The Essential Role of Soil Organic Matter in Enhancing Soil Fertility and Sequestering Carbon

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Abstract
Soil organic matter (SOM) is pivotal in maintaining soil fertility and acting as a significant carbon sink, thus playing a critical role in both agricultural productivity and climate regulation. SOM enhances soil structure, water retention, and nutrient availability, fostering robust plant growth. Additionally, it sequesters carbon, mitigating greenhouse gas emissions and contributing to climate change mitigation efforts. Understanding the dynamics of SOM, its formation, and decomposition processes is essential for sustainable land management practices aimed at improving soil health and resilience while addressing global environmental challenges.

Keywords: ***Soil organic matter, soil fertility, carbon sequestration, nutrient availability, soil health, climate regulation, sustainable agriculture, greenhouse gas mitigation, soil structure, water retention.***

1.Introduction
Soil organic matter (SOM) is an indispensable component of terrestrial ecosystems, exerting a profound influence on soil fertility and carbon storage. Comprising plant and animal residues at various stages of decomposition, cells and tissues of soil organisms, and substances synthesized by soil organisms, SOM is a dynamic and complex mixture that plays a crucial role in both agricultural productivity and environmental sustainability. Its central importance in soil fertility and carbon storage makes it a focal point for research and practical applications in soil science and land management(1).

Soil Fertility and SOM:

Soil fertility refers to the ability of soil to supply essential nutrients to plants in adequate amounts and proportions for their growth and reproduction. SOM is integral to this process, influencing numerous soil properties and processes that determine fertility. Firstly, SOM improves soil structure by promoting the formation of soil aggregates, which enhance porosity and aeration, facilitating root growth and microbial activity. Enhanced soil structure also improves water infiltration and retention, crucial for plant water availability, especially in arid and semi-arid regions.

Nutrient availability is another critical aspect of soil fertility where SOM plays a pivotal role. As organic matter decomposes, it releases essential nutrients such as nitrogen, phosphorus, and sulfur in forms that plants can readily absorb(2). This process, known as mineralization, is mediated by soil microorganisms, highlighting the symbiotic relationship between SOM and the soil biota. Additionally, SOM contributes to the cation exchange capacity (CEC) of soils, enabling soils to retain and supply nutrients over time. By acting as a reservoir of nutrients and enhancing microbial activity, SOM sustains soil fertility and supports high crop yields.

Carbon Storage and SOM:

Beyond its role in soil fertility, SOM is a significant component of the global carbon cycle. Soil is one of the largest carbon reservoirs on Earth, storing more carbon than the atmosphere and vegetation combined. SOM contributes to this carbon pool by sequestering carbon derived from plant photosynthesis. This process of carbon sequestration in soils can mitigate the accumulation of greenhouse gases in the atmosphere, thus playing a crucial role in climate change mitigation(3).

The ability of SOM to store carbon is influenced by various factors, including climate, vegetation type, soil texture, and land management practices. Practices such as reduced tillage, cover cropping, and organic amendments can enhance SOM content and thus increase soil carbon storage. Conversely, soil degradation and poor land management can deplete SOM, releasing stored carbon back into the atmosphere and exacerbating climate change. Therefore, understanding and managing SOM dynamics is critical for developing strategies to enhance soil carbon sequestration and reduce atmospheric carbon dioxide levels(4).

Challenges and Opportunities:

Despite its importance, maintaining and enhancing SOM presents several challenges. Soil degradation, deforestation, and unsustainable agricultural practices can lead to the depletion of SOM, reducing soil fertility and carbon storage capacity. Climate change, with its associated extreme weather events, further complicates the management of SOM, as it can accelerate decomposition rates and alter soil microbial communities.

However, these challenges also present opportunities. Sustainable land management practices that promote the buildup of SOM can have multiple co-benefits, including improved soil health, increased agricultural productivity, and enhanced resilience to climate change. Practices such as agroforestry, conservation agriculture, and organic farming can help maintain and enhance SOM levels. Additionally, advancements in soil science, such as the development of biochar and other organic amendments, offer promising avenues for increasing SOM content and soil carbon storage.

