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Evaluating the Crucial Relationships between Soil Health and Climate Change

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***Abstract:** Content of paper emphasizes the significant influence of soil health on global warming and climate stability. Soil affects the Earth's carbon cycle by acting as a source and sink of greenhouse gases. Climate is considered important a factor in soil formation, but also soils also have an impact on the climate. Therefore, soils are affected by the current climate change as well, particularly because they may release excessive amounts of carbon dioxide (CO_2) and other greenhouse gases (GHG) as a result of changing their usage or poor management or human wrong practices. The pressure that climate change places on soil ecosystems has a significant impact on agriculture, biodiversity, and ecosystem services. For effective climate mitigation and adaptation policies to be developed, it is essential to understand these relationships. Worthwhile that the greatest soil management practices for reducing climate change focus on increasing soil organic matter content and water retention. The enormous carbon and nitrogen (N) store that is soil. acting as a possible regulator of the CO_2, N_2O, and CH_4—the three main greenhouse gases in the atmosphere. Because biota is the organic matter carrier to the soil, both in living organisms and through their decomposing remains, mature soils rich in life are frequently CO_2 sinks. But heterotrophic organisms that live in soil are also OM net consumers, and they release CO_2 into the atmosphere through respiration. The interactions between plants, soil organisms, and abiotic soil conditions are actually changing as a result of climate change, which has an impact on plant performance, plant diversity, and community structure. The loss of soil organic matter (OM) and its development to the atmosphere quickly became a significant effect of tillage and any other activity, agricultural or otherwise, that disturbs the natural soils since then. It is anticipated that the areas affected by salinization would increase due to climate change which affects the suitability of the soil agriculture or any other development purposes.The conclusion of the current study Carbon sequestration can reduced the green house gas emission.*

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Keywords: Carbon Sequestration, Greenhouse Gases (GHG) Anthropogenic Soils Land Surface Albedo Emissions Trading, Soil Organic Carbon Etc.

1. INTRODUCTION

Climate is a factor in soil formation, but soils also have an impact on the climate. Therefore, soils are affected by the current climate change as well, particularly because they may release excessive amounts of (CO2) and other (GHG) as a result of changing their usage or poor management (Oertel et. 2016). On the other hand, it has been demonstrated that soil managing is one of the ways to stored (C) and possibly slow down global warming (Bossio et. 2020). In addition to being a passive observer of clime variation, soil also acts as a regulator of it by creating and managing a variety of positive and negative feedback loops. Following that, attempted to quantify the sum of C release into the air as a consequence of soil cultivation and deforestation since 1860, while calculated the magnitude of the impact of anthropogenic activity at the time on the soil C reservoir and the C cycle. As opposed to that, (Houghtonet et. 1990; Pankrath et. 1979; Kobak et. 1987). described a series of computer experimentations evaluating the impact of extensive irrigation on quick variations in hydrology and clime, coming to the conclusion that soil humidity anomalies brought on by irrigation would have real effects in both areas. In recent years, research on soil's role in regulating climate has grown significantly, effectively proving that the greatest soil management practices for reducing climate change focus on increasing soil organic matter content and water retention .
The enormous Carbon and Nitrogen store that is soil (Yeh et.1984; Amelung et. 2020) acting as a possible regulator of the CO2, N2O, and CH4—the 3 main GHGs in the environment. These figures are significantly larger than the corresponding levels in the atmosphere. Because organic matter (OM) is generally stored in soil for a lengthy period of time, soil can act as a buffer against atmospheric CO2 concentration. have really shown that the top 1 m of soil has an OM age of 4830 1730 years on a worldwide scale. There is a theoretical limit to the amount of organic matter that can agglomerate in soil, and this limit is determined by the intrinsic and ecological features of each soil (Schmidt et. 2011). Many soils, particularly those used for agriculture, are far from this limit, and better management might greatly enhance their Carbon stock. (Lal et. 2021). UN CC Meeting, stakeholders to put some practical measures into place, such as agroforestry, agroecology, and land managing, conservation agriculture with the goal of increasing the soil Carbon stock at a rate of 4 per year in the first 40 cm of soil and lowering the Carbon dioxide concentration in the air to safe levels. But questions concerning the true efficacy of this and other attempts for regulating soil C sequestration on a worldwide scale have been raised throughout time. The soils in terms of GHG released is one worry that the current global warming produces. As the most significant flux in the global cycle carbon, soil-dwelling organisms account for 80 or 70% of gross primary productivity globally (Schlesinger et. 2019). So, even small increased in respiration of soil may be comparable to the annual anthropogenic Carbon dioxide intake, with positive feedback to clime change as a result Bond-(Lamberty et. 2018).

