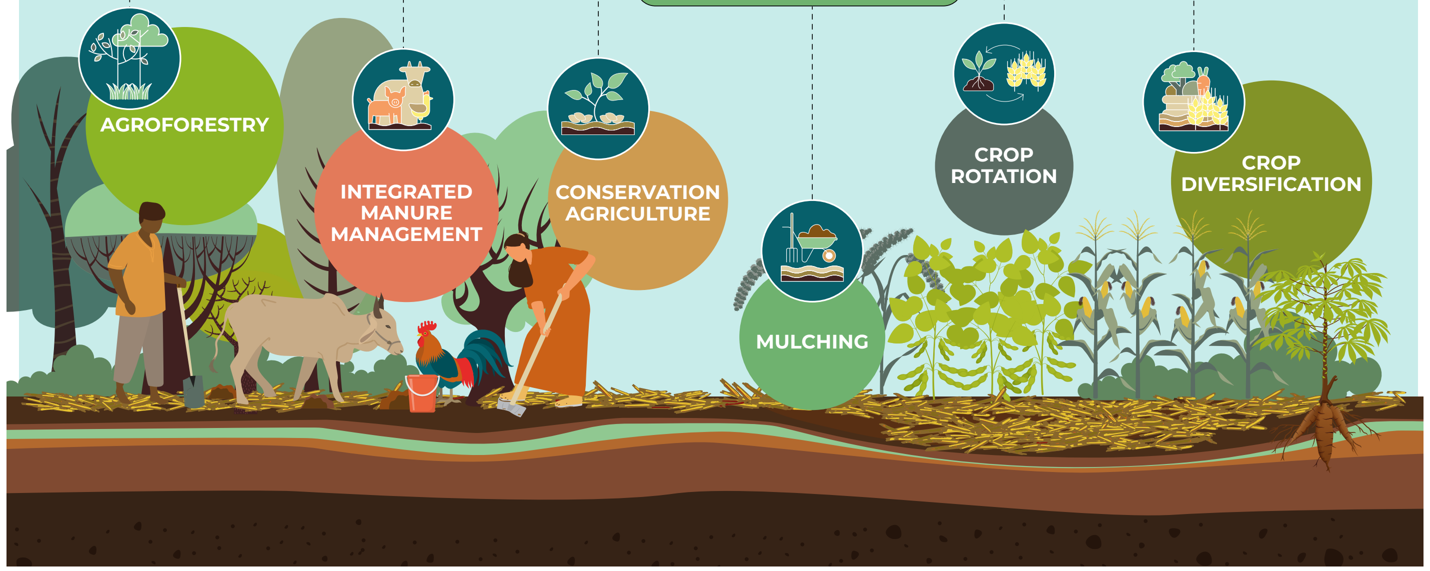
- Restores soil fertility
- Reduces soil erosion
- Reduces nutrient leaching
- Enhances the resilience of soil to climate change
- Increases soil organic carbon

Involves covering the topsoil with plant material such as leaves, grass, twigs, crop residues, straw etc.

- Enhances the activity of soil organisms
- Improves soil structure contributing to aeration and water infiltration
- Conserves in-soil water
- Increases soil organic carbon
- Reduces soil erosion

