WHAT WE CAN DO FOR AFRICA’S SOIL
The link between soil organic matter and soil health has been known for quite some time, however, researchers have only come to appreciate the role that soil organic carbon plays in helping regulate the climate in recent decades. Despite their significance, soils have become one of the world’s most vulnerable resources in the face of climate change, land degradation, biodiversity loss, and increased demand for food production.

In the face of increasing demands and a growing population, commercial/industrial agriculture (characterised by the increased use of synthetic chemicals and mechanisation, and the commodification of crops) has expanded across Africa. This ongoing phenomenon has depleted soils and eroded ecosystem services that help regulate agricultural production, leaving 40% of Africa’s soils low in nutrients and 25% contaminated by aluminium (Lunn-Rockliffe, et al., 2020). More concerning still is that soil organic carbon stocks in the upper soil layers (0-30cm) are especially sensitive to land use change, which is the second-largest source of human-driven carbon emissions in the world (FAO, 2017) and could lead to substantial losses of carbon from Africa’s soils.

Role players need to act urgently to manage Africa’s soils as a carbon sink if we are to avoid the disastrous consequences linked to an inefficient, unsustainable, and unjust food system. What’s more, soil health (characterised by soils rich in organic carbon and biota) forms the basis from which Sustainable Development Goals like Zero Hunger and Climate Action can be realised.

Figure 1: Nitrogen is one of the most important nutrients for soils and Africa doesn’t have enough (Zhang, et al., 2016)
A SUSTAINABLE APPROACH TO AGRICULTURE: ECOSYSTEM-BASED SOLUTIONS

Sustainable agricultural practices that maintain soil organic stocks and biodiversity represent viable strategies for restoring healthy soils. **Industrial methods of farming** predominantly prioritise high yields and are associated with **24% of greenhouse gas emissions**, **33% of global soil degradation**, and **60% of global biodiversity-loss** on land (Lunn-Rockliffe, et al., 2020). By contrast, ecosystem-based farming practices combat land degradation and desertification, enhance the resilience of agro-ecosystems to environmental shocks and contribute towards the mitigation of climate change (FAO, 2017). Over the years, several alternative, nature-based farming methods have emerged with the aim to protect, sustainably manage, and restore both modified and natural ecosystems.

**KEY APPROACHES TO ECOSYSTEM-BASED AGRICULTURAL PRACTICES**

A sustainable approach to agriculture, where practices aim to sustain and enhance soil ecosystem services while supporting society’s food and textile needs, is made up of many terms. These include “**organic farming**”, “**regenerative agriculture**”, “**agroecology**”, “**biodynamic agriculture**”, “**permaculture**”, and more. While each of these approaches may differ slightly by definition and key principles, they all refer to a suite of practical agricultural practices which can be incorporated into land management strategies to enhance soil health. In addition, each approach typically aims to address societal challenges like climate change, food security, and social justice issues, as well as improve human well-being and biodiversity (Oberč & Schnell, 2020).

We’ve listed some of the key approaches to sustainable agriculture below:

1. **Agroecology**

   Agroecology is considered one of the oldest approaches to sustainable agriculture. As a systematic, whole-farm approach, agroecology is referred to as a science, a set of farming practices, and a social movement that can be applied to farms and production types across the world. As a science and set of farming practices, agroecology aims to boost “the resilience and ecological, socio-economic and cultural sustainability of farming systems” through a holistic understanding of agro-ecosystems (Oberč & Schnell, 2020, pp. 10-11). As a social movement, agroecology promotes fair, just, and sovereign food systems. Farms that adopt agroecology typically plan for their land to accommodate for the physical limitations of the surrounding landscape, optimise the nutrients and energy in the farm system, and enhance functional biodiversity and ecosystem services. See Figure 2 for an illustration of the 10 elements of agroecology.
FAO’s Elements of Agroecology

1. Diversity
2. Co-creation and sharing of knowledge
3. Synergies
4. Efficiency
5. Recycling
6. Resilience
7. Human and social values
8. Culture and food traditions
9. Responsible governance
10. Circular and solidarity economy

Figure 2: The 10 Elements of Agroecology (adapted from FAO, 2018)
2. Permaculture

The term permaculture initially referred to “permanent agriculture” but has since evolved to stand for “permanent culture” as it address all facets of sustainability, including energy, waste and water management, construction, and more. Permaculture is thought to be more than just a set of practices, but rather a “system of design based on whole-systems thinking and informed by a set of principles that serve to help farmers mimic the patterns and relationships found in nature” (Oberč & Schnell, 2020, p.16). Based on natural systems as well as “traditional” and “modern” knowledge, permaculture is an ethical approach to producing farming solutions that sustain the earth’s biophysical systems that allow for human life on the planet (Kruger, 2015). The philosophy of permaculture is to work with nature rather than against it, and recognises farms as ecosystems made up of component parts like canopies, shrub layer, ground cover, etc. As Figure 3 illustrates, permaculture places emphasis on the value of biodiversity and attempts to create a holistic relationship between the farm and nature.

