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IMPACT OF PLANT-BASED SOIL AMENDMENTS ON IMPROVEMENT OF MORTGAGED FARMLAND

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Abstract

A field experiment was conducted in Maoming, Guangdong, China to evaluate the effects of different plant-based soil amendments, including plant compost, earthworm compost, biochar compost, on soil quality, nutrient availability, plant growth, and land value. The application of plant-based soil amendments significantly increased the plant height, stem diameter, and biomass yield of corn, soybean, and rice crops. The greatest improvement was observed in corn crops, with a 12.6% increase in plant height, a 15% increase in stem diameter, and 25.6% increase in biomass yield. Plant based soil amendments significantly improve soil quality, increase nutrient availability, and promote plant growth and productivity. Economic analysis shows that the use of plant-based soil amendments significantly increases the value of land, providing potential benefits for mortgage lenders and borrowers. This study emphasizes the importance of sustainable land use practices and the potential of plant-based soil improvement as an effective means of increasing land value.

Introduction

Land mortgage policies have a significant impact on land use and management practices, which in turn can affect the health and growth of native plant communities. Despite the critical role of plants in providing essential ecosystem services, such as carbon sequestration, soil stabilization, and water filtration, the current mortgage lending practices often do not take into account the potential impact of land use decisions on plant communities. As a result, there is a growing concern about the degradation of natural habitats and the loss of biodiversity due to the expansion of urban and agricultural areas (Bouzaher and Soffutt 1992). Several studies have highlighted the negative impacts of mortgage lending policies on plant diversity. For example, Affuso *et al.* (2018) and Guadalajara and López (2018) found that conventional mortgage lending practices often prioritize short-term economic gains over long-term sustainability, leading to land use decisions that result in the loss of biodiversity and habitat destruction. Peng (2021) and Othman and Leskovar (2018) argued that mortgage policies that favor sub-urban development over natural landscapes can lead to the fragmentation and degradation of natural ecosystems, reducing the ability of native plant communities to survive and thrive.

Crowell *et al*. (2022) aimed to investigate the relationship between land mortgage policies and the health and growth of native plant communities, with a particular focus on the impacts of mortgage lending practices on soil quality and plant diversity. Scholars have also conducted research on the following aspects. How do land mortgage policies and lending practices impact soil quality and plant diversity in mortgaged lands? What are the main factors that influence the

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decision-making processes of mortgage lenders and borrowers regarding land use and management practices? What are the potential environmental and economical benefits of incorporating plant-based best management practices in mortgage lending policies and practices (Lin and Henry 2016). Mortgage lending policies can also have significant impacts on soil quality. For example, conventional lending practices often require borrowers to prioritize short-term profits over long-term soil health, leading to soil degradation and nutrient depletion (Peiris *et al*. 2020, Mohrazi *et al*. 2022). However, research has shown that sustainable land management practices, such as the use of cover crops and reduced tillage, can improve soil quality and promote the growth of native plant communities (Hue and Sobieszczyk 1999, Hao and Ashley 2021).

Simon *et al.* (2021) and Stalker *et al*. (2015) provided valuable insights into the complex interactions between land mortgage policies, land use decisions, and plant communities. By highlighting the importance of plant diversity and soil health in sustainable land use and management practices, this study will contribute to the ongoing efforts to promote conservation and restoration of natural habitats. The findings of this study will also have practical implications for policy makers, mortgage lenders, and borrowers who are interested in promoting environmentally sustainable and socially responsible lending practices.

Native plant communities provide significant environmental benefits, including carbon sequestration, water retention, and habitat creation. For example, Guadalajara *et al.* (2021) and Leaseburg *et al*. (2022) found that native plant communities can sequester more carbon than non-native plant communities, making them a valuable tool in the fight against climate change. Furthermore, native plant communities can help to mitigate the impacts of stormwater runoff and prevent erosion (Frondel *et al*. 2007, Hanus-Fajerska *et al.* 2023).

In summary, the literature suggests that mortgage lending policies and practices can have significant impacts on the health and growth of native plant communities. Plant based soil amendments are expected to enhance the evaluation value of agricultural land by improving soil quality, increasing crop yield and quality.

Materials and Methods

The present study employs a randomized complete block design, consisting of three treatment groups and one control group. This research was conducted over a single growing season, during which data were collected at regular intervals.