In this review we have discussed physical properties of the soil and the other side the carbon sequestration can reduced the grean house gas emission, biota, human activities

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different types of land destroy and temprature soil formation ,climate feadback loop,soil organic carbon etc.

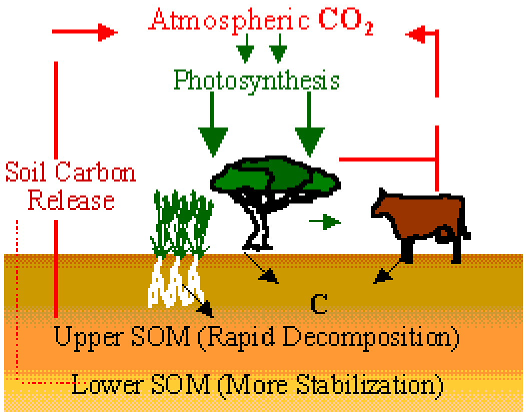

Figure 1. Linkage between climate change and Soil (Tschakert 2001)

2. METHOD

As much data as I have, all my Google Scholars have gone to Google to find these things, and all the research papers, books which are downloaded from a google scholar and google, ResearchGate, Gfsoso. I got the idea of my topic from Google Scholar, Google these things. No one has worked on the topic I have worked on it. My work is an original work. My work no one has worked on it in 2023 and my work is a new work and very interesting work. I hope that the benefit of my work will be available to all researchers in upcoming future.

Aims and Objectives

1. To investigate Carbon sequestration that decrease the greenhouse gas emission
2. To Evaluated the connection between soil healthy and Climate
3. Climate change mitigation should be a key component of all soil management practices.
4. Maximizing soil water retention, soil organic matter content, and vegetation growth are all necessary to achieve this goal.

2.1.1. Biota

In general, the ability of the soil to provide essential environment services, storing carbon and water, such as fostering plant growth increases with the diversity and abundance of the soil's living organisms (Barrios et. 2017). Sadly, there is mounting evidence that the biodiversity of ecosystems, including the soil microbiome, which controls the biogeochemical cycle of elements, is declining as a consequence of environment variation (Bellard et. 2012). Because biota is the OM transporter to the soil, both in living organisms and complete their decomposing remains, mature soils rich in life are frequently CO2 sinks. But heterotrophic organisms that live in soil are also OM net consumers, and they release CO2 into the atmosphere through respiration. The rate of total soil respiration, also known as the soil-to-atmosphere CO2 flux, is highly variable across both time and location Jansson et. 2020; Luo et. 2006; Raich et. 2002; Pantani et. 2020). The composition and functionality of the soil ecology are shaped by

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variations in plant community composition brought on by clime change which in turn alter soil respiration rates. (Kardol et. 2010; Xu et. 2022) Due to the C sequestration in biomass and soil, or the reforestation places that were once used for agriculture is typically viewed positively in terms of mitigating climate change (Bond-Lamberty *et al.,* 2010).