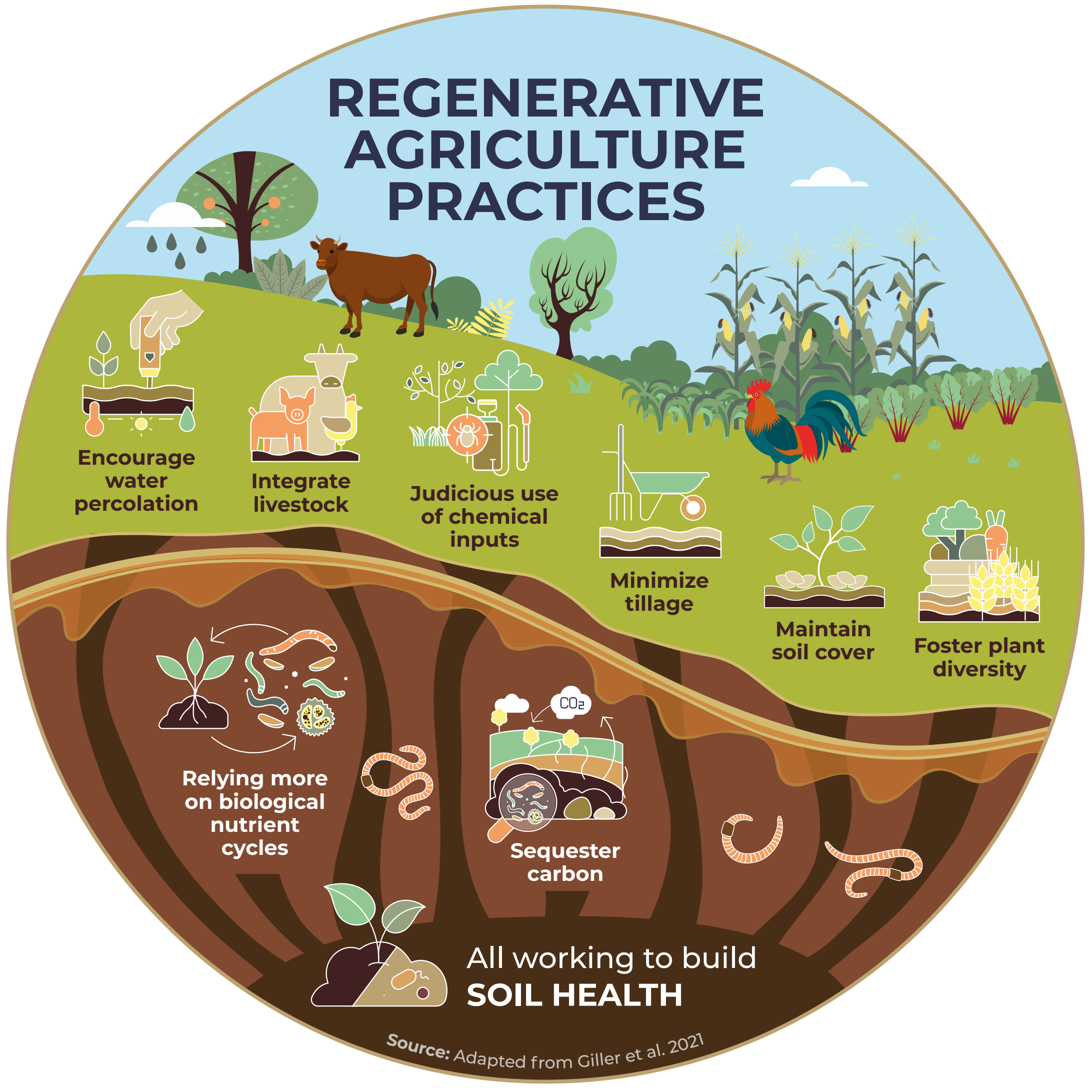
Involves cultivating at least two varieties of crops that belong to the same or different species in a given area in a form of mixed cropping or monocropping.

- Conserves in-soil water
- Increases soil organic carbon
- Reduces soil erosion
- Improves soil nutrient availability and fertility
- Enhances soil microbial dynamics



[25] https://www.coalitionforsoilhealth.org.

Regenerative agriculture – is a holistic approach to farming that focuses on enhancing soil fertility, carbon content, and nutrient availability as well as ensuring the integration of beneficial insects, birds, and other animals into the agricultural system[26].



Scaling up action on soil health

Healthy soils can make an essential contribution to combating climate change and food insecurity in Africa. It is a critical time for multi-stakeholder action to build an enabling environment for supporting, financing, scaling and monitoring healthy soil ecosystems. Strengthening the science-policy-society interface and investing in knowledge-based solutions will be key. Recommendations for scaling up soil health action include integrating soil into policy, expanding research and monitoring, increasing farmers' adoption of sustainable soil practices that are inclusive and evidence-based, and increasing finance and investments for soil health.

[26] Mishra AK, Pavithra P, Sahoo MR, Sharma S. 2023. Bridging the gap between traditional and regenerative agriculture with the agro-biodiversity index. Rice Today. International Rice Research Institute (IRRI).

Recommendations for integrating soil health into policy

- Determine opportunities and entry points for integrating soil health into policy.
- Ensure soil health is prioritised within the climate agenda, Nationally Determined Contributions (NDCs) and Land Degradation Neutrality (LDN) goals.
- Establish a clear roadmap for action on soil health within both global and national level policy frameworks.
- Integrate soil health into broader strategies for addressing the interlinked challenges of climate change, biodiversity loss, poverty and food security.
- Policy needs to promote agricultural production that yields nutritious, high-quality foods cultivated with minimal chemical and synthetic inputs.
- Countries should build national teams to address the inclusion of SOC in their NDCs, this will increase the resilience of these systems into the future[27].
- Subsidise sustainable land management approaches such as agroecology in the long term and anchor them in policy[28].