2.Literature Survey

1. Soil Organic Matter and Soil Fertility:

Numerous studies highlight the critical role of soil organic matter in enhancing soil fertility. Brady and Weil (2016) emphasize that SOM improves soil structure, which in turn enhances root penetration, water infiltration, and microbial activity, all essential for plant growth. SOM's contribution to nutrient cycling is extensively documented. For instance, Stevenson (1994) details how the decomposition of organic matter releases essential nutrients like nitrogen, phosphorus, and sulfur, which are vital for plant nutrition. Additionally, Six et al. (2002) discuss the importance of SOM in maintaining cation exchange capacity (CEC), which helps soils retain and supply nutrients to plants over time(5).

2. Soil Organic Matter and Carbon Sequestration:

The role of SOM in carbon sequestration is well-documented. Lal (2004) underscores that soil is a significant global carbon sink, storing more carbon than the atmosphere and vegetation combined. This capacity for carbon storage is crucial for mitigating climate change. Post and Kwon (2000) review various studies demonstrating how SOM acts as a reservoir for carbon derived from plant photosynthesis, thus reducing greenhouse gas concentrations in the atmosphere. Furthermore, Paustian et al. (2016) highlight how land management practices such as reduced tillage, cover cropping, and organic amendments can enhance SOM content and increase soil carbon storage.

3. Challenges in Maintaining Soil Organic Matter:

Despite its benefits, maintaining and enhancing SOM poses several challenges. Powlson et al. (2011) discuss how soil degradation, deforestation, and unsustainable agricultural practices can deplete SOM, reducing soil fertility and carbon storage capacity. Similarly, Lal (2015) highlights the impact of climate change, noting that increased temperatures and extreme weather events can accelerate SOM decomposition and alter soil microbial communities. These challenges necessitate the development of sustainable land management practices to preserve and enhance SOM levels(6).

4. Sustainable Land Management Practices:

There is a growing body of literature on sustainable land management practices that promote the buildup of SOM. Conservation agriculture, which includes practices like minimal soil disturbance, crop rotation, and cover cropping, is shown to enhance SOM content (Kassam et al., 2009). Agroforestry, which integrates trees into agricultural landscapes, also contributes to increased SOM and improved soil health (Nair, 2011). Furthermore, studies on organic farming practices, such as those by Mäder et al. (2002), demonstrate that organic amendments and reduced chemical inputs can significantly boost SOM levels and soil fertility.

3.Existing and Proposed System

Current agricultural systems and soil management practices vary widely in their effectiveness at maintaining and enhancing soil organic matter (SOM). Traditional farming practices often involve intensive tillage, monocropping, and the heavy use of chemical fertilizers and pesticides. These methods can degrade soil structure, reduce microbial diversity, and deplete SOM over time. Tillage, in particular, disrupts soil aggregates and exposes SOM to rapid decomposition, leading to significant carbon losses. According to Powlson et al. (2011), these practices contribute to a decline in soil fertility and a reduction in the soil's ability to store carbon(7).

Conservation agriculture, which includes practices such as no-till farming, crop rotation, and cover cropping, is a more sustainable approach currently implemented in some agricultural systems. These practices help maintain and build SOM by minimizing soil disturbance, enhancing biodiversity, and promoting continuous soil cover. Kassam et al.

(2009) report that conservation agriculture can significantly improve soil structure, increase water infiltration, and enhance nutrient cycling, thereby boosting soil fertility and carbon storage capacity. However, the adoption of these practices is not yet widespread, partly due to socioeconomic and knowledge barriers.

Organic farming systems, which emphasize the use of organic amendments like compost and manure, also play a role in maintaining SOM. Studies by Mäder et al. (2002) show that organic farming can lead to higher SOM levels compared to conventional farming. Organic amendments not only provide a direct source of organic matter but also stimulate soil microbial activity, which is crucial for the decomposition and stabilization of SOM. Despite these benefits, organic farming represents a small fraction of global agricultural practices and faces challenges such as lower initial yields and higher labor requirements(8).

Proposed Systems:

To further enhance SOM levels and maximize its benefits for soil fertility and carbon storage, several innovative and integrated approaches are proposed. These systems aim to combine the best practices from existing methods while addressing their limitations. One promising approach is the integration of agroecological principles into mainstream agriculture. Agroecology emphasizes the use of ecological processes and biodiversity to sustain agricultural productivity. This includes practices such as agroforestry, polycultures, and the incorporation of perennial crops, which can significantly increase SOM by adding diverse organic residues and improving soil structure. Nair (2011) highlights the potential of agroforestry to enhance SOM and sequester carbon, especially in tropical and subtropical regions.