2.1.2. Humans

Humans possess culture and reason, which makes them unique among organisms in that they can choose to act in the best interests of soil quality and clime variation mitigation. There are numerous instances of how humans alter soil, potentially changing how it interacts with the climate. Humans have almost universally evolved into a factor that either indirectly directly or influences pedogenesis (Bettset et. 2000; Scalenghe et. 2016). In any case, it is considered that the balance between the amount of soil that has been disturbed or even destroyed and the amount that human activity has supported the creation of new soil is highly loss-making. Since the advent of agriculture, a thousand years ago, humans have had an impact on the climate through the soil. This has led to variations in the temperature, moisture, evaporation, and runoff regimes of the soil as well as an increase in surface wind speed (Ruiz et. 2020). The loss of soil (OM) and its development to the atmosphere quickly became a significant effect of agricultural or and effect of tillage activity then, that disturbs the natural soils since then (Fig. 5). organic matter contributes to soil water retention both directly and by improve the establishment of soil structure (Sanderman et. 2017). Animal dung has been added to arable soils for millennia to keep the OM content there reasonably high (Rawls et. 2003). However, its widespread use could have detrimental long-term consequences on the environment as a whole (Smith et. 2012). Widespread irrigation (Fig. 5), Temporarily reduces land surface albedo, is another anthropogenic factor that affects the climate through agriculture. can prevent clouds from accumulating by discharging soot-rich smoke into the atmosphere. (De Sales et al., 2019). It is anticipated that the areas affected by salinization would increase due to climate change. (Yin et. 2022). Military operations have the potential to have one of the most effects on soils. These can drastically alter soil biology, composition, and morphological to the point where full recovery takes a very long time or is even impossible (Marquès et. 2016). The most frequent effects of combat on the land include soil compaction, digs, blast craters, and chemical contamination, all of which have obvious or previously described effects on the climate. The term "anthropogenic soils" refers to any soil that has been significantly impacted by human activity, such as extensive enrichment of artifacts, extensive fertilizer addition, sealing by impermeable materials, serious contamination. (Certini et al., 2013) Urbanization is growing, and with it, there are more asphalt-covered roads. These factors cause drainage, which prevents rainwater from penetrating the soil and slowing evaporation. (IUSS et al., 2022).

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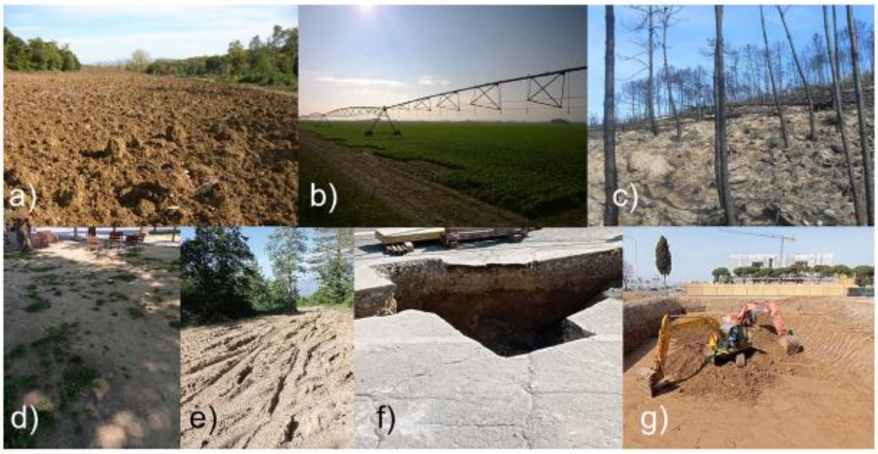

Fig. 5.a Humans can disrupt the soil in a variety of ways For example: a) tilling for agricultural purposes; b) irrigating to make up for crop water shortages; c) lighting fires, which leaves the surface bare and prone to erosion; d) compacting through repeated and frequent crushing; e) through the way of heavy machinery for forest operations; or f) sealing with impermeable.

2.1.3. Climate Feedback Loops

Thus, for instance, a warmer atmosphere caused by an increase in GHG concentration will absorb more WP, which will then trap more heat, further warming the globe (Timm et. 2018). Climate controls all biogeo-chemical reactions in the soil and, consequently, the pace of pedogenesis through temperature and moisture. Most places are experiencing pedoclimatic regime disruption due to climate change, which has clear effects on soil biota and the metamorphosis of their remains of skeletons. (Tobias et. 2018).It is suggested that the number of weakly crystal-like raw materials in soil and, subsequently, the storage of OM , with which they have a high affinity, are proximally governed by the weather rate rather than the weather state. There may be positive and negative feedback loops between the biogeo-chemical cycle of several other elements and climate change (Chung et. 2014).

