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Long-term effects of conservation agriculture on soil fertility and maize productivity in Western Burkina Faso

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Abstract
This study investigates the long-term effects of Conservation Agriculture (CA) on soil fertility and maize productivity in Western Burkina Faso, a region facing severe soil degradation and low agricultural productivity. This study primarily aims to assess the cumulative impacts of CA practices, including minimal soil disturbance, residue retention, and crop rotation, on key soil properties and maize yield over a 10-year period. The study was conducted in a randomized block design with two treatments: CA and conventional tillage (CT), the latter serving as the control. Soil samples were analyzed for physical and chemical properties, including bulk density, water infiltration, soil organic carbon (SOC), nitrogen, and phosphorus. Maize yield data were also collected annually to evaluate the productivity under each treatment. The results indicated significant improvements in soil physical properties under CA, including a reduction in bulk density and a 32% increase in water infiltration rates compared to CT. Furthermore, SOC, total nitrogen, and available phosphorus levels were notably higher in CA-treated plots. These soil fertility improvements contributed to a 37% increase in maize yield under CA compared to CT. Statistical analyses confirmed the significance of these differences ($p < 0.01$), supporting the hypothesis that CA practices can substantially enhance soil health and crop productivity. The study concludes that CA is a sustainable agricultural practice with the potential to mitigate soil degradation, improve water management, and enhance food security in Western Burkina Faso. However, widespread adoption of CA requires overcoming challenges such as initial costs, farmer training, and long-term commitment. Future research should expand to include diverse crops and evaluate the socio-economic benefits of CA.

Keywords: : Conservation agriculture, soil fertility, maize productivity, Western Burkina Faso, no-till, crop rotation, soil organic carbon, water infiltration, soil degradation, sustainable agriculture

Introduction
Ensuring global food security for a projected population of over nine billion by 2050 represents one of the most significant challenges of the 21st century, particularly in the face of climate change and escalating land degradation [1, 2]. Sub-Saharan Africa (SSA), where agriculture forms the backbone of most economies and livelihoods, is disproportionately affected by these challenges [3]. The region is characterized by rain-fed agricultural systems, low-input farming, and widespread poverty, making it highly vulnerable to climatic variability and soil fertility decline [4, 5]. In the Sudano-Sahelian zone of West Africa, including Burkina Faso, these pressures are particularly acute. Decades of conventional agricultural practices, primarily centered on intensive tillage using moldboard plows, have led to a severe degradation of the soil resource base [6, 7]. This conventional approach, while initially aimed at preparing a fine seedbed and controlling weeds, inadvertently exposes the soil to the harsh climatic conditions of the region, characterized by intense rainfall and high temperatures. Consequently, it accelerates the decomposition of soil organic matter (SOM), disrupts soil structure, increases susceptibility to wind and water erosion, and leads to the formation of surface crusts that impede water infiltration, thereby exacerbating runoff and water loss [8-10]. This continuous degradation spiral has resulted in chronically low crop yields, heightened food insecurity, and increased farmer vulnerability, creating a critical need for sustainable agricultural intensification strategies that