Another proposed system is the use of advanced soil amendments like biochar. Biochar, a stable form of carbon produced from biomass through pyrolysis, can be added to soils to enhance their carbon content and improve fertility. Research by Lehmann and Joseph (2015) shows that biochar can increase soil carbon sequestration and improve nutrient retention, water holding capacity, and microbial activity. Integrating biochar into agricultural systems, especially in combination with organic farming practices, could provide a sustainable way to boost SOM and mitigate climate change(9).

Precision agriculture, which leverages technology to optimize field-level management practices, offers another avenue for improving SOM. By using tools such as GPS, remote sensing, and soil sensors, farmers can apply inputs more efficiently and tailor practices to the specific needs of their soils. This can reduce the overuse of chemical fertilizers and pesticides, promote the use of cover crops, and minimize soil disturbance, thereby enhancing SOM levels. Precision agriculture can also facilitate the monitoring of SOM changes over time, allowing for more effective management strategies(10).

4. The Cycle of Mineral Plant Nutrients and Organic Matter

Soil organic matter (SOM) plays a fundamental role in the cycling of mineral plant nutrients, which are essential for plant growth and development. Organic matter serves as a reservoir of nutrients, releasing them slowly over time as it decomposes, a process mediated by soil microorganisms. This slow release of nutrients, including nitrogen, phosphorus, sulfur, and micronutrients such as zinc and copper, is crucial for maintaining soil fertility and ensuring that plants receive a continuous supply of the nutrients they need. The decomposition of organic matter begins with the breakdown of complex organic compounds into simpler molecules through microbial activity. Bacteria and fungi are key players in this process, converting organic forms of nutrients into inorganic forms that plants can readily absorb(11).

Nitrogen is one of the most critical nutrients in this cycle, and its availability is closely linked to SOM. Nitrogen in organic matter is present in proteins, amino acids, and other nitrogenous compounds. As microorganisms decompose these compounds, they convert organic nitrogen into ammonium ($NH4+$), a process known as mineralization. Ammonium can then be further converted into nitrate ($NO3-$) through nitrification, making it available for plant uptake. However, this nitrogen is also subject to losses through leaching and denitrification, which can release nitrogen back into the atmosphere as gases. Maintaining adequate levels of SOM is essential to ensure a steady supply of nitrogen to plants, reduce nitrogen losses, and enhance nitrogen use efficiency.

Phosphorus cycling is another crucial aspect of SOM's role in nutrient dynamics. Phosphorus in organic matter is primarily found in the form of organic phosphates, which are released through the enzymatic activity of soil microorganisms. Phosphatase enzymes break down organic phosphates, converting them into inorganic phosphate ions that plants can absorb. This process is vital because phosphorus is often a limiting nutrient in many soils, and its availability can significantly impact plant growth and productivity. Moreover, SOM can bind to phosphorus, reducing its fixation by soil minerals and making it more available to plants. This buffering effect of SOM on phosphorus availability is particularly important in soils with high phosphorus-fixing capacities, such as those rich in iron and aluminum oxides(12).

Sulfur and micronutrients also rely on SOM for their cycling in the soil. Sulfur in organic matter is present in amino acids and other organic compounds. Microbial decomposition releases sulfur as sulfate (SO_4^{2-}), the form that plants can take up. Similarly, micronutrients such as zinc, copper, and manganese are often complexed with organic matter, and their availability is influenced by the decomposition and mineralization of SOM. The chelating properties of organic matter can help maintain these micronutrients in bioavailable forms, preventing them from precipitating or becoming fixed in unavailable forms.

The interactions between SOM and soil microorganisms are central to the cycling of these nutrients. The activity of soil fauna, such as earthworms and insects, also plays a role by fragmenting organic matter and enhancing microbial decomposition. This biological activity leads to the formation of humus, a stable form of organic matter that can persist in the soil for long periods. Humus not only contributes to the nutrient supply but also improves soil structure, water retention, and cation exchange capacity, all of which enhance nutrient availability and plant growth.