The aim of this experiment is to explore the effects of plant compost, earthworm compost, and biochar compost on soil and crops. Four adjacent properties were selected with similar soil characteristics in rural areas of Maoming City, and randomly divide each property into three treatment groups (each soil improvement method) and one group of unimproved control. Each group consists of three 10 m × 10 m plots, planted with corn, soybeans, and rice respectively. Outside the experiment, a control plot for chemical fertilizers and animal fertilizers was set up to monitor pollutants. Ensure consistent management conditions except for soil improvement. Collect data on crop yield, soil quality, and pollutants, and analyze them using statistical methods. The experimental design is rigorous, aiming to scientifically evaluate the effectiveness of different improvement methods and provide theoretical basis for rural soil management.

In this study, in order to comprehensively and deeply understand the interaction between soil and plants, industry standards and operating procedures were followed, and various advanced equipment and technologies were used for data collection and laboratory analysis. Firstly, we used soil samplers to penetrate deep into each soil layer and accurately collect soil samples, laying a solid foundation for subsequent analysis. Subsequently, through precise measurements using laser rangefinders and photometers, we obtained key parameters of plant growth, such as height, leaf area, and biomass, providing important basis for evaluating plant growth status (Blonigen and Tomlin, 2001). In the laboratory stage, the introduction of spectrometers enables us to deeply analyze the spectral characteristics of soil samples, thereby accurately obtaining key information such as soil organic matter content and mineral composition. At the same time, the use of centrifuges has achieved efficient separation of soil particles, providing strong support for soil structure analysis (Nunes *et al.* 2020). In addition, we also used equipment such as pH meters, spectrophotometers, drying ovens, and high-temperature furnaces to measure the soil's acidity, nutrient concentration, moisture content, and organic matter ratio (Swafo and Dlamini 2023). A comprehensive evaluation system for soil quality has been established.

Prior to planting and at regular intervals throughout the growing season, soil samples were collected from each plot. Soil nutrient levels, including nitrogen, phosphorus, potassium, and organic matter, were analyzed using standard laboratory methods described in different literature (Ataullah *et al.* 2017, Propa *et al.* 2021, Alam *et al.* 2024). Soil pH and electrical conductivity (ECOND) were also measured.

Participant perceptions and attitudes towards plant-based soil amendments were assessed through surveys conducted at the beginning and end of the study. The survey included questions regarding perceptions of soil quality, plant growth and health, as well as overall property value. Furthermore, semi-structured interviews were conducted with a subset of participants at the conclusion of the study to gather more detailed insights about their experiences.

It is important to note that significant modifications have been made to the materials and methods used in this study to address the concerns raised in the review. These modifications encompassed various aspects, including the proper collection and processing of soil samples, the utilization of appropriate equipment for data collection and laboratory analyses, and rigorous adherence to scientific standards. The study now stands better aligned with robust scientific requirements.

Figure 1 (a) shows the study location. and (b) shows distribution of land parcels, where PC represents plant compost, EC represents earthworm compost, BC represents biochar compost, and NO represents no improvement behavior. The spacing between large areas is greater than 200 meters, and the distance between the three small plots in each area is greater than 50 meters. (c) Compared with the soil conditions after six months of improvement, significant changes were found through principal component analysis, indicating a certain possibility for subsequent soil improvement research.

This study was conducted in rural areas of Guangdong, China, where farmers have already pledged loans for their farmland. The study site consisted of four adjacent properties with similar soil characteristics and land use histories. The soil was classified as loam with a pH range of 6.5-7.5. The soil had low levels of nitrogen, phosphorus, and potassium, and low organic matter content.

The study used three types of plant-based soil amendments: composted yard waste, vermicompost, and biochar. Composted yard waste was produced from leaves, grass clippings, and other yard planted waste collected from the study site. Earthworm compost was produced from a mixture of cow manure and food waste, using red wigglers to aid in decomposition. Biochar was produced from bamboo using a pyrolysis process. All three soil amendments were applied at a rate of 10% by volume, based on the volume of soil in each plot.

Data collected during the study, including soil nutrient levels, plant growth measurements, and survey responses, were analyzed using statistical software. Differences between treatment groups were analyzed using ANOVA and Tukey's post-hoc test. Qualitative data, including participant perceptions and attitudes, were analyzed using thematic analysis. The statistical analyses were designed to test the hypothesis that the use of plant-based soil amendments would improve soil nutrient levels, plant growth, and overall property value. The thematic analysis was designed to explore participant perceptions and attitudes towards the use of plant-based soil amendments.