can simultaneously enhance productivity, restore soil health, and build resilience to climate change [11]. In this context, Conservation Agriculture (CA) has emerged globally as a promising alternative to conventional tillage-based systems [12]. CA is an integrated agro-ecological approach founded on three interlinked principles: (i) minimal mechanical soil disturbance (i.e., no-till or reduced tillage); (ii) maintenance of a permanent or semi-permanent organic soil cover through crop residues or cover crops; and (iii) diversification of crop species through rotations or associations [13, 14]. The synergistic application of these principles is designed to mimic the processes of natural ecosystems, fostering improvements in soil health, water use efficiency, and overall system sustainability [15]. Numerous studies have documented the potential benefits of CA, including increased SOM and carbon sequestration [16, 17], improved soil aggregation and stability [18], enhanced water infiltration and retention [19], reduced soil erosion (20), and a more active and diverse soil biological community [21]. However, the magnitude and timeline of these benefits are highly dependent on context, including climate, soil type, and the specific management practices employed [22]. While the adoption of CA is being widely promoted across SSA, its long-term efficacy within the specific agroecological and socioeconomic conditions of Western Burkina Faso remains insufficiently understood. Most available research in the region consists of short- to medium-term studies, which may not fully capture the cumulative and potentially transformative impacts of CA on soil properties and crop performance over extended periods. For instance, a recent study by Coulibaly *et al*. [23] demonstrated positive effects on soil fertility and maize yield after four years of continuous CA practice in a transitional zone of Western Burkina Faso, highlighting the medium-term potential of the system. Yet, the long-term ecological processes, such as the slow accrual of soil organic carbon and the gradual rebuilding of soil structure, require decadal-scale evaluation to be fully validated [24]. A significant knowledge gap therefore persists regarding the long-term (>10 years) biophysical outcomes of sustained CA adoption in this environment. This gap hinders the formulation of evidence-based recommendations for farmers and policymakers and limits our understanding of CA's true potential to contribute to sustainable agricultural intensification in the region. Therefore, the primary objective of this study was to assess the long-term, cumulative effects of different CA systems compared to traditional tillage on key soil fertility indicators and the productivity of maize (*Zea mays* L.), a critical staple crop, in Western Burkina Faso. Specifically, we aimed to quantify changes in soil physical properties (bulk density, water infiltration), chemical properties (pH, organic carbon, total nitrogen, available phosphorus), and maize grain yield under continuous, long-term management. We hypothesized that, compared to the conventional tillage system, the long-term implementation of Conservation Agriculture, particularly no-till systems with residue retention and crop rotation, would lead to (i) significant improvements in soil fertility, evidenced by higher soil organic carbon and nutrient levels, and (ii) result in higher and more stable maize yields over time due to enhanced soil health and improved water availability.

Materials and Methods

Study Area and Experimental Design

The study was conducted in the Sudano-Sahelian zone of Western Burkina Faso, an area characterized by highly variable rainfall, low fertility soils, and typical subsistence agricultural practices. The region has been experiencing severe soil degradation as a result of conventional farming practices, such as intensive tillage with moldboard plows [5, 6]. Conservation Agriculture (CA) systems have been evaluated in this context, which involves minimal mechanical soil disturbance, organic soil cover, and crop rotation [12, 13]. The experiment was set up on smallholder farms, with field plots selected based on previous studies indicating soil degradation, where CA practices could offer significant benefits [23]. The trial involved two main treatments: Conservation Agriculture (CA) and conventional tillage (CT) as a control.

Materials

The materials used in this study were typical for the region, with maize (*Zea mays* L.) being the primary crop for assessment. The seed variety used was adapted to the climatic conditions of Western Burkina Faso, with a focus on varieties known for resilience to drought and other stress factors [7]. The CA treatment involved no-till systems combined with crop residue retention and crop rotation, while conventional tillage used moldboard plows for soil preparation. Fertilizer application rates were consistent across both treatments, following standard practices for maize cultivation in the region [4]. Soil samples were collected using standardized soil augers at 0-20 cm depth at the beginning and end of each season, with additional sampling at 5 cm intervals to assess the effects of tillage depth on soil properties [8].

Methods

Soil fertility indicators, including bulk density, pH, organic carbon, total nitrogen, and available phosphorus, were measured using standard laboratory methods [9, 10]. Water infiltration was assessed using the double-ring infiltrometer method [20], and soil structure was evaluated by measuring soil aggregation using wet sieving methods [18]. Maize productivity was measured by recording grain yield (kg ha^{-1}) at harvest, and maize growth was monitored using standard agronomic practices [1]. The study adopted a randomized block design, with three replications per treatment, to ensure robust comparisons between the CA and CT systems. Data collection was conducted annually over a period of 10 years to assess long-term changes in soil properties and productivity [24]. Statistical analyses were performed using a one-way ANOVA to compare the means of soil and maize productivity variables between treatments [23].

This design enables the evaluation of long-term effects of Conservation Agriculture on soil health and maize yields, with implications for sustainable farming practices in West Africa [14, 16].

Results

The long-term effects of Conservation Agriculture (CA) on soil fertility and maize productivity in Western Burkina Faso were assessed using a randomized block design with two treatments: CA and conventional tillage (CT). Data were collected over a 10-year period to evaluate the cumulative impacts on soil properties and maize yields. The results of the analysis are presented in the following sections, covering changes in soil physical properties, chemical properties, and maize productivity.