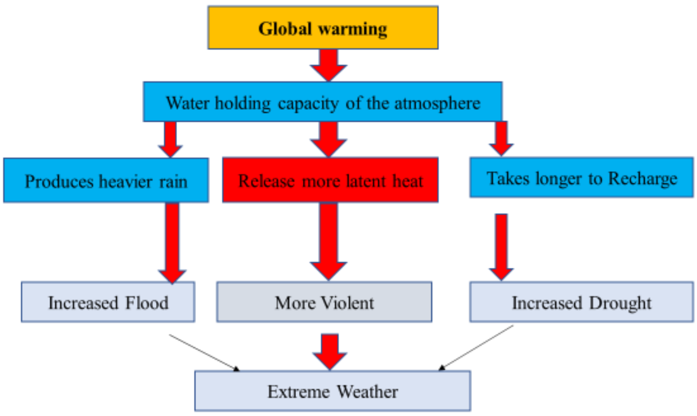

Figure.6 Conceptual concection between and extreme weather and warming climate. (yi et al., 2015)

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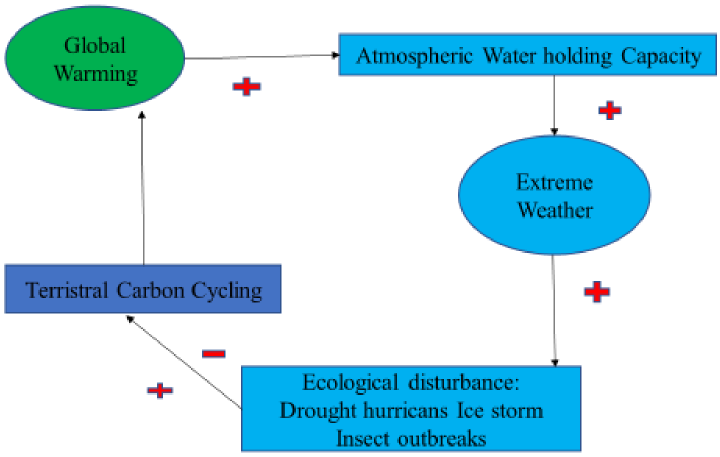

Figure.7 climate-carbon feedback loop. links between extreme weather/climate and the carbon cycle (yi et al., 2015)

2.1.4. Soil Organic Carbon

Recent research has indicated that the predicted catastrophic losses of soil carbon as noted by (Bormann et al., 2012). may not occur as a result of the impact of climate change on Soil organic Carbon reserves due to balanced interacting mechanisms. According to Istanbulluoglu et al., 2006). When litter bags were exposed to drought for six weeks over the course of an 11-month period, decomposition in a temperate grassland was found to be affected by climate change. Their findings demonstrated that grassland decomposition was significantly accelerated by frequent cutting. Healthy soil function may be considerably reduced by soil moisture stress, which will impact plant productivity (Rawls et. 2003; Walter et. 2013). highlighted that variations in precipitation might affect the water supply, whereas drier and warmer soil conditions may produce an increase in organic carbon turnover. The authors also emphasized how organic matter decomposition is accelerated in rainy settings, which has severe long-term consequences on hydro physical soil parameters. (Walter et. 2013).

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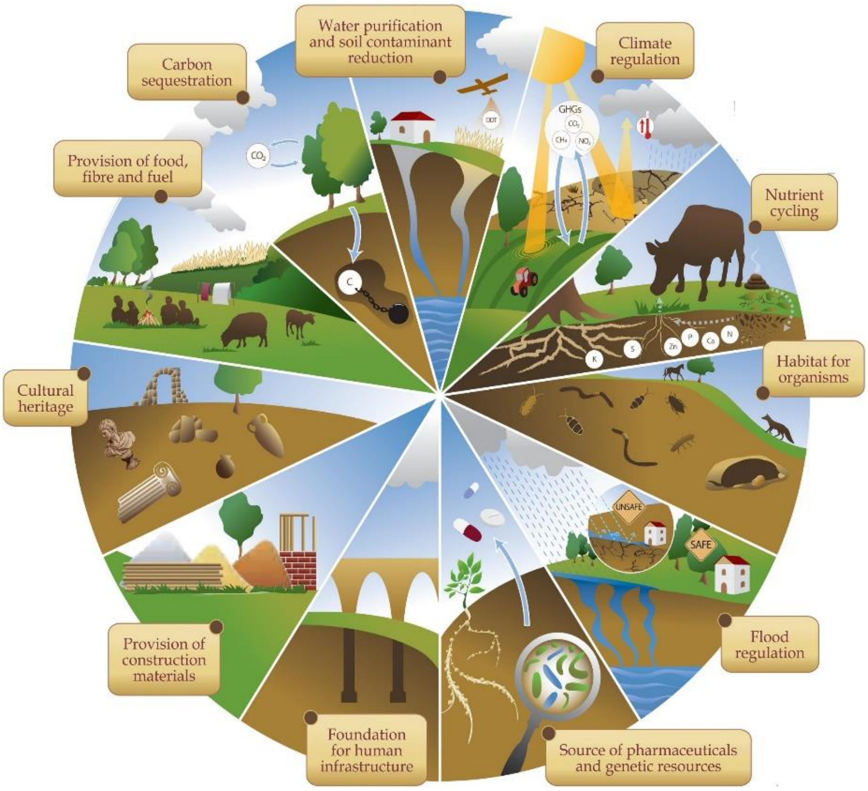