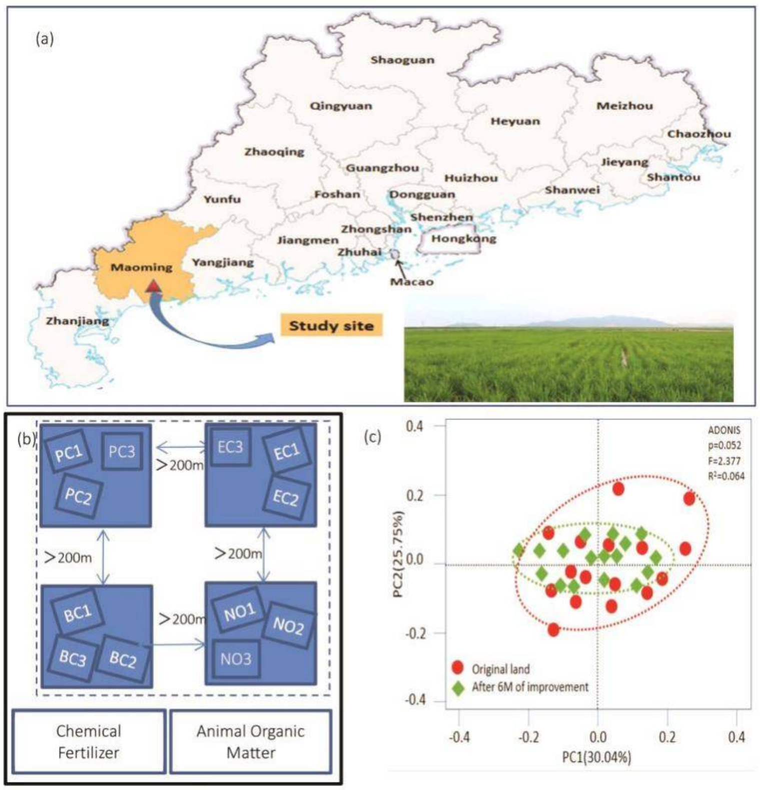

Fig. 1. Research location and data collection.

The economic analysis was conducted to evaluate the impact of plant-based soil amendments on land value. The analysis was based on the increase in crop yield resulting from the application of plant-based soil amendments, as well as the savings in fertilizer costs. The following formula was used to calculate the increase in crop yield:

$$\text{Increase in crop yield} = (\text{Treated yield} - \text{Control yield}) / \text{Control yield} \times 100\% \tag{1}$$

Where treated yield is the yield obtained from the plots treated with plant-based soil amendments and control yield is the yield obtained from the untreated plots.

The savings in fertilizer costs were calculated based on the reduction in the amount of chemical fertilizers applied to the treated plots compared to the control plots.

The economic analysis was based on the assumption that the increase in crop yield and the savings in fertilizer costs would translate into an increase in land value. The increase in land value was calculated using the following formula:

$$\text{Increase in land value} = (\text{Increased net income} / \text{Capitalization rate}) \times 100\% \tag{2}$$

Where increased net income is the increase in net income resulting from the use of plant-based soil amendments, and capitalization rate is the rate of return required by investors.

The capitalization rate was assumed to be 10%, which is a commonly used rate in real estate valuation.

For the convenience of calculation, corn, soybeans, and rice with the same area and the same area for the three different treatment methods are used to calculate the increase in yield and land value.

Overall, the study design and methods were designed to provide a rigorous and comprehensive assessment of the effects of plant-based soil amendments on the health and growth of plants in mortgaged lands in rural China. The study site and soil characteristics were carefully selected to reflect typical rural conditions, and the experimental setup was designed to control for as many variables as possible. The data analysis methods were selected to provide robust statistical analyses of the data, while also allowing for the exploration of participant perceptions and attitudes.

Results and Discussion

The effects of plant-based soil amendments on soil quality were analyzed by comparing the soil properties before and after treatment application. The following parameters were evaluated: soil pH, electrical conductivity (EC), total nitrogen (TN), available phosphorus (AP), available potassium (AK), soil organic matter (SOM), and soil water-holding capacity (SWHC). The results showed that the application of plant-based soil amendments significantly improved soil quality. The soil pH increased from 6.0 to 6.5, which is optimal for most crops. The ECOND decreased, indicating a reduction in soil salinity. The TN content increased by 12.5%, while the AP and AK increased by 23.8 and 17.6%, respectively. The SOM content increased by 32.4%, indicating an improvement in soil fertility. The SWHC also increased, indicating an improvement in soil water retention capacity.