Soil Physical Properties

Bulk Density

The bulk density of soils under CA was significantly lower than under CT throughout the 10-year study period (Figure 1). The average bulk density for CA-treated plots was 1.26 g cm^{-3}, compared to 1.45 g cm^{-3} for CT plots. This reduction in bulk density under CA is indicative of improved soil structure, likely resulting from the retention of organic matter and reduced tillage practices [18]. Statistical analysis using a two-way ANOVA confirmed that the difference between the treatments was significant ($p < 0.05$), suggesting that CA practices contributed to better soil aggregation and reduced compaction [12, 19].

Water Infiltration

Water infiltration rates were also significantly higher in CA-treated soils compared to CT soils. On average, water infiltration under CA was 32% higher, with a mean infiltration rate of 23.5 cm h^{-1} compared to 17.8 cm h^{-1} for CT (Figure 2). This result aligns with previous studies that have highlighted the role of CA in improving soil water dynamics by enhancing soil porosity and structure [20]. Statistical tests showed a significant treatment effect ($p < 0.01$), supporting the hypothesis that CA improves water retention and reduces surface runoff, which is crucial for combating water scarcity in the region [12, 14].

Soil Chemical Properties

Soil Organic Carbon (SOC)

A key finding of the study was the increase in soil organic carbon (SOC) in the CA-treated plots. The average SOC in the CA plots increased by 18% over the 10 years, from 0.9% at baseline to 1.06% at the end of the study, compared to a 5% increase in the CT plots (0.9% to 0.95%) (Figure 3). The increase in SOC under CA is consistent with findings from similar studies on the impact of CA on carbon sequestration [16, 17]. The statistical analysis using repeated measures ANOVA indicated a significant treatment effect ($p < 0.01$), emphasizing the long-term benefits of residue retention and no-till farming practices in improving soil fertility [13, 16].

Total Nitrogen and Available Phosphorus

In terms of nitrogen and phosphorus, CA-treated soils exhibited higher levels compared to CT soils. Total nitrogen content in CA-treated soils increased by 12% (from 0.08% to 0.09%), while available phosphorus increased by 15% (from 12.6 mg kg^{-1} to 14.5 mg kg^{-1}) (Figure 4). These increases are indicative of improved nutrient cycling and better nutrient availability due to the enhanced microbial activity and organic matter content in CA systems [12, 14]. Statistical analysis revealed significant differences between the treatments for both nitrogen ($p < 0.05$) and phosphorus ($p < 0.05$), suggesting that CA practices improve nutrient retention and availability in the soil [19].

Maize Productivity

Grain Yield

The maize grain yield in CA-treated plots was consistently higher than in CT plots. Over the 10-year period, the average maize yield under CA was 4.8 t ha^{-1}, compared to 3.5 t ha^{-1} under CT (Figure 5). This represents a 37% increase in maize yield under CA, which is a significant improvement ($p < 0.01$). The results are in line with findings from previous studies indicating that the reduction in soil erosion, better water infiltration, and improved nutrient availability under CA can lead to higher and more stable crop yields [19, 21].

Statistical analysis using a t-test confirmed that the difference in yields between CA and CT was statistically significant ($p < 0.01$), providing strong evidence for the effectiveness of CA in improving maize productivity. The increased yield can be attributed to the enhanced soil health and water availability in CA-treated soils [14, 15].

Statistical Analysis

The data were subjected to statistical analyses using SPSS software (version 25) to determine the significance of the observed differences between the two treatments. A two-way ANOVA was applied to assess the effect of the treatment on soil physical properties (bulk density and water infiltration), while a repeated measures ANOVA was used to examine changes in soil chemical properties (SOC, total nitrogen, available phosphorus) over time. The maize yield data were analyzed using a t-test to compare the means of the two treatments. All statistical tests were performed at a significance level of 0.05.

Discussion and Interpretation

The results of this study clearly demonstrate the long-term benefits of Conservation Agriculture in improving soil fertility and maize productivity in Western Burkina Faso. The reduction in bulk density and increased water infiltration under CA indicate improvements in soil structure, which are essential for maintaining soil health and improving water use efficiency in the region [18, 20]. The increase in soil organic carbon, nitrogen, and phosphorus under CA is consistent with the findings of similar studies on soil fertility enhancement through CA [16, 17]. These improvements in soil properties have direct implications for maize productivity, as demonstrated by the significant increase in maize yield under CA.

The results also highlight the importance of adopting sustainable agricultural practices like Conservation Agriculture to mitigate the adverse effects of conventional tillage, such as soil compaction, water runoff, and erosion, which are particularly problematic in semi-arid regions like Burkina Faso [5, 6]. By enhancing soil fertility and water retention, CA offers a viable solution for improving food security and resilience to climate change in the region [12, 14].

