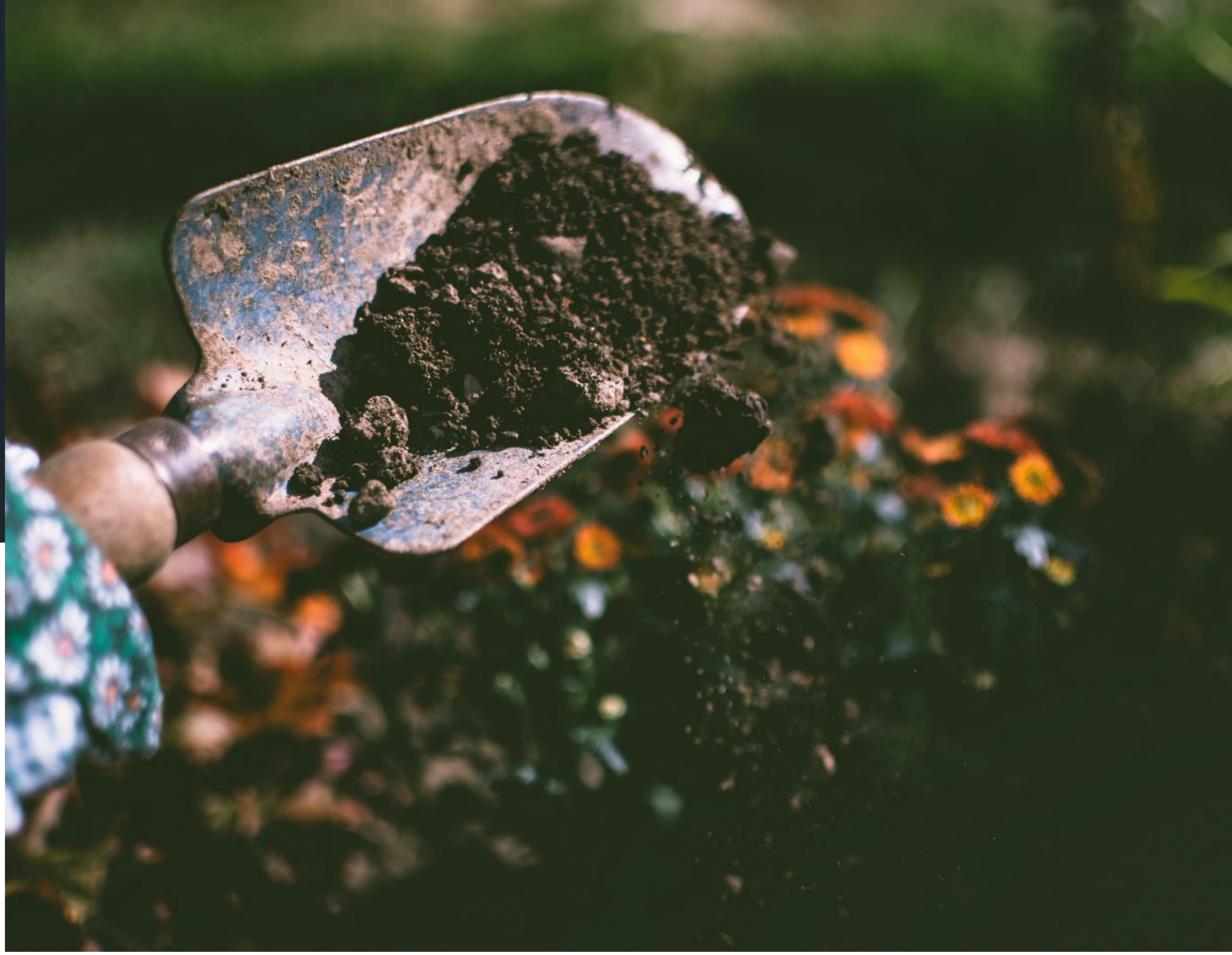
IMPACT OF BIOCHAR ON SOIL HEALTH



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INTRODUCTION

The word "soil quality" first appeared in the literature in the early 1990s, and the soil science society of America's Ad Hoc Committee on soil quality approved the first official use of the term. Soil quality is described as a reference soil's ability to work within natural or controlled ecosystem boundaries to support plant and animal productivity, as well as maintain or improve the quality of water and air along with supporting human health and habitation. Soil quality refers to soil functioning, while soil health refers to the soil as a finite, nonrenewable, and dynamic living resource.

WHAT IS SOIL HEALTH?