Furthermore, the addition of organic amendments such as compost, manure, and crop residues can boost SOM levels and promote nutrient cycling. These practices provide a continuous supply of organic matter, enhancing microbial activity and nutrient mineralization. Organic amendments also introduce beneficial microorganisms and enzymes that further aid in the breakdown of organic matter and release of nutrients. Studies have shown that soils with higher organic matter content have greater microbial biomass and diversity, leading to more efficient nutrient cycling and improved soil health(13).

5. Effects of Soil Organic Carbon on the Environment

Soil organic carbon (SOC) is a vital component of soil organic matter (SOM) and plays a critical role in a wide range of ecological processes. As the main constituent of SOM, SOC profoundly influences soil health, ecosystem function, and the global carbon cycle. Its ecological effects extend to soil fertility, water dynamics, biodiversity, and climate regulation, making it a cornerstone of sustainable land management and environmental stewardship.

Water Dynamics and Soil Structure:

SOC significantly affects the water-holding capacity of soils, which is vital for plant water availability, especially in arid and semi-arid regions. Soils rich in organic carbon can absorb and retain more water, reducing the need for irrigation and enhancing drought resilience. Improved soil structure due to SOC also facilitates better water infiltration and reduces surface runoff, which minimizes soil erosion and nutrient loss. By maintaining soil moisture levels, SOC helps stabilize temperatures and provides a more consistent growing environment for plants.

Biodiversity and Soil Health:

High levels of SOC contribute to greater biodiversity both above and below ground. Diverse soil microbial communities, including bacteria, fungi, and protozoa, thrive in carbon-rich environments, driving key ecological processes such as decomposition, nutrient cycling, and disease suppression. These microorganisms form symbiotic relationships with plant roots, enhancing nutrient uptake and plant health. SOC also supports the proliferation of soil fauna such as earthworms and insects, which further break down organic matter and improve soil aeration and structure. Above ground, plant diversity is often higher in soils with abundant SOC, as diverse plant communities contribute different types of organic residues, further enriching the soil carbon pool.

Climate Regulation and Carbon Sequestration:

SOC plays a pivotal role in climate regulation through carbon sequestration. Soils are one of the largest carbon sinks, storing more carbon than the atmosphere and vegetation combined. By sequestering carbon in stable forms, SOC helps mitigate the accumulation of greenhouse gases in the atmosphere, thereby contributing to climate change mitigation. Practices that increase SOC, such as no-till farming, cover cropping, and the application of organic amendments, can enhance soil carbon storage and reduce carbon dioxide levels in the atmosphere. Conversely, soil degradation and the loss of SOC through erosion, deforestation, and unsustainable agricultural practices can release stored carbon back into the atmosphere, exacerbating climate change.

Ecosystem Resilience and Adaptation:
SOC enhances the resilience of ecosystems to environmental stresses such as drought, flooding, and temperature extremes. Soils with high organic carbon content are better able to retain water during dry periods and maintain structural integrity during heavy rainfall, reducing the risk of erosion and landslides. The improved soil structure and moisture retention also buffer plants against extreme temperatures, providing a more stable environment for growth. Additionally, SOC-rich soils support diverse microbial communities that can adapt to changing conditions and maintain ecosystem functions, contributing to the overall resilience and sustainability of ecosystems.
Carbon-Nitrogen Interactions:
The interactions between SOC and soil nitrogen are crucial for maintaining soil fertility and supporting plant growth. SOC provides a substrate for nitrogen-fixing bacteria, which convert atmospheric nitrogen into forms that plants can use. This symbiotic relationship enhances the availability of nitrogen in the soil, which is essential for plant development. Furthermore, the presence of SOC can reduce nitrogen losses through leaching and volatilization by promoting the formation of stable organic nitrogen compounds. These interactions highlight the importance of balanced nutrient management practices that consider both carbon and nitrogen dynamics in the soil.
Impacts on Soil pH and Buffering Capacity:
Impact on Soil pH:

- Soil pH is a measure of the acidity or alkalinity of soil, which affects nutrient availability, microbial activity, and plant health. SOM generally tends to:
- Moderate Soil pH: As organic matter decomposes, it releases organic acids which can naturally lower the pH of alkaline soils. Conversely, in acidic soils, the decomposition process often produces bases (like ammonia), which can slightly raise the soil pH, thus helping to neutralize extreme soil environments.
- Provide a More Favorable Environment for Microbes: Many soil microorganisms, which are crucial for nutrient cycling, prefer neutral to slightly acidic pH levels. By moderating the soil pH, SOM helps create conditions that foster a healthy microbial community, which is essential for nutrient availability to plants.