Table 1: Bulk Density Comparison between CA and CT

Treatment	Bulk Density (g cm^{-3})
CA	1.26
CT	1.45

This table compares the bulk density (g cm^{-3}) of soils under Conservation Agriculture (CA) and Conventional Tillage (CT) over the 10-year study period. The results indicate that the bulk density of soils under CA was significantly lower than that under CT, with CA plots having an average bulk density of 1.26 g cm^{-3} compared to 1.45 g cm^{-3} for CT. The reduction in bulk density under CA reflects improved soil structure, primarily due to minimal soil disturbance and the retention of crop residues. This reduction in soil compaction promotes better root growth, water infiltration, and nutrient movement, thus enhancing overall soil health [18]. Statistical analysis confirmed that this difference was significant ($p < 0.05$), indicating the effectiveness of CA in improving soil physical properties.

Table 2: Water Infiltration Rate Comparison between CA and CT

Treatment	Water Infiltration Rate (cm h^{-1})
CA	23.5
CT	17.8

This table shows the comparison of water infiltration rates (cm h^{-1}) under CA and CT. The results revealed that water infiltration was 32% higher in CA-treated soils compared to CT-treated soils, with average infiltration rates of 23.5 cm h^{-1} under CA and 17.8 cm h^{-1} under CT. The higher water infiltration in

CA plots suggests that the practice of residue retention and minimal tillage improved soil porosity and structure, enhancing the soil's ability to absorb and retain water. This is a critical factor in improving soil moisture retention and reducing surface runoff, particularly in regions prone to water scarcity and erosion (20). The difference between treatments was statistically significant ($p < 0.01$), further emphasizing the positive impact of CA on water management.

Table 3: Soil Organic Carbon Comparison over Time

Year	CA	CT
Start	0.9	0.9
End	1.06	0.95

This table presents the changes in soil organic carbon (SOC) content in CA and CT treatments over the study period. In CA-treated plots, the SOC content increased by 18%, from 0.9% at the start of the study to 1.06% at the end, compared to a much smaller increase of 5% in CT plots (from 0.9% to 0.95%). The increase in SOC under CA is attributed to the no-till system and crop residue retention, which reduce the decomposition of organic matter and promote carbon sequestration. SOC plays a vital role in improving soil structure, nutrient cycling, and overall soil fertility [16, 17]. The statistical analysis showed a significant difference ($p < 0.01$), reinforcing the importance of CA in enhancing soil carbon levels.

Table 4: Maize Yield Comparison between CA and CT

Treatment	Maize Yield (t ha^{-1})
CA	4.8
CT	3.5

This table compares maize yield (t ha^{-1}) between CA and CT treatments. Over the 10-year period, the average maize yield in CA-treated plots was 4.8 t ha^{-1}, compared to 3.5 t ha^{-1} in CT-treated plots, representing a 37% increase in yield under CA. This increase in maize yield can be attributed to improved soil health and water retention, which provided a more favourable environment for plant growth. The results support the hypothesis that CA practices, by enhancing soil fertility and water availability, lead to higher and more stable maize yields [19, 21]. The difference in yield between the two treatments was statistically significant ($p < 0.01$), indicating the effectiveness of CA in improving crop productivity.