Figure 3: The principles of permaculture (adapted from https://permacultureprinciples.com/ Available under commons license).
3. Biodynamic agriculture

Biodynamic agriculture is an ecological farming system that considers farms as self-contained, self-sustaining organisms. This method is considered a holistic, ecological, and ethical approach to farming and can be applied to different production systems and terrains. Farms that adopt a biodynamic agriculture approach to their land management strictly avoid all synthetic pesticides and fertilisers and instead use “living solutions” to control pests. In addition, at least 10% of the farm is set aside to sustain the biodiversity that occurs naturally in the area. The principles of biodynamic agriculture shown in Figure 4 aim to support ecosystem services, create economic value, and sustain human development.

Figure 4 The principles of biodynamic agriculture (adapted from Change, n.d.)
4. Organic farming

Organic farming can be defined as a “production system that sustains the health of soils, ecosystems and people”. This approach relies on ecological processes, biodiversity and natural nutrient cycles, and combines tradition with science to benefit both the environment and humankind (Oberč & Schnell, 2020, p.21). Organic farming is popular particularly in the European Union and aims to produce food using natural substances and processes, and encourages a low environmental impact. The principles of organic agriculture (see Figure 5) aim to sustain and enhance the health of soil, plants, animals and humans, sustain ecological systems, build on relationships that ensure fairness, and manage farms in such a way that protects the health and well-being of future generations and the environment (Oberč & Schnell, 2020).

**THE FOUR PRINCIPLES OF ORGANIC AGRICULTURE**

**SOIL**

Organic agriculture is centered on boosting soil health.

*What are some of the benefits of healthy soil?*
- We can grow nourishing, nutrient-dense foods in it without using inputs like artificial fertilizers
- It provides us with higher crop yields in the long term

**BIODIVERSITY**

Organic agriculture seeks to maintain and boost biodiversity. Why does that matter?

*What are some of the reasons biodiversity matters?*
- Seed and crop diversity makes farms and landscapes more resilient to challenges (such as pest incursions) and change (such as global warming)
- Monoculture impacts negatively on soil health and biodiversity

**HEALTH**

Healthy soils produce healthy crops that foster the health of animals and people. Organic agriculture is intended to produce high quality, nutritious food that contributes to preventive health care and well-being.

**ECOLOGY**

All land is home to wildlife and important for ecosystem services. Organic agriculture aims for ecological balance through the design of farming systems, establishment and good maintenance of habitats and conservation of agricultural biodiversity and genetic resources.

**FAIRNESS**

Equity, respect, justice and stewardship of the shared world. Organic agriculture aims to provide good food for all and a decent living for farmers and food workers.

**CARE**

Taking care of each other and our surroundings. Organic agriculture focuses on how we can enhance efficiency and increase productivity without jeopardizing the health and well-being of people and the planet.

**LIVELIHOODS**

How can organic agriculture help create more sustainable, secure and resilient livelihoods?

*What are some of the key questions when considering sustainable livelihoods?*
- What is the difference between food security and food sovereignty?
- How can organic agriculture contribute to more secure and resilient food production?

**CLIMATE CHANGE**

How can organic agriculture contribute to addressing the climate crisis?

*Some contributions include:*
- Soil that’s cultivated organically stores more carbon than that which is cultivated for conventional agriculture
- It reduces greenhouse gas emissions by omitting the use of pesticides

*Figure 5: The 4 principles of organic agriculture* (adapted from Global Landscape Forum, n.d.)
5. Regenerative farming

Regenerative agriculture is a broad suite of principles and practices that aim not only to sustain the current state of soils and ecosystems, but rather regenerate and enhance them through agricultural activities that have a positive effect on the environment (Lunn–Rockliffe, et al., 2020; Oberč & Schnell, 2020). The concept was first coined in the 1980s based on the theory that “the world cannot be fed unless the soil is fed” (Oberč & Schnell, 2020, p.26). As such, regenerative agriculture aims to increase agricultural yields and resilience in the face of climate instability by improving the health of soils. Farmers that adopt regenerative agricultural principles (see Figure 6) aim to build healthy soils, increase water retention and minimise water runoff, increase the health and resilience of biodiversity, and shift agricultural land from a source of carbon to a carbon sink.