INTEGRATING SOIL ORGANIC CARBON INTO NATIONAL LEVEL POLICY

The Accelerating Impacts of CGIAR Climate Research for Africa (AICCRA) project interviewed several key informants from the project's target countries (Ethiopia, Kenya, Ghana, Mali, Senegal and Zambia) involved in the NDC process. Opportunities for the inclusion of SOC into the countries' NDCs were identified as a key step for governments to support farmers in investing in their soils. Some of the key findings and recommendations are outlined below.

Zambia[29]

- Zambia's first NDC included SOC, but it was excluded from the subsequent two versions. However, the three NDCs developed to date are complementary and are all taken into consideration during the development of any policies, strategies and programmes that are climate related.
- Although efforts have been made to understand the health of soils in Zambia, the most recent comprehensive soils map provided by the Government was completed in 1991.
- There is need for external technical and financial support particularly for evaluating progress on targets, developing of monitoring, reporting and verification (MRV), and measuring of trends and patterns at the farm and catchment level.

[27] Wiese-Rozanov LW. 2023. In: Policy Roundtable: Integrating Soil Organic Carbon into the Nationally Determined Contributions. Blog. Coalition of Action 4 Soil Health (CA4SH).

[28] Chotte JL, Barot S, Blanchart E, Blanfort V, Brauman A, Cardinael R, Chevallier T, Demenois J, Lardy L, Luu P, Masse D, Trap J, Wadoux AMJC. 2023. Healthy soils sustain food system transformations to contribute to the net zero CO2 emission target by 2050. Policy brief. Coalition of Action 4 Soil Health (CA4SH).

[29] Masikati P, Mwanza M, Aynekulu E, Vagen TG, Winowiecki LA. 2022. Including soil organic carbon into nationally determined contributions: Insights from Zambia. AICCRA Policy Brief. Accelerating Impacts of CGIAR Climate Research for Africa (AICCRA).

Kenya[30]

SOC has not been included in Kenya's NDCs and the following needs to be addressed:

- Lack of enabling conditions such as institutional, financial, technical, and physical capacities to address NDC implementation gaps and MRV of SOC at the national and county levels.
- Lack of SOC data and evidence on the impact of sustainable land management practices on SOC sequestration and storage.
- Lack of standard metrics and methods that can be used to measure the role of SOC in climate change adaption.
- Lack of adequate resources, including time and funding for an in-depth situational analysis on the role of SOC in NDCs, during the NDC target setting processes.

Ethiopia[31]

- SOC was included as part of the updated NDC, but the level of contribution of SOC in the NDC target is unclear, and no institution has been tasked with monitoring SOC.
- There is a need to:
  - Broaden stakeholder participation in the NDC planning, implementation and updating process;
  - Strengthen institutional capacity in MRV of SOC as well as technical and financial skills;
  - Promote CSA and tree-based landscape restoration practices to enhance SOC contribution to NDC targets;
  - Foster nationally coordinated and well-equipped soil research (central data repository system) to improve MRV of SOC as part of NDC progress tracking.

Mali[32]

- Soil health and SOC were not included in Mali's NDC framework, but there is a mention of the role of soil health for adaptation measures.
- There is a need for research to better understand the impact of land management on SOC.
- Support is needed to:
  - Increase collaboration between countries with experience in managing SOC and countries needing support to develop SOC related targets, policies, and measures; and
  - Enhance collaboration between research institutions with expertise in soil health and land degradation surveillance and the agriculture, forestry, and land use sectors.

[30] Aynekulu E, Vagen TG, Winowiecki LA. 2022. Including soil organic carbon into nationally determined contributions: Insights from Kenya. AICCRA Policy Brief. Accelerating Impacts of CGIAR Climate Research for Africa (AICCRA).

[31] Wolde-Meskel E, Amanu T, Aynekulu E and Winowiecki L. 2022. Integrating soil organic carbon (SOC) into the Nationally Determined Contribution (NDC) of Ethiopia. AICCRA policy brief. Accelerating Impacts of CGIAR Climate Research for Africa (AICCRA).

[32] Kapoury S, Arinloye D, Aynekulu E, Vagen T-G and Winowiecki L. 2022. Integrating soil organic carbon (SOC) into the Nationally Determined Contribution (NDC) of Mali. AICCRA policy brief. Accelerating Impacts of CGIAR Climate Research for Africa (AICCRA).

