



Geoparks Investment  
Advisory Council

Insights

# Good Soil as the Backbone of Healthy Food Systems — Lessons from Geopark Agribusinesses

Agribusiness · Food Systems



## Soil at the Heart of Geopark Food Systems

Soil health is at the heart of every thriving food system. Whether on a small family farm or within vast agricultural landscapes, the quality of the soil determines the future of food production, ecosystem health, and economic stability. Geoparks, regions of great geological and ecological significance, provide an exceptional framework for understanding the role of soil in sustainable agribusiness. These natural areas offer rich biodiversity, fertile land, and unique farming practices that provide valuable lessons on how good soil can drive both environmental sustainability and food security.

As geopark stakeholders we must explore how healthy soil—the backbone of any food system—plays a central role in geopark agribusiness. We delve into the lessons from geoparks, highlighting their practices of soil conservation and sustainable agriculture, and discuss how these can be applied to improve food systems worldwide.

## Soil Health as the Foundation of Healthy Food Systems

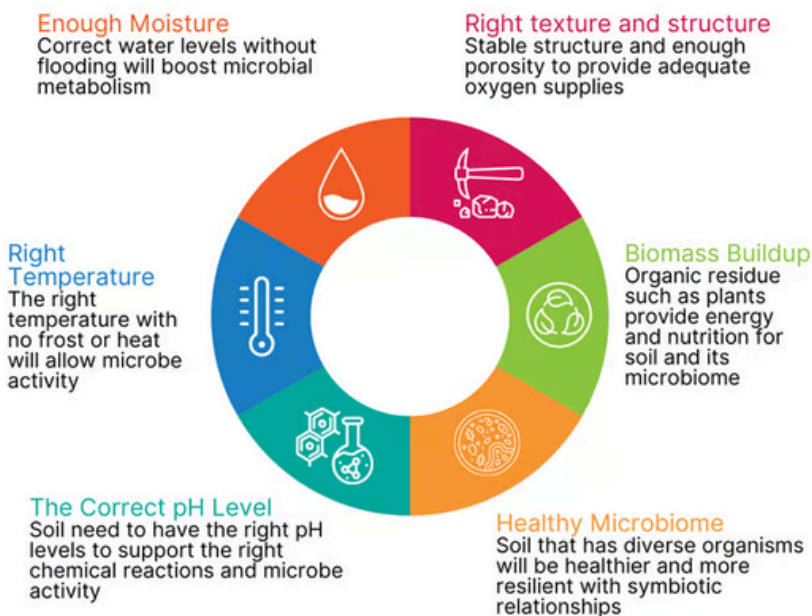
Geoparks represent a harmonious blend of nature's design and human

cultivation. In these protected areas, soil health is not just a byproduct of farming, but the very foundation on which healthy food systems are built. Good soil supports biodiversity, facilitates healthy crop growth, and sustains local economies. It is a renewable resource when managed responsibly, offering an invaluable asset to both local communities and global food systems.

Soil in geoparks is often rich in organic matter and diverse microbial life—elements that contribute to healthy, resilient crops. Practices such as agroforestry, crop rotation, and organic farming ensure that soil remains fertile, productive, and able to retain essential nutrients and water. In contrast to industrial agricultural methods that degrade soil quality over time, these sustainable approaches restore and maintain soil health, ensuring higher yields and greater resilience to climate fluctuations.

The use of regenerative agriculture methods in geoparks also plays a critical role in enhancing soil quality. By enriching the soil with organic matter and minimizing the disturbance to its natural structure, these practices help prevent erosion, boost water retention, and increase biodiversity, all of which are essential to maintaining

Fig. 1. The Six Ingredients for Healthy Soil



Source: GIAC



food production systems that are resilient to climate change. But healthy soil is not just about nutrient-rich land; it's also about biodiversity. Soil organisms—ranging from earthworms to fungi—play a crucial role in maintaining soil structure, enhancing nutrient cycling, and promoting plant growth. Geoparks, with their rich and varied ecosystems, offer a model for how diverse soil organisms can be fostered through agricultural practices that

preserve or even enhance biodiversity.

By fostering a strong soil microbiome, geoparks provide a natural blueprint for improving agricultural productivity while reducing the need for synthetic chemicals. This approach offers long-term food security benefits, helping farms maintain higher yields over multiple growing seasons.

## Understanding the Secret Behind Soil Restoration and Preservation

Soil is an incredibly dynamic and living resource, yet its health and productivity can be easily compromised by unsustainable farming practices, deforestation, and climate change. In geoparks, the secret to maintaining healthy soil lies in a combination of restoration and preservation practices, rooted in both modern science and traditional agricultural knowledge. The lessons from geoparks offer valuable insights into how we can restore degraded soils, preserve their fertility, and enhance their ability to support healthy food systems.