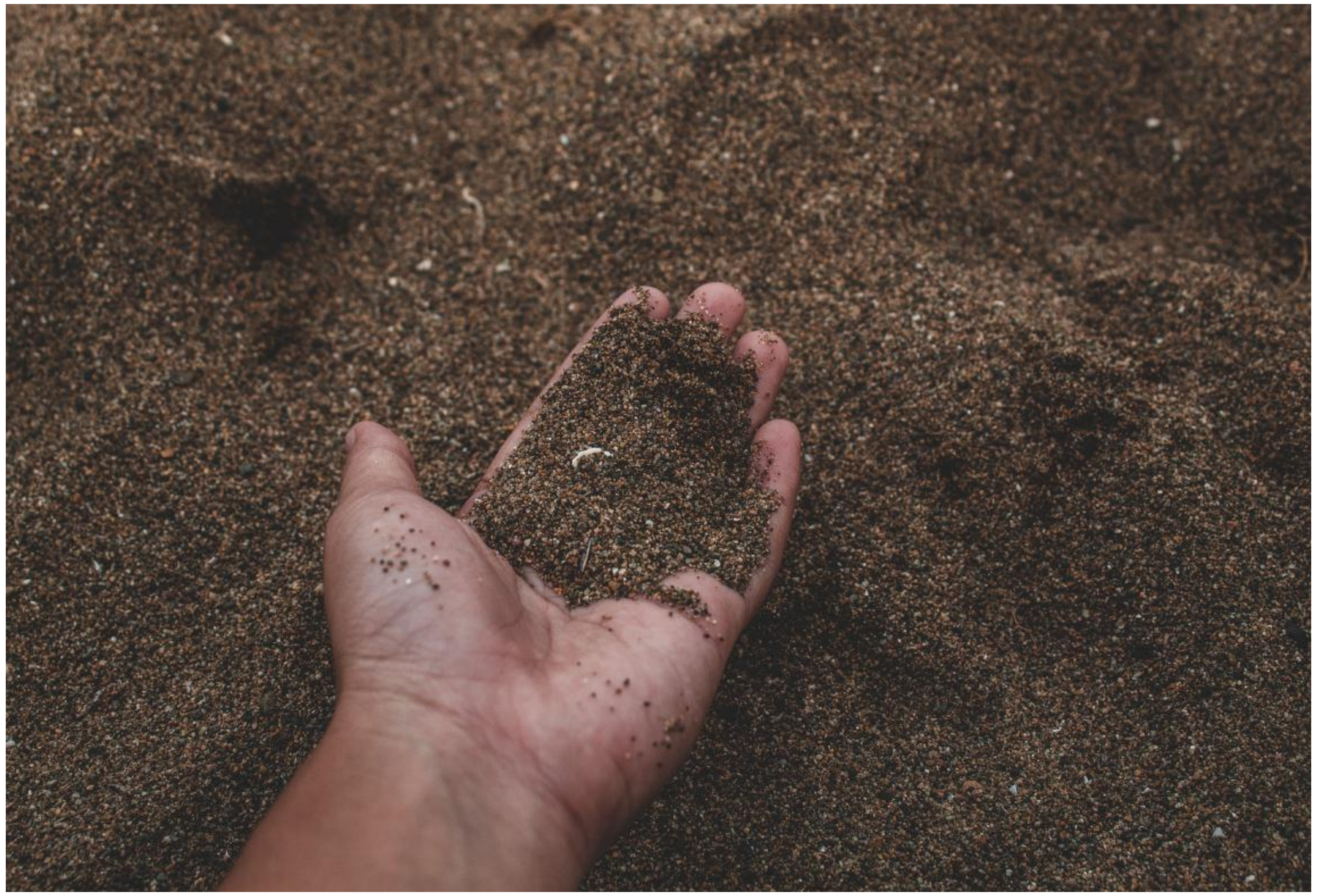
The words "soil health" and "soil quality" are becoming more widely used around the world. Soil quality is characterized as a soil's ability to work within the ecosystem and land-use boundaries to maintain productivity, maintain environmental quality, and promote plant and animal health." In general, the terms "soil health" and "soil quality" are considered interchangeable. Inherent soil quality refers to the aspects of soil quality relating to a soil's natural composition and properties influenced by elements and processes of soil formation, in the absence of human impacts," according to the definition. Dynamic soil quality, on the other hand, refers to soil properties that change over time as a result of soil use and management.

HEALTHY FUNCTIONING SOILS

1. Produce food, fuel, fiber, and medicinal products.
2. Store, filter, and release water.
3. Detoxification of harmful chemicals.
4. Store and cycle carbon.
5. Store and cycle nutrients internally.
6. Maintain biodiversity and habitat.

WHAT IS SOIL HEALTH?

1. Good soil tilth.
2. Sufficient depth.
3. Sufficient supply of nutrients.
4. Highly populated by beneficial organisms.
5. Short of plant pathogens and insect pests.
6. Free of allelochemicals.
7. Resistant to degradation.



HOW TO EVALUATE SOIL HEALTH

1. Indicators:

Soil health indicators are functions and qualities that can be measured to monitor changes in the soil, that give clues about how well the soil can function.

2. Types of indicators:

a. Physical indicators.
b. Chemical indicators.
c. Biological indicators.