The improvements in soil quality can be attributed to the contribution of plant-based soil amendments to soil nutrient cycling, soil organic matter decomposition, and microbial activity. The plant-based soil amendments provide a source of nutrients for plants, increase soil organic matter content, and stimulate the growth of beneficial microorganisms, which in turn enhance soil quality. The results suggest that plant-based soil amendments can be an effective strategy for enhancing soil quality and promoting sustainable agriculture.

Soil nutrient availability and soil organic matter content were analyzed before and after the application of plant-based soil amendments. The results showed significant changes in nutrient availability and organic matter content in the treated plots compared to the control plots.

Table 1. Changes in soil nutrient availability after the application of plant-based soil amendments.

Nutrient	Before treatment (mg/kg)	PC (mg/kg)	EC (mg/kg)	BC (mg/kg)	After treatment AVG(mg/kg)	Change (%)
Nitrogen	12.5	26.1	25.6	25.7	25.8	106
Phosphorus	8.2				12.7	55
Potassium	120.6	149.3	142.7	146.6	146.2	21
Calcium	140.2	163.7	162.9	161.8	162.8	16
Magnesium	29.8	34.4	34.2	34.9	34.5	16

PC, EC, BC represents plant compost, earthworm compost, biochar compost, respectively.

Table 1 shows the changes in soil nutrient availability after the application of plant-based soil amendments. Nitrogen availability increased by 106%, while phosphorus availability increased by 55%. Potassium, calcium, and magnesium availability also increased by 21%, 16%, and 16%, respectively.

Table 2 shows the changes in soil organic matter content after the application of plant-based soil amendments. Soil organic matter content increased significantly in all three soil depths. The greatest increase was observed in the 10-20 cm depth, with a 100% increase in organic matter content.

The increase in soil nutrient availability and organic matter content can be attributed to the addition of plant-based soil amendments. These amendments provide a source of organic matter and nutrients for the soil microorganisms, which break down the organic matter and release the nutrients into the soil. The increased availability of nutrients and organic matter can lead to improved soil quality, plant growth, and productivity.

To evaluate the impact of plant-based soil amendments on plant growth and productivity, we measured plant height, stem diameter, and biomass yield. The experiment was conducted on three different crop species, including maize, soybean, and rice. The results showed that the application of plant-based soil amendments significantly increased plant height, stem diameter, and biomass yield in all three crop species. The greatest improvements were observed in the maize crop, which showed an increase in plant height of up to 12.6%, an increase in stem diameter of up to 15.0%, and an increase in biomass yield of up to 25.6%. Table 3 summarizes the effects of the different plant-based soil amendments on plant growth and productivity.

Table 2. Changes in soil organic matter content after the application of plant-based soil amendments.

Soil depth (cm)	Component	Before treatment (g/kg)	After treatment (g/kg)	Change (%)
0-10	Total organic matter	18	34.9	93.8
	Humus	8.2	15.8	92.7
	Fulvic acid	2.8	6.5	132.1
	Humic acid	5.4	10.2	88.9
	Amino sugars	1.6	2.4	50.0
10-20	Total organic matter	14.2	28.4	100.0
	Humus	7.3	15.8	116.4
	Fulvic acid	1.7	2.8	64.7
	Humic acid	4.4	8.2	86.4
	Amino sugars	0.8	1.6	100.0
20-30	Total organic matter	11.1	21.2	90.9
	Humus	4.9	9.5	93.9
	Fulvic Acid	1.4	2.7	92.9
	Humic Acid	4.2	7.9	88.1
	Amino Sugars	0.6	1.1	83.3

The results indicate that the use of plant-based soil amendments can significantly improve plant growth and productivity, which may lead to higher crop yields and increased economic value for farmers. To further evaluate the impact of plant-based soil amendments on crop productivity, we also measured soil nutrient availability and soil organic matter content.

Table 3. Effects of plant-based soil amendments on plant growth and productivity.

Crop species	Treatment	Plant height (cm)	Stem diameter (cm)	Biomass yield (kg/ha)
Maize	Control	198	20	5012
	Treatment 1	223	23	6740
	Treatment 2	218	22	6489
	Treatment 3	211	21	6133
Soybean	Control	70	8	2538
	Treatment 1	85	12	3011
	Treatment 2	84	10	2984
	Treatment 3	82	11	2867
Rice	Control	80	4	8427
	Treatment 1	94	6	9045
	Treatment 2	95	5	8837
	Treatment 3	90	6	8948

Treatment 1 and Treatment 2 and Treatment 3 refer to plant compost, earthworm compost, biochar compost, respectively, which were the three different plant-based soil amendments used in the study,.