Senegal[33]

- There is no formal integration of SOC into the country's current NDC.
- Technical support is needed to fully consider soil health in the NDC planning process (i.e. monitoring protocols, laboratory analysis, knowledge sharing, financial and institutional capacity building).
- Need to conduct applied research on soil health and SOC in relation to agricultural soil productivity.
- Need to strengthen existing efforts on the carbon sequestration and carbon stocks monitoring system and to establish it at a national scale.

Ghana[34]

- SOC is not clearly indicated in the NDC but indirectly referred to in the sustainable land management, forestry and landscape restoration projects.
- There is a need for technical capacity building to enable the operationalisation the NDCs at national regional and local levels.
- Financial support is required for training a network of national experts on the role of SOC in climate change adaptation and mitigation.
- There is a need for applied research targeting soil health and SOC for food security and resilience, but also for evidence on the impacts of NDCs measures on soil conditions for climate change adaptation and mitigation. Policy-relevant information and data from the research could improve the integration of SOC into future NDC target setting.

Recommendations for soil health monitoring and research

- Affirm SOC as an indicator of soil health, ensure it is central to soil restoration interventions, and communicate its importance to farmers[35].
- Undertake MRV to understand the financial needs and to report on and verify the application of sustainable soil management practices[28].
- Develop soil health metrics and associated MRV tools by engaging with relevant scientists, policymakers, smallholder farmers and other stakeholders[28].
- Develop methodologies, indicators, and metrics to successfully communicate the concept of soil health to a wide audience.
- Identify and address data and research gaps.
- Incorporate foresight planning as part of the decision-making process to take into account uncertainty.

[33] Chabi A, Arinloye DA, Vagen TG, Aynekulu E, Winowiecki LA. 2022. Including soil organic carbon into nationally determined contributions: Insights from Senegal. AICCRA Policy Brief. Accelerating Impacts of CGIAR Climate Research for Africa (AICCRA).

[34] Diwediga B, Chabi A, Arinloye DA, Chesterman S, Vagen TG, Aynekulu E, Winowiecki LA. 2022. Including soil organic carbon into nationally determined contributions: Insights from Ghana. AICCRA Policy Brief. Accelerating Impacts of CGIAR Climate Research for Africa (AICCRA).

[35] Mwanza M. 2023. In: Policy Roundtable: Integrating Soil Organic Carbon into the Nationally Determined Contributions. Blog. Coalition of Action 4 Soil Health (CA4SH)

- Build the capacity of relevant institutions in monitoring and reporting on SOC.
- Generate soil health data that is measurable, accessible, comparable, and exchangeable through relevant research.
- Document and share evidence on successful (and unsuccessful) soil management practices and interventions.
- Develop supportive policy and increase investment in research to scale sustainable soil management practices.

Recommendations for stakeholder engagement, collaboration and communication

- Communicate the critical role that soil health plays in sustainable agriculture, emphasising that healthy soils are the foundation for productive and resilient food systems.
- Align public and private stakeholders to close the soil health investment gap and incentivise farmers for implementing sustainable soil management practices.
- Align producers, investors, financial institutions, policy makers and other stakeholders along value chains to address the social, economic and technical barriers experienced by farmers in adopting healthy soil practices.
- Institutional linkages should support and connect strategies and action plans with a means of implementation[36].
- Encourage collaboration amongst stakeholders including farmers, scientists, policymakers, and industry leaders, to promote knowledge sharing, innovation, and the scaling up of sustainable soil management practices.
- Engage with, guide and empower farmers to adopt improved soil practices as they have a keystone role to play as land stewards and agents of change.
- Build the capacity of smallholder farmers to adopt improved soil management practices, ensuring the provision of necessary technical and financial support.
- Co-design sustainable soil management practices and technologies that are appropriate to the local context by strengthening the multi-stakeholder arena[28].
- Build the skills of all relevant stakeholders to stimulate interdisciplinarity and multi-stakeholder dialogue[28].
- Foster public-private partnerships.
- Disseminate and scale-up sustainable soil management practices in an inclusive way.

Recommendations for finance and investments for soil health

- Promote the business case for private investment in soil health as a capital asset.
- Increase investment in research and development for healthy soil solutions.
- Establish financial incentives for the adoption of sustainable soil management practices.
- Encourage private and public sector funding to assist in scaling locally appropriate soil interventions.
- Where evidence is lacking, invest in innovative solutions for monitoring and measuring soil health.

[36] Oeba VO. 2023. In: Policy Roundtable: Integrating Soil Organic Carbon into the Nationally Determined Contributions. Blog. Coalition of Action 4 Soil Health (CA4SH).

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