Soil is made up of various components, with approximately 47% minerals, 24% air, and 25% water. The remaining 3% to 7% consists of soil organic matter (SOM), a crucial element for soil vitality. SOM plays a vital role in improving soil structure, preventing erosion, and regulating the storage of water, air, and nutrients. It also has the ability to sequester carbon, which contributes to combating climate change, while nourishing the microbes and organisms that are essential for nutrient cycling and plant growth.

SOM is composed of four key elements: fresh residues, resistant organic matter, humus, and the living organisms that form the soil's microbiome. The first two elements primarily serve as food for soil organisms and are the starting materials for the formation of humus, the organic matter that sustains soil fertility. Humus, in particular, is vital because it stores most of the soil's nutrients, stabilizes the soil structure, and retains moisture.

The buildup of SOM is determined by six critical factors: adequate moisture, proper soil texture and structure, a healthy microbiome, continuous biomass buildup, optimal pH, and favorable temperatures. These elements work together to sustain the soil's capacity to support plant life, regulate water cycles, and contribute to the soil's overall resilience. (See Figure 1).

If these factors are not in harmony, soil cannot develop the necessary soil organic matter (SOM) to support robust and healthy plant growth. For instance, deserts lack sufficient rainfall, preventing the growth of vegetation that is essential for maintaining the carbon cycle, which would help build a healthy SOM layer.

On the other hand, excessive water in peatlands disrupts the soil's microbial activity and pH balance, inhibiting the formation of fertile soil layers needed for effective crop production, although it strengthens peatlands' role as a carbon sink.

Healthy soil not only boosts crop yields and reduces erosion but also minimizes the need for synthetic fertilizers and mechanical irrigation. It enhances crop resilience during floods or droughts by improving its ability to absorb and retain water. Additionally, its ability to capture and store atmospheric carbon significantly contributes to reducing greenhouse gas emissions.

Can these benefits be measured in economic terms? And if so, what value do they bring?

### How Restoring Soil Can Bring New Added Value into Geopark Economies

Soil restoration is a multi-step process that aims to bring degraded, infertile, or eroded land back to productive use. The success of soil restoration in geoparks often hinges on the careful integration of sustainable farming techniques and the rehabilitation of natural ecosystems. But restoring soil

isn't just about environmental sustainability—it's also about unlocking new economic opportunities. By implementing restoration practices, such as agroforestry, regenerative farming, and effective water management, businesses in the agribusiness sector can reap long-term economic benefits, improve yield resilience, reduce input costs, and create value for local communities. There are several key strategies involved in this process.

#### *Agroforestry and Reforestation*

One of the most effective methods of soil restoration in geoparks is the integration of agroforestry practices, which involve growing trees alongside crops. This not only helps reduce soil erosion but also improves soil structure and nutrient content. The roots of trees create a network that stabilizes the soil, while their canopies provide much-needed shade, which helps retain moisture in the soil. Geoparks with a focus on reforestation initiatives further restore the balance of ecosystems, preventing the loss of topsoil and promoting long-term soil health.

Agroforestry and reforestation are powerful strategies for restoring soil health while simultaneously improving

the economic viability of farmland. By integrating trees with crops, agroforestry promotes soil fertility through enhanced organic matter, reduced soil erosion, and better water retention. The roots of trees bind the soil, preventing erosion and stabilizing nutrient-rich topsoil. In addition to boosting soil health, agroforestry offers new streams of revenue through timber, fruit, nuts, and other non-timber products. A study in tropical regions showed that agroforestry systems increased farmer income by as much as 30%, demonstrating the significant economic value of these practices. Reforestation also contributes to carbon sequestration, which could lead to carbon credit revenue opportunities for farmers and businesses involved in environmental sustainability programs.

### *Cover Cropping and Crop Rotation*

The use of cover crops, such as legumes, during off-seasons, is another restorative practice. These crops help replenish nutrients in the soil, reduce erosion, and improve organic matter. Similarly, crop rotation, the practice of alternating the types of crops grown in a particular field each season, prevents the depletion of specific nutrients and disrupts pest and disease cycles. Both of these

practices contribute significantly to the regeneration of degraded soil and help maintain its long-term fertility.

Cover cropping and crop rotation are two simple yet effective techniques for restoring soil and increasing its productivity. Cover crops such as legumes can fix nitrogen into the soil, reducing the need for synthetic fertilizers and improving soil structure. Crop rotation, which alternates different crops to break pest cycles and replenish soil nutrients, prevents the depletion of specific soil elements, ensuring long-term soil health. These practices help reduce the costs of synthetic fertilizers and pesticides, while increasing crop yields over time by maintaining soil fertility. This leads to more consistent productivity, reduced input costs, and enhanced profitability. Additionally, crop rotation improves soil resilience to pests and diseases, minimizing losses and ensuring more stable harvests year after year.