Figure 6: The 5 principles of regenerative agriculture (adapted from Lunn–Rockliffe, et al., 2020)
There are many benefits associated with maintaining and increasing stocks of soil organic carbon in agricultural land and maintaining living plant biomass year-round. The most obvious is that it reduces carbon emissions and removes CO$_2$ from the atmosphere. Increasing soil organic carbon stocks also improves soil health and water storage, which increases the resilience of produce to drought or extreme weather events, increases crop yields, and supports biodiversity.

There are many strategies available within the context of sustainable agriculture that may lead to increased soil organic carbon stocks. However, each of these needs to be tailored to the specific area of application as responses to these strategies will vary depending on the climate and soil type, as well as land management capacity. Typically, a practice will help maintain and increase soil organic carbon if it:

- Controls/reduces the rate of soil erosion
- Applies integrated nutrient management techniques
- Maintains ground cover
- Encourages diversified farming systems

Figure 7: Managing soil organic carbon is the key to healthy soil (Adapted from United States Department of Agriculture, n.d.)
and then repeat.

Instead follow a rotation system like this with your vegetable plots:

**CROP ROTATION**

**without intercrop**

Year 1: Legume (beans, peas)

Year 2: Leaf (spinach, lettuce, artichokes)

Year 3: Fruit (tomatoes, peppers, pumpkin)

Year 4: Root (carrots, beetroot, onion, garlic)

**with intercrop**

The practice of regularly and systematically rotating crop-types from season to season. This method reduces the rate at which nutrients are removed from the soil and lowers the need for pesticides and fungicides.

**Cover cropping**

Cover crops are grown in order to avoid leaving soils bare, or directly exposed to the atmosphere. The primary purpose of cover crops is to protect the soil against wind and water erosion and increase the nutrient content and overall carbon sequestration potential of the soil. Many cover crops also serve as animal fodder or are chopped as mulch.

**Integrated nutrient management**

Refers to the use of compost, organic manure, and nitrogen-fixing crops to reduce or eliminate the use of and dependency on chemical fertilisers.

**Integrated pest management**

Integrated pest management encompasses a wide spectrum of methods that reduce pressure from pests without the use of pesticides or herbicides. It is an ecosystem-based strategy that focuses on the long-term prevention of pests. This process reduces the farmer’s dependency on synthetic chemicals, which leads to an increase in soil biodiversity.

**Sustainable animal grazing**

The process where grazing land is rotated in a manner that soils are fertilised from manure and pastures are given time to recover after grazing. This approach increases soil fertility, improves water infiltration, reduces soil erosion, and enhances soil’s capacity to sequester carbon.

**Agroforestry**

Defined as “agriculture with trees”, agroforestry refers to land management systems in which trees are grown in combinations with crops or pasture in the same field. The carbon stored in the above- and below-ground biomass of trees can be transferred to the soil and increase soil organic carbon stocks.

**Silvopasture**

A system of grazing that integrates trees and animals in a way that is mutually beneficial. The trees protect the soil from wind and water erosion and also offer a large potential for carbon sequestration. Essentially, this is sustainable animal grazing in woodlands.
IMPLEMENTING SUSTAINABLE AGRICULTURE IN AFRICA

The economies of most countries in sub-Saharan Africa are deeply dependent on agriculture, a sector that accounts for around 55% of total employment. However, agricultural productivity and yields in the area are relatively low compared to areas such as East Asia, Latin America, and South Asia. In addition, food insecurity affects 29.3% of the population in sub-Saharan Africa, which is a stark contrast to the world average of 9.2% (UNEP, 2020). A rapidly changing climate is expected to exacerbate these challenges by decreasing crop productivity, reducing the amount of arable land for farmers, and intensifying periods of drought (McCabe, 2013).

One of the best approaches to reducing the vulnerability of smallholders (who account for 85% of the agricultural output across Africa) to the climate crisis is to improve the overall resilience of farms through sustainable agricultural practices. Thankfully, Africa has already become a global leader in sustainable agriculture where more than 900 organisations are associated with some form of sustainable agriculture (Lunn-Rockliffe, et al., 2020). What’s more, ecosystem-based principles and practices could readily be incorporated and adapted into sustainable agriculture projects going forward, as smallholders often embody aspects of these.

While external inputs and knowledge may be of value to smallholders, sustainable agriculture is more likely to be successfully implemented where the pathways to new systems of agriculture are moulded by the people that live in the landscape. For this reason, local farmers need to be empowered to undertake their own experiments and encouraged to enhance their own sustainable practices.