Physical indicators	Chemical indicators	Biological indicators
Texture	pH	Soil organic carbon
Bulk density	Base saturation	Soil microbial biomass
Aggregation	Total nutrient	Nitrogen mineralization
Pore size distribution	Plant available nutrient	Soil flora
Available water capacity	Cation exchange capacity	Enzymatic activity
Infiltration rate	Calcium carbonate	Soil respiration rate
	Electrical conductivity	Earthworm

BIOCHAR

Biochar is the carbon-rich solid product left over after biomass (plant organic matter) is heated to temperatures between 300°C and 700°C in the absence of oxygen and the process is known as pyrolysis.

Modes of Production

Sl. No.	Modes	Conditions	Yields (%)		
			Liquid	Char	Gas
1	Slow pyrolysis	Low temperature, long resident time	30	35	35
2	Fast pyrolysis	High temperature, short resident time	75	12	13
3	Gasification	High temperature, long resident time	5	10	85

Effect of Biochar on Physical Properties

Biochar is a low-density substance that improves water infiltration, root penetration, and soil aeration and also increases soil aggregate stability. The micro-aggregate component of the soil has the highest biochar content, while the macro-aggregates have lower content.

Through encapsulation of the organic fractions, micro-aggregates play an important role in reducing biochar decomposition. As biochar is broken down into humic acid, it may increase aggregation. However, aggregation can only play a minor role in reducing the biochar's decomposition rate, with its inherent recalcitrance playing a stronger effect.

Impact of Biochar on Chemical Properties

Biochar serves as a source of energy as well as a soil amendment. Due to its polycyclic aromatic carbon structure, black carbon (analogous to biochar) is very stable and resistant to physical and microbial breakdown, encouraging it to remain in soil due to the presence of crystalline morphology, the proportion of which may alter with pyrolysis temperature.

Biochar-enriched soils have high fertility and biochar helps to reduce climate change by lowering greenhouse gas emissions from agricultural soils. Biochar increases the ability of soils to maintain nutrients and plant usable water and decreases the leaching of nutrients and agricultural chemicals due to its high surface area and high surface charge density.

Influence of Biochar on Soil Microorganisms

The pH of soil amended with biochar is more suitable for the growth of microbes, especially fungal hyphae. Biochar is known to enhance the fertility of soils and carbon sequestration, but relatively little information is currently available about its effect on the soil microbial community, a component of terrestrial ecosystems that plays a key role in nutrient cycling. Microbial populations can be especially higher in soil rich in black carbon, thus the interaction between biochar as a soil amendment plays a vital role in soil biota.

Impact on Mycorrhizal Fungi and Biological Nitrogen Fixation

Biochar soil amelioration in degraded landscapes has the potential to increase grassland plant production, enrich soil microbial populations, and stimulate arbuscular mycorrhizal persistence. Biochar addition to soil increases in root colonization of arbuscular mycorrhiza fungi (AMF). Biochar enhances biological N fixation (BNF) amendments in soil. This is mainly due to the:

1. Availability of nitrogen (N) in the soil is lower due to the high C/N ratio of the biochar, resulting in N immobilization.
2. Higher availability of nutrients other than N and the pH are higher
3. Biochar enhances mycorrhizal infection.

A combination of factors related to nutrient availability in soil and stimulation of plant-microbe interactions are most likely to be responsible for the improved BNF.

Biochar in Sequestering Soil Carbon

Soil carbon sequestration (SOC) is the process of raising the concentration of carbon in the soil by changing land use and implementing prescribed agricultural management practices. Another significant SOC sequestration technique is the use of manure and other organic amendments and the development of charcoal and the use of biochar as a fertilizer. Biochar is a component of the oldest C pool found in soil and deep-sea sediments, suggesting that black carbon may be a major global carbon sink. It is proposed that by using this approach to "tie up" carbon, existing global carbon emissions could be reduced by 10 percent.

Biochar in Remediation of Soil

Chars, charcoals, biochar, soots, and graphite are all examples of black carbon, which is thermally modified, partially charred to an extremely concentrated form of organic carbon. It functions as a recalcitrant pool, influencing hydrophobic organic chemicals (HOCs) mobility, extractability, and bioavailability in the soil, as well as helping in stabilizing and restoring soil organic matter. The soil remediation with biochar improves cation exchange capacity, nutrient binding, and subsequent control of nutrient run-off, reduces nitrogen leaching, improves soil water-holding capacity, neutralizes soil acidity, and provides a microorganism-friendly environment.

CONCLUSION

It is required to develop low-cost biochar kilns to make the technology affordable to small and marginal farmers. Further inter-disciplinary and location-specific research has to be taken up for studying the long-term impact of biochar application on soil physical properties, nutrient availability, soil microbial activities, carbon sequestration potential, crop productivity, and greenhouse gas mitigation