Figure. 8 a) An illustration of the functions of soil. This diagram is a portion of an FAO "infographic" on soil functions that is captioned, "Soils deliver ecosystem services that enable life on earth," and does not include any additional information. This specific figure examines the roles of "carbon sequestration" and "climate regulation" separately (Adapted from) (Baveye et al., 2020).

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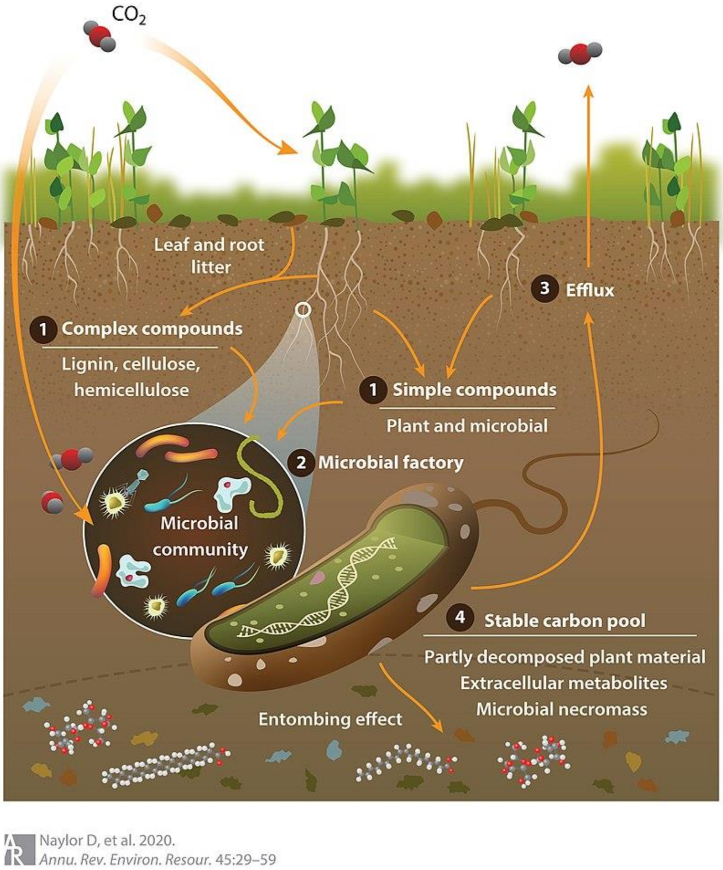

Figure 8 b) Carbon cycle in the soil via the microbial loop Plants (or autotrophic microbes) fix atmospheric carbon dioxide and add it to the soil through processes including (1) low-molecular-weight simple carbon compounds exuding from the roots of plants, or (2) leaf and root litter deposition resulting in the formation of complex plant polysaccharides. The microbial metabolic "factory" uses these mechanisms to make carbon accessible, after which it is either (3) respired to the atmosphere or (4) joins the stable carbon pool as microbial necromass. A number of variables, such as the makeup of the above ground plant community and the profiles of root exudates, environmental parameters, and collective microbiological phenotypes