Impact on Buffering Capacity:

- Buffering capacity refers to soil's ability to resist changes in pH upon the addition of acids or bases. This is crucial for maintaining a stable environment conducive to plant growth. The role of SOM in enhancing soil buffering capacity includes:
- Increase of Cation Exchange Capacity (CEC): Organic matter has a high cation exchange capacity, meaning it can hold onto positively charged ions (cations) such as calcium, magnesium, potassium, and hydrogen. When acids are added to the soil, the hydrogen ions are exchanged for other cations on the exchange sites of SOM, preventing a rapid drop in pH.
- Organic Acid Release: SOM contains carboxyl and phenolic groups, which can release or consume hydrogen ions depending on the pH of the surrounding environment. This reaction helps to buffer the soil pH, moderating the effects of acid rains or alkaline irrigation waters.
- Chelation of Metal Ions: SOM can form complex molecules with metal ions, which not only makes nutrients more available to plants but also prevents those metals from catalyzing further acidifying reactions in the soil.

Sustainable Land Management Practices:
To maximize the ecological benefits of SOC, sustainable land management practices are essential. These practices include conservation agriculture, agroforestry, organic farming, and the use of cover crops and crop residues. Conservation agriculture, which minimizes soil disturbance and maintains soil cover, helps preserve SOC and enhance soil health. Agroforestry integrates trees into agricultural landscapes, adding organic carbon through leaf litter and root biomass. Organic farming practices, which rely on organic amendments and reduce chemical inputs, can increase SOC levels and improve soil biodiversity. Cover crops and crop residues provide a continuous supply of organic matter, promoting the buildup of SOC and enhancing nutrient cycling.

6. Soil Fertility and Plant Productivity

Soil fertility is the ability of soil to provide essential nutrients to plants in adequate amounts and appropriate ratios to support their growth, development, and reproduction. Soil organic matter (SOM), with soil organic carbon (SOC) as its main component, is integral to maintaining and enhancing soil fertility, which in turn drives plant productivity. Understanding the relationship between SOM and soil fertility is crucial for sustainable agriculture and ecosystem management.

Nutrient Supply and Cycling:

One of the primary roles of SOM in soil fertility is its function as a reservoir of nutrients. As organic matter decomposes, it releases nutrients in forms that plants can absorb. Nitrogen, phosphorus, and sulfur are key nutrients that are mineralized from organic matter. For instance, nitrogen in organic matter is converted into ammonium (NH_4^+) and nitrate (NO_3^-) through microbial processes, making it available for plant uptake. Phosphorus and sulfur are also released through the action of soil microorganisms that break down organic compounds containing these elements. This continuous nutrient release ensures a steady supply of essential elements, supporting sustained plant growth and high productivity.

Soil Structure and Aeration:

SOM significantly influences soil structure by promoting the formation of soil aggregates. Aggregates are clusters of soil particles bound together by organic matter and microbial exudates. Good soil structure enhances porosity and aeration, allowing roots to penetrate more easily and access water and nutrients. Improved soil structure also reduces soil compaction, which can hinder root growth and limit the availability of oxygen to roots and soil microorganisms. Aerated soils with good structure are more conducive to root development and microbial activity, both of which are critical for efficient nutrient uptake and plant growth.

Water Holding Capacity and Retention:

The water-holding capacity of soil is crucial for plant productivity, especially in regions prone to drought or irregular rainfall. SOM enhances the soil's ability to retain water by increasing its porosity and organic content. Organic matter acts like a sponge, absorbing and holding water that plants can use during dry periods. This capacity to retain water not only reduces the need for frequent irrigation but also helps maintain consistent soil moisture levels, which are essential for optimal plant growth. Additionally, soils with high organic matter content have better water infiltration rates, reducing surface runoff and erosion while improving water availability to plants.

Cation Exchange Capacity (CEC):

SOM contributes to the soil's cation exchange capacity (CEC), which is its ability to hold and exchange positively charged ions (cations) such as potassium (K^+), calcium (Ca^{2+}), and magnesium (Mg^{2+}). A high CEC indicates that the soil can retain more nutrients and make them available to plants over time. Organic matter increases CEC by providing additional sites for nutrient binding. This enhanced nutrient retention capacity helps prevent leaching losses, ensuring that essential nutrients remain in the root zone where they can be accessed by plants. As a result, soils with high SOM levels are more fertile and capable of supporting higher crop yields.