### *Organic and Regenerative Farming*

Transitioning to organic farming and regenerative agriculture can be particularly effective in restoring soil health. By avoiding the use of synthetic fertilizers and pesticides, farmers in geoparks rely on natural



methods such as composting, mulching, and the introduction of beneficial organisms to restore soil structure and fertility. These techniques help build up the soil's organic matter, enhance microbial diversity, and improve its ability to sequester carbon, making it more resilient to environmental stress.

Organic and regenerative farming focus on enriching the soil through natural methods—avoiding chemical fertilizers and pesticides while promoting soil biodiversity. These practices increase soil organic matter (SOM), which improves the soil's water retention, nutrient availability, and overall fertility. Although organic farming may come with initial investment costs, it can yield higher market prices for crops due to the growing demand for organic produce. Regenerative farming, which focuses on restoring soil health, enhances long-term yield stability, reducing the impact of extreme weather events like droughts and floods. Moreover, these practices can reduce dependency on costly chemical inputs, leading to lower operational costs for farmers and higher profit margins in the long run.

### *Minimizing Soil Disturbance*

No-till or low-till farming methods, commonly practiced in geoparks, help minimize soil disturbance. Conventional tilling can damage soil structure, increase erosion, and deplete organic matter. By avoiding or reducing tillage, soil is allowed to retain its natural structure, which improves water infiltration and reduces soil compaction. This preservation technique supports the healthy growth of crops while maintaining the soil's natural biodiversity and resilience.

Minimizing soil disturbance through practices like no-till or low-till farming can significantly improve soil structure, increase water retention, and promote microbial diversity. This approach preserves the integrity of the soil's ecosystem, allowing for better nutrient cycling and greater resilience to environmental challenges. Less disturbance to the soil leads to lower fuel and equipment costs for farmers, as it reduces the need for ploughing and tilling. Additionally, healthier soil results in improved crop yields, reducing the need for expensive synthetic fertilizers and irrigation. The practice of no-till farming can also help mitigate soil erosion, ensuring that valuable topsoil is not lost, which is critical for long-term agricultural productivity.

## *Soil Mulching and Organic Matter*

The use of mulch—organic materials such as straw, leaves, or wood chips—on the soil surface is a key preservation practice. Mulching helps to protect the soil from direct sun exposure, reducing moisture loss, and preventing soil erosion. Additionally, the decomposing mulch acts as a natural fertilizer, enriching the soil with organic matter, improving its water retention capacity, and fostering a diverse soil microbiome.

Soil mulching and the incorporation of organic matter into the soil are essential for protecting soil from erosion, retaining moisture, and increasing organic matter content.

Organic mulches, such as compost or crop residues, help regulate temperature, reduce water evaporation, and provide food for soil organisms, contributing to soil structure and fertility. Mulching reduces the need for irrigation, which can lead to substantial water savings. Additionally, the practice decreases reliance on chemical fertilizers, as decomposing organic matter naturally enriches the soil with nutrients. For farmers, this means reduced operational costs and less dependency on external inputs, ultimately increasing profitability. Mulching also improves the resilience

of crops, leading to more consistent yields and fewer losses due to extreme weather conditions.

## *Water Management and Erosion Control*

Proper water management is critical in both soil restoration and preservation. Geoparks often implement systems that optimize water use, such as rainwater harvesting and drip irrigation. These methods reduce the risk of overwatering and ensure that water is distributed efficiently to crops while preventing soil from becoming waterlogged or eroded. Similarly, practices like planting grass strips along riverbanks or using terracing can prevent erosion and stabilize soil, particularly in sloped regions.

Effective water management and erosion control are critical components of soil restoration, especially in regions prone to droughts or heavy rainfall. Practices like rainwater harvesting, drip irrigation, and contour farming help optimize water use and prevent soil erosion. These techniques ensure that the soil remains fertile, and water is used efficiently for crop production. Proper water management reduces water costs, enhances crop resilience during droughts, and increases overall yield potential. By preventing erosion, businesses avoid costly soil loss, ensuring that farmland remains productive for years to come. Additionally, effective erosion control can help preserve infrastructure and prevent damage to nearby ecosystems, adding long-term value to the land.



## *Fostering Soil Microbial Health*

A vibrant soil microbiome is at the heart of healthy soil. Soil is home to billions of microorganisms—bacteria, fungi, and other organisms—that play a key role in nutrient cycling, organic matter decomposition, and plant health. Geoparks prioritize soil preservation by encouraging farming practices that support microbial life, such as avoiding harmful chemicals and using bio-fertilizers or composts to feed the soil. By promoting a diverse soil microbiome, these practices enhance the soil's ability to maintain its fertility and fight off diseases.