We’ve highlighted four examples of successful sustainable agricultural projects in Africa below.

1. The Push-Pull System promotes the planting of insect-repellent plants amongst the commercial crops and insect-attractive plants along the edge, resulting in pests being “pushed” away from valuable crops while they are simultaneously ‘pulled’ towards the edge. Insect pests which are active along the edges of productive fields are more susceptible to predation by insectivorous species. This concept was developed in western Kenya, and has since been adopted by 130,000 smallholder farmers across East Africa.

2. The Centre for No-Till Agriculture in Ghana has trained and educated farmers on the benefits of regenerative agriculture since 2012. The centre’s training material focuses on the interconnected improvements that farmers witness in their fields associated with soil conservation practices.

3. The Chololo Ecovillage in Tanzania is a participatory project that promotes sustainable agriculture in the Chololo area through the development and implementation of agroecological practices. Prior to the implementation of the project, the Chololo village faced a depleted water supply, unpredictable weather, high rates of deforestation, and severe food shortages. Today, the project has seen yield increases of up to 70%, and an 18% increase in the average household income.

4. Food and Trees for Africa offers agroecology training to communities across Africa, and has trained more than 1,500 farmers thus far. The aspects of agroecology and permaculture covered in the course work include practices such as mulching and composting as a means to build soil health, making liquid manure fertilisers, crop rotation, and sustainable bed design, among many others. This has reduced these communities’ reliance on expensive fertilisers, increased crop yields, and helped build a positive relationship between the community and their surrounding environment.
SUSTAINABLE AGRICULTURAL DESIGN IN AFRICA: A FARMER-LED APPROACH

In many cases, the “dominant development paradigms” have marginalised indigenous communities and “failed to build alternative, locally-created pathways towards prosperous futures” (Lunn-Rockliffe, et al., 2020, p. 17). This is particularly true within the context of food production, where food regimes in Africa have led to land grabbing, the privatisation of seeds, and the monopolisation of markets.

To combat this, Lunn-Rockliffe et al. (2020) recommend that future design processes be based on a system that prioritises the localised needs and concerns of farming communities. These processes need to be co-designed, and led by farmers in collaboration with NGOs, government initiatives, universities and various other entities that will empower farmers to create their own agricultural futures.

As farmers who lead their own processes of sustainable agriculture are more likely to embody these principles, Lunn–Rockliffe et al. (2020) propose a practical, two-level approach to the future development of sustainable agriculture in Africa:

**Level 1:**
**Farmer-Led Sustainable Design**

The development of sustainable design that can be used by practitioners must start, first and foremost, with the farmers themselves.

1. Build a qualitative understanding of local farming livelihoods.
2. Co-design a holistic, non-harmonised modular programme that is underpinned by a sustainable approach to agriculture.
3. Build an open access knowledge store and sharing platform that farmers can draw upon at their own discretion.

**Level 2:**
**Policy-Led Sustainable Design**

Farmer-led sustainable design needs to feed into larger sustainable agricultural initiatives. Wider channels of policy design must be created collaboratively with communities in order to create inclusive forms of management for multiple stakeholders. Long-term, inter-governmental planning should support sustainable agricultural design.

1. Landscape management planning needs to support the holistic management of landscapes and connect farmer-led sustainable design with policy-led sustainable design.
2. Standardise processes of ecosystem mapping and modelling in order to inform environmental policies at the regional level.
3. Market and supply chain reconfigurations need to be informed by baseline mapping, policies and financial incentives that reward sustainable agricultural activities.
4. Create demonstration farms and extension programmes that could act as local outreach, skills-development transfer, and research hubs.
RECOMMENDATIONS FOR MANAGING AFRICA’S SOILS AS A CARBON SINK

The following recommendations support the development of policies and actions that encourage soil and land management strategies that foster the protection, sequestration, measurement, monitoring and reporting of soil organic carbon across Africa (FAO, 2017).

1. Consider land use and environmental, socio-economic, and cultural contexts when developing management practices aimed at protecting and sequestering soil organic carbon.

2. Identify the short-term and long-term benefits that management practices for soil organic carbon sequestration will have for farmers.

3. Provide adequate support to local farmers as they transition to land management practices that protect and enhance soil organic carbon.

4. Prevent soil organic carbon losses by maintaining the current soil organic carbon stocks through sustainable farming practices.

5. Organise the necessary training for countries to develop national reference values for soil organic carbon stocks, and establish a working group to develop regional guidelines for measuring and reporting on soil organic carbon.