2.2.1 Soil Chemical Properties and Climate Change

The pH, soluble salt content (measured by electric conductivity), nutrient and carbonate levels and their distribution in the soil profile, (CEC), and base saturation (BS) value are some of the most crucial soil chemical properties. The issue is too broad for the current research, therefore the attention is restricted to some of the direct effects on soil chemical properties. Although it is essential to take soil carbon cycling into account to better understand soil chemical reactions to climate change, the topic is too wide for the paper. Due to the fact that soil pH is regulated by the rate of weathering, the parent material, the vegetation, and the climate, it is not anticipated to alter quickly as a result of climate change's immediate consequences. If buffering pools are exhausted, soil acidity may worsen under a wetter environment. (Buytaert et al., 2011). examined the changes in glaciated soil surfaces caused by vegetation and surface age

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over a 16–28-year period. The predicted 50-year changes demonstrated that, if vegetation begins to grow, soil pH may significantly decrease, whereas on a bare soil surface, pH change may be negligible for decades (Buytaert et al., 2011). While Alnus was present for the first 10 years, the soil's calcium carbonate level dropped quickly. On the other hand, scenario 3's combination of rising temperatures and decreased precipitation might cause capillary water movement and groundwater evaporation, which would cause salt to build up in the soil (i.e. salinization) (Brinkman et al., 1990). Saturation (BS%), where soils' BS% often rises as soil pH increases. High levels of H+ and Al3+ may be present in very acidic soils, whereas Ca2+ and Mg2+ predominate in neutral and moderately alkaline soils. (Crocker et al., 1955). The scientists found that treatments with higher EC values and organic matter had greater tensile strength, while treatments with higher SAR had lower tensile strength Amezketa et al., 1999).

3. RESULTS AND DISCUSSION

Several important findings have been established from the evaluation of the critical connections between soil health and climate change. First, it became clear that the ability of healthy soil to sequester carbon is crucial for reducing the effects of climate change. The conversation also emphasized the critical link between soil quality and water retention capacity, which has an immediate influence on climate resilience.

3.1 Carbon is Crucial for Reducing the Effects of Climate Change

(Gangopadhyay et al., 2022) reported that Adopting alternative rice farming practices could reduce GHG emissions and increase carbon (C) sequestration.
(Rodrigues et al., 2023 reported) The world's greatest terrestrial carbon storage, soil is essential for the global carbon cycle and to the fight against climate change.
(Buotte et al., 2020) investigated Our research shows how ecological criteria and process models can be used to prioritize landscape preservation in a rapidly changing climate in order to reduce GHG emissions and maintain biodiversity.
Xu et al., 2020 one of the information collected Soil carbon (C) has a significant impact on climate change and is essential to the global C cycle.
Zhao et al., 2021 investigated the functioning of terrestrial ecosystems and the global carbon cycle depend significantly on soil organic carbon (SOC).
(Chatting et al., 2022) highlighted since mangroves are significant organic carbon (C) sinks, there is a lot of interest in using them to reduce greenhouse gas emissions.

3.2 Agricultural Practices Improve the Soil Healthy and Lower Greenhouse Emission

(Chataut et al., 2023) reported that In this case, carbon sequestration is enhanced by organic farming practices. There are several ways to decrease GHG emissions.
(Krupnik et al.,2022) one of the information collected Even though there has been debate over the ability of CA soil to sequester carbon tillage reduction can minimize greenhouse gas emissions.
Finally, it became clear that raising public awareness and educating the public are essential to establishing a shared commitment to improving soil health in order to help mitigate climate change. All things considered, the conversation clarified the intricate and varied relationships

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between soil health and climate change, highlighting the pressing need for coordinated actions to protect our ecosystem.

4. CONCLUSIONS

In summary, the analysis of the critical connections between soil health and climate change has highlighted how complex and multidimensional these linkages are. The interaction of soil water retention, carbon sequestration, and quality has emerged as a key component in climate change mitigation. It has been determined that promoting soil health and lowering greenhouse gas emissions require the implementation of sustainable farming techniques. Developing policies and doing ongoing research are essential to properly addressing these relationships. In the end, it is evident that addressing the issues of climate change and protecting our environment require coordinated efforts, public awareness, and education.

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Auther Declaration
The author declared there is no conflict of interest.

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