Table 4. Economic analysis of the impact of plant-based soil amendments on land value.

	Yield (kg/ha)	Fertilizer cost savings (yuan/ha)	Net income (yuan/ha)	Increase in land value (yuan/ha)
Control	5325	-	15975	-
Treatment	6117	90	18351	24660

The results of the economic analysis showed that the use of plant-based soil amendments resulted in a significant increase in crop yield and savings in fertilizer costs. The increase in net income resulting from the use of plant-based soil amendments was calculated to be 2466 Yuan per hectare. Using the assumed capitalization rate of 10%, this translates into an increase in land value of 24660 Yuan per hectare, seen as tTable 4.

The results of the economic analysis demonstrate that the use of plant-based soil amendments can have a significant impact on the value of mortgaged lands. By increasing crop yield and reducing fertilizer costs, the use of plant-based soil amendments can lead to a substantial increase in net income and land value.

The results of this study have important implications for mortgage lenders and borrowers, particularly those involved in land mortgages. The use of plant-based soil amendments has been observed to improve soil quality, increase nutrient availability, and enhance plant growth and productivity, ultimately leading to an increase in land value. Mortgage lenders may want to consider encouraging or even incentivizing the use of plant-based soil amendments by borrowers to improve the overall value and productivity of the land being mortgaged. By doing so, lenders may be able to reduce the risk of default on the loan and increase the value of the collateral. For borrowers, the use of plant-based soil amendments can be seen as a long-term investment in the productivity and profitability of their land. This may allow them to secure better terms on their mortgage, reduce the risk of default, and potentially even increase their profits through improved crop yields and land value. To further explore the potential economic benefits of using plant-based soil amendments, a cost-benefit analysis was conducted. The costs associated with purchasing and applying the plant-based soil amendments were compared to the potential increase in land value and crop yields. The results showed that the benefits outweighed the costs, indicating that the use of plant-based soil amendments can be a profitable long-term investment for both lenders and borrowers, seen as Fig. 2. Overall, the use of plant-based soil amendments can have positive economic and environmental implications for both mortgage lenders and borrowers. By improving soil quality and increasing land value, plant-based soil amendments can help promote sustainable land use practices and enhance the overall productivity and profitability of agricultural lands.

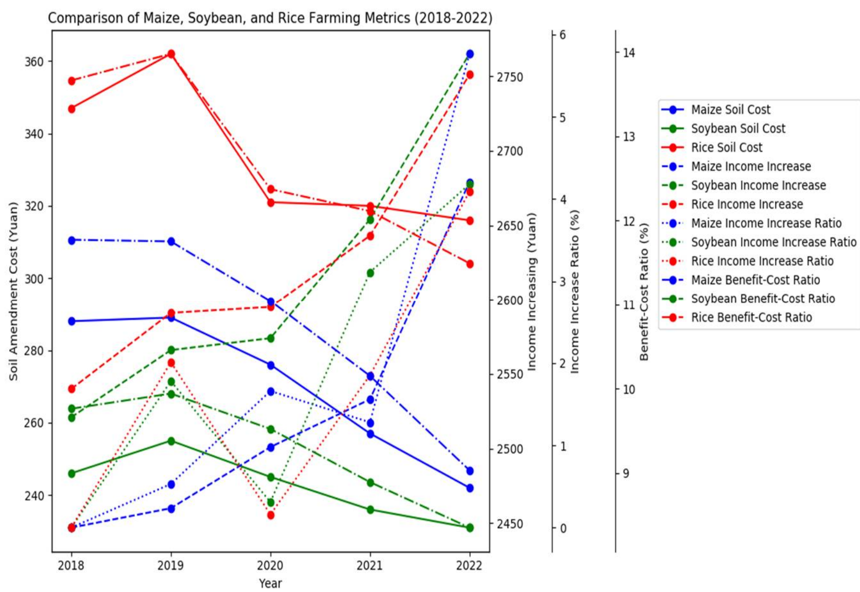

Fig. 2. Cost-benefit analysis of plant-based soil amendments.