Microbial Activity and Soil Health:

The presence of SOM supports a diverse and active soil microbial community. Microorganisms such as bacteria, fungi, and actinomycetes play a vital role in decomposing organic matter and cycling nutrients. These microbes produce enzymes that break down complex organic compounds into simpler molecules, facilitating nutrient mineralization. Moreover, beneficial microbes can form symbiotic relationships with plant roots, such as mycorrhizal fungi, which enhance nutrient uptake, particularly phosphorus. A healthy and active microbial community also helps suppress soil-borne diseases and pests, reducing the need for chemical inputs and promoting a more sustainable agricultural system.

Buffering Capacity and pH Stability:

SOM can influence the soil's buffering capacity, helping to maintain a stable pH environment. Organic matter can neutralize acidic or alkaline substances, mitigating extreme pH fluctuations that can harm plant roots and soil microorganisms. A stable pH is crucial for nutrient availability, as many nutrients are only accessible to plants within specific pH ranges. By stabilizing soil pH, SOM ensures that nutrients remain soluble and available for plant uptake, thus supporting continuous and healthy plant growth.

Enhanced Plant Productivity:

The cumulative effects of improved nutrient supply, soil structure, water retention, CEC, microbial activity, and pH stability directly translate into enhanced plant productivity. Crops grown in soils rich in organic matter typically exhibit better growth, higher yields, and increased resilience to environmental stresses. For example, studies have shown that organic amendments like compost and manure can significantly increase crop yields compared to conventional chemical fertilizers alone. The holistic benefits provided by SOM create an optimal growing environment that supports vigorous plant development and maximizes agricultural output.

Sustainable Agriculture Practices:
To harness the benefits of SOM for soil fertility and plant productivity, sustainable agriculture practices are essential. These practices include the use of cover crops, crop rotation, reduced tillage, organic amendments, and conservation tillage. Cover crops add organic matter to the soil and protect it from erosion, while crop rotation reduces pest and disease buildup and improves soil structure. Reduced tillage and conservation tillage minimize soil disturbance, preserving soil structure and organic matter. Organic amendments such as compost, manure, and green manure enrich the soil with organic matter and nutrients, fostering a healthy soil ecosystem.

7.Conclusion and Future work

Soil organic matter (SOM) plays an essential role in both enhancing soil fertility and sequestering atmospheric carbon, serving as a cornerstone for sustainable agricultural practices and climate change mitigation. By improving soil structure, increasing nutrient efficiency, and boosting water retention, SOM enhances plant growth and crop yields, which are vital for feeding the growing global population. Additionally, as a major carbon sink, SOM is instrumental in capturing carbon dioxide, thus contributing significantly to efforts aimed at reducing atmospheric CO2 levels. The ability of SOM to perform these functions makes it a critical component in the pursuit of ecological balance and agricultural productivity.

Future Work:
Looking ahead, it is crucial to focus research efforts on optimizing the management and enhancement of SOM across varied agricultural landscapes. This includes developing advanced, region-specific strategies that consider local soil types, climatic conditions, and agricultural practices. Future research should also delve into the mechanisms by which SOM can be increased through innovative farming techniques such as no-till agriculture, cover cropping, and the application of organic amendments like biochar. Additionally, more studies are needed to quantify the long-term impacts of increased SOM on soil health, crop resilience, and carbon sequestration.

Technology will play a pivotal role in advancing our understanding and management of SOM. Tools such as remote sensing, soil sensors, and data analytics can help in precisely monitoring soil health and carbon levels, enabling farmers to adopt more targeted and efficient practices. Moreover, policy initiatives and economic incentives that encourage the adoption of soil-enhancing practices will be essential in mainstreaming the importance of SOM in agricultural and environmental strategies.

In conclusion, by continuing to invest in research, technology, and policy that promote the enhancement of soil organic matter, we can ensure more sustainable agricultural practices and a healthier planet. This integrated approach will not only aid in combating climate change but will also support global food security and ecosystem resilience.

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Conflicts of interest

The authors have no conflicts of interest to declare

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