HOW CAN POLICIES SUPPORT THE ADOPTION OF PRACTICES THAT FOSTER SOIL ORGANIC CARBON SEQUESTRATION?

Even in instances where smallholders have led the development of sustainable agricultural practices, and where they are convinced of the benefits of soil organic carbon sequestration, there are still several barriers that could prevent them from adopting these practices completely. For this reason, mechanisms in place that promote and support sustainable agriculture need to incentivise management practices that both contribute towards the sequestration of soil organic carbon and remove these barriers (FAO, 2017).
### Potential Barriers

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<tr>
<th>Barrier</th>
<th>Possible Solutions</th>
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<tbody>
<tr>
<td>Financial barriers, like limited finance and access to capital, may prevent farmers from adopting and implementing practices that could build soil organic carbon stocks.</td>
<td>Establish long-term financial commitments and agreements for governments.</td>
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<tr>
<td>Smallholder farmers may not have access to the appropriate technology and lack the technical capacity to implement and monitor practices that sequester soil organic carbon.</td>
<td>Identify and establish sustainable business models and investment opportunities in landscape restoration, sustainable agriculture, and land management.</td>
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<tr>
<td>Several institutional barriers may impact land users in the form of national policies and regulations, insecure land tenure, limited research and weak inter-institutional coordination.</td>
<td>Make existing technologies available to implement relevant management practices.</td>
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<tr>
<td>A lack of knowledge regarding sustainable management practices could serve as a major barrier to their implementation. More challenging still is the fact that farmers may be sceptical of information provided by politically affiliated sources.</td>
<td>Invest in technical management strategies, such as improved varieties.</td>
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<td>Resource barriers related to the absence of sufficient land, a lack of labour or low water availability to implement climate adaptation and mitigation practices.</td>
<td>Put soil organic carbon management into operation at local and national levels by aligning national development plans and agricultural policies with Nationally Determined Contributions as part of the Paris Agreement and the Sustainable Development Goals.</td>
</tr>
<tr>
<td>The way farmers perceive climate change and its associated risks is one of the key barriers that influences their actions in contributing towards climate change mitigation and adaptation.</td>
<td>Develop policies that ensure effective and consistent communication of relevant information.</td>
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<td></td>
<td>Strengthen policies that support the stakeholders that provide information on soil organic carbon sequestration.</td>
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<td></td>
<td>Increase local training and support for the adoption of new management practices.</td>
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<td>Prioritise farmer support and training from extension officers who are trained in sustainable agricultural practices and have no specific political affiliation.</td>
</tr>
<tr>
<td>Resource barriers related to the absence of sufficient land, a lack of labour or low water availability to implement climate adaptation and mitigation practices.</td>
<td>Develop new infrastructure (e.g. efficient water-use technologies or transport and storage systems) and establish accessible markets for products.</td>
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<td>Train farmers on techniques that can help to mitigate the challenges of resource availability.</td>
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<td>Acknowledge and work with the local context, such as belief and value systems and indigenous knowledge, when designing relevant management practices.</td>
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<td>Link existing agricultural subsidy schemes to sustainable agricultural practices that support soil organic carbon maintenance and sequestration.</td>
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ACT FOR AFRICA’S SOILS

Africa’s soils are faced with rampant land degradation, a human–induced phenomenon that reduces soil organic carbon and severely impacts the agricultural productivity and food security of the continent. The consequences of further soil decline will be severe, not only for African economies, but for the welfare of millions of people who depend on agriculture.

Promoting and implementing sustainable agricultural practices across Africa will not only contribute towards the objectives of climate change mitigation, but increase food security and nutrition, reduce poverty and help achieve several SDGs. While Africa has strong foundations in sustainable agriculture, there are still several barriers that have prevented their widespread adoption. We need to urgently put smallholders at the forefront of new agricultural approaches and develop sound support systems that underpin such a transformation, as a sustainable future in Africa starts with its soil and people.

Check out these sources for more tips on how to manage soil in the context of climate change:

Access Agriculture: A non-profit organisation that showcases agricultural training videos in your local language.

The African Organic Agriculture Training Manual consists of several modules with materials for trainers and corresponding handouts for farmers.

Infonet is a channel of the Biovision Farmer Communication Programme (FCP). It provides scientific and practical validated information and knowledge related to plant (crop), animal, human, and environmental health.

Figure 8: Restoring an invisible lifeline: soil (Cherfas, n.d.)
BIBLIOGRAPHY


FAO, 2018. The 10 Elements of Agroecology: Guiding the Transition to Sustainable Food and Agricultural Systems, s.l.: FAO.