Soil microbial health is fundamental to soil fertility. A rich and diverse soil microbiome is essential for nutrient cycling, organic matter decomposition, and promoting plant health. Practices like reducing chemical inputs, adding compost or bio-fertilizers, and supporting biodiversity help nurture a thriving soil microbiome. Healthy soils can significantly increase crop productivity by enhancing nutrient uptake and improving plant growth. This leads to higher yields and less reliance on synthetic fertilizers, reducing operational costs for farmers. Moreover, soils rich in beneficial microbes are more resilient to diseases, which can reduce losses and ensure more stable harvests.

Additionally, maintaining microbial diversity supports the ecosystem services provided by the soil, such as carbon sequestration and water filtration, which may have broader economic and environmental benefits.

## Lessons from the Geopark Agribusiness Sector

The agribusiness industry has highlighted for years the role soil has in regulating carbon storage and water retention is essential for both mitigating climate change and building climate resilience. By maintaining and improving soil health, geoparks contribute to the broader environmental health, helping to absorb carbon emissions and reduce the effects of climate change on local agriculture. This is particularly relevant as agribusiness faces the dual challenge of increasing food production while addressing environmental sustainability. In regions with geoparks, farmers are encouraged to use local knowledge and sustainable farming practices that work in harmony with the environment. These practices help mitigate soil degradation, maintain carbon sequestration, and build greater resilience against climate-induced stresses like droughts or floods. What sets geoparks apart from other agricultural regions is their holistic approach to soil management. In geoparks, soil restoration and preservation are not merely agricultural practices—they are embedded in the broader goal of conserving natural landscapes and biodiversity. These areas

often serve as living laboratories where land management, conservation, and agriculture intersect, allowing us to observe the positive effects of sustainable practices on soil health in real-time. For instance, the careful management of grazing practices in geoparks—where overgrazing is avoided—ensures that grasslands maintain their soil fertility. Similarly, protecting wetlands within geoparks helps regulate water quality and prevent soil salinization or erosion. These integrated conservation practices provide a model for how agricultural systems and ecosystems can coexist, restoring and preserving the land for future generations.

Healthy soils are not just an environmental asset—they're also an economic one. The agribusiness sector can gain substantial economic benefits by investing in soil health and sustainable agriculture. In geoparks, healthier soils have been linked to increased crop yields, reduced input costs (such as fertilizers and irrigation), and more profitable farming systems.

This can be seen in some geopark regions, where soil health improvements have been associated

with an increase in local food production and the promotion of high-value, sustainable crops. These crops, grown with minimal environmental impact, can attract premium prices in local and international markets, supporting farmers economically and ensuring the sustainability of local economies.

## A Collaborative Approach in Building Resilient Food Systems in Geoparks

The lessons learned from geopark agribusiness highlight that healthy soil is fundamental not just to individual farms but to food systems as a whole. To maximize the potential of geoparks in improving food security and sustainability, collaboration between stakeholders is critical.

Local communities are at the forefront of preserving soil health within geoparks. By involving farmers in soil management strategies, encouraging traditional farming methods, and offering training in sustainable practices, communities can improve both their food security and their economic well-being. The connection between healthy soil and a thriving local economy cannot be overstated. In geoparks, local farmers often benefit directly from the recognition of the unique value of their soil, through initiatives like agri-tourism and organic food production. Meanwhile governments, agribusinesses, and environmental organizations must collaborate to ensure that soil health is prioritized in food production systems.

This means implementing policies that promote sustainable farming, funding research on soil and climate resilience, and offering incentives for farmers who adopt soil-friendly practices. Agribusinesses, for their part, have an important role to play in facilitating the widespread adoption of soil-friendly technologies and providing farmers with the tools they need to improve soil quality. This includes investment in innovative technologies that enhance soil monitoring, provide better irrigation solutions, and offer more efficient fertilizers.

Geoparks offer valuable lessons on the symbiotic relationship between good soil and resilient food systems. By focusing on sustainable practices, preserving biodiversity, and improving soil health, geoparks can enhance food security and strengthen local economies. The key to this success lies in collaboration among all stakeholders—from farmers to policymakers to agribusinesses—to build food systems that are not only productive but also environmentally sustainable.

## Conclusions

As we look to the future, the practices and lessons from geopark agribusiness must be integrated into

broader food systems strategies. Healthy soil is the backbone of a sustainable and secure food future, and geoparks show us how to harness this potential for the benefit of people, the planet, and the economy.