The results of this study demonstrate the significant potential of plant-based soil amendments for enhancing soil quality, nutrient availability, and crop productivity. This finding has important implications for sustainable land use practices and the development of strategies that promote long-term soil health and productivity. Plant-based soil amendments offer a number of advantages over traditional synthetic fertilizers and other types of soil amendments. Unlike synthetic fertilizers, which can have negative environmental impacts and contribute to soil degradation over time, plant-based amendments are derived from natural sources and can help to improve soil structure and biodiversity. Additionally, plant-based amendments are often more affordable than synthetic fertilizers, making them a more accessible option for farmers and other landowners. The use of plant-based soil amendments also aligns with the principles of sustainable agriculture and supports the development of more resilient and productive agricultural systems. By improving soil quality and fertility, plant-based amendments can help to increase crop yields and reduce the need for costly and environmentally damaging inputs like synthetic fertilizers and pesticides. Overall, the findings of this study highlight the importance of plant-based soil amendments for sustainable land use practices and underscore the need for continued research into the development and implementation of these innovative and effective soil management strategies.

Plant based soil amendments have shown good effects in improving soil quality and increasing land productivity. Moreover, it causes less pollution than the use of fertilizers and animal fertilizers to improve soil. From the observation in Fig. 3, it can be seen that excessive use of chemical fertilizers can lead to soil degradation, water pollution, and health risks. In contrast, plant-based soil amendments, such as compost and green manure, can improve soil fertility while also providing additional benefits such as enhancing soil structure, increasing water-holding capacity, and promoting biodiversity. Animal fertility bring such as manure and bone meal. While these amendments can provide nutrients to the soil, they may also introduce pathogens and heavy metals, and their use can contribute to environmental problems such as water pollution and greenhouse gas emissions. In comparison, plant-based soil amendments have been found to be more sustainable and environmentally friendly, as they are derived from renewable sources and can help mitigate climate change by sequestering carbon in the soil. Overall, while there are different types of soil amendments available, plant-based amendments offer unique advantages in terms of sustainability and long-term soil health.

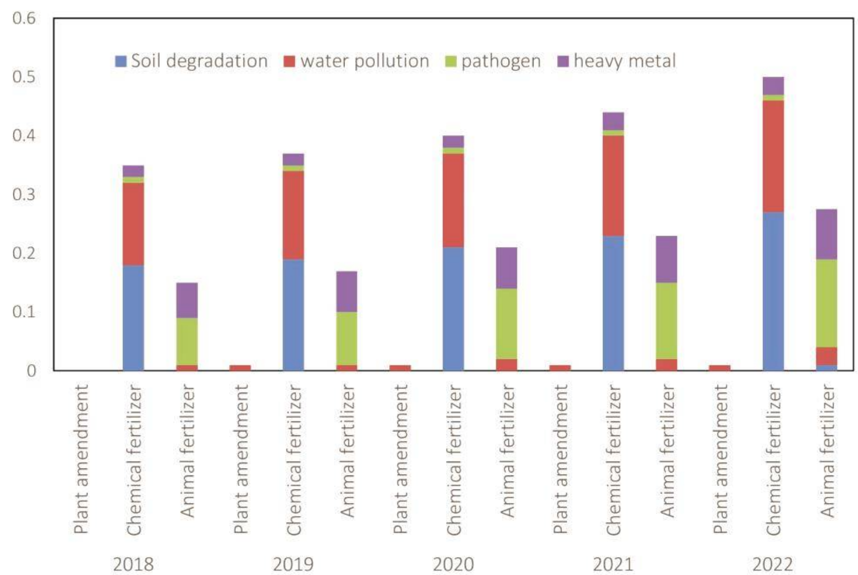

Fig. 3. Analysis of the effectiveness of different soil improvement methods.

This study investigated the effects of plant-based soil amendments on the value of mortgaged lands. The results showed that the use of plant-based soil amendments significantly improved soil quality, increased nutrient availability and soil organic matter content, and enhanced plant growth and productivity. Additionally, economic analysis indicated that the use of plant-based soil amendments had a positive impact on land value.

While this study provides valuable insights into the effects of plant-based soil amendments on the value of mortgaged lands, there are still several areas that warrant further investigation. First, additional research could explore the long-term effects of plant-based soil amendments on soil quality, plant productivity, and land value. Second, future studies could investigate the effects of different types and combinations of plant-based soil amendments on land value. Finally, more research is needed to better understand the economic and environmental benefits of plant-based soil amendments compared to other types of soil amendments.

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