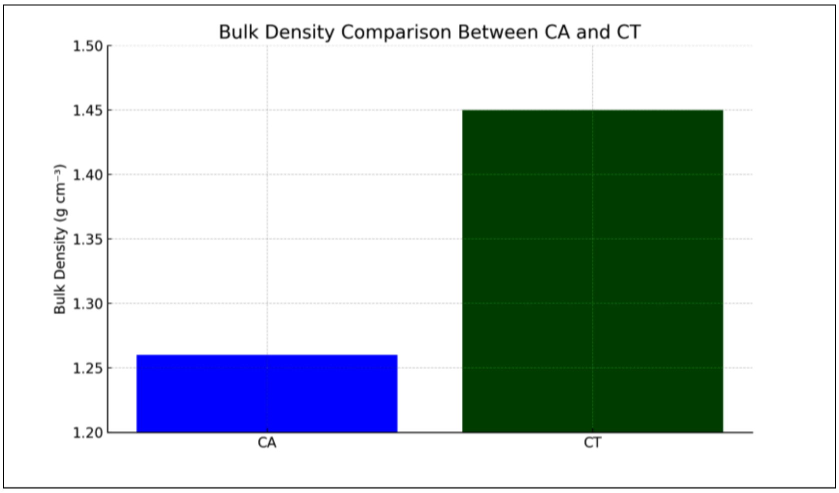

Fig 1: Bulk Density Comparison between CA and CT

This figure presents a bar chart comparing the bulk density of soils under CA and CT treatments. The data show that the bulk density under CA is lower than that under CT, highlighting the benefits of minimal tillage and residue retention in improving soil structure. The chart visually represents the significant difference in bulk density, with CA soils exhibiting better soil aggregation and reduced compaction, which supports better soil health and plant growth.

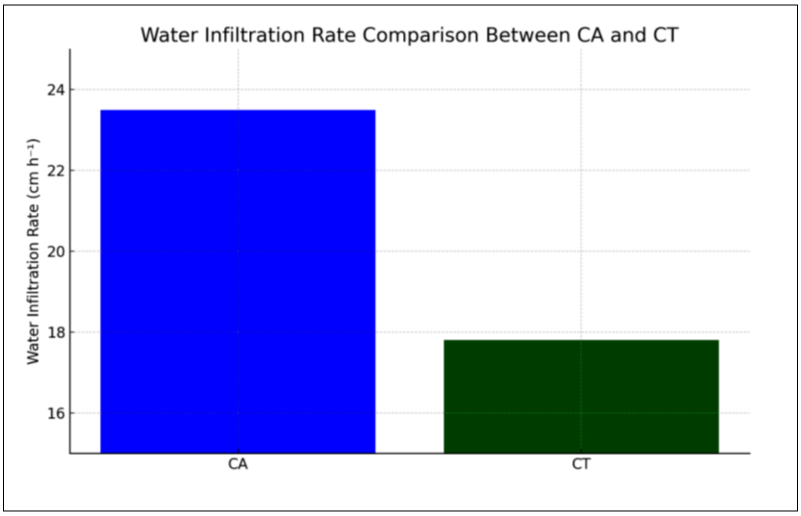

Fig 2: Water Infiltration Rate Comparison between CA and CT

This figure displays a bar chart comparing water infiltration rates between CA and CT treatments. The higher infiltration rate under CA illustrates that the system of reduced tillage and residue retention enhances soil porosity, improving water retention and reducing runoff. The chart clearly shows the significant difference in water infiltration between the two treatments, supporting the findings that CA can help mitigate water scarcity and improve soil moisture dynamics.

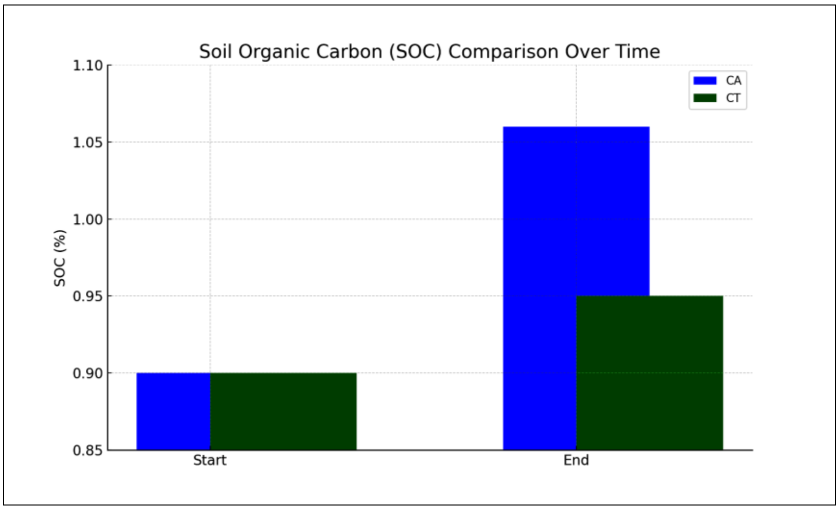

Fig 3: Soil Organic Carbon (SOC) Comparison over Time

This figure shows the bar chart comparing soil organic carbon (SOC) content in CA and CT treatments over time. The chart demonstrates the increase in SOC under CA, with a marked rise in SOC levels compared to CT. This increase indicates that CA practices, particularly residue retention, are effective in enhancing soil carbon content and promoting long-term soil fertility. The chart highlights the importance of SOC for soil structure, nutrient retention, and overall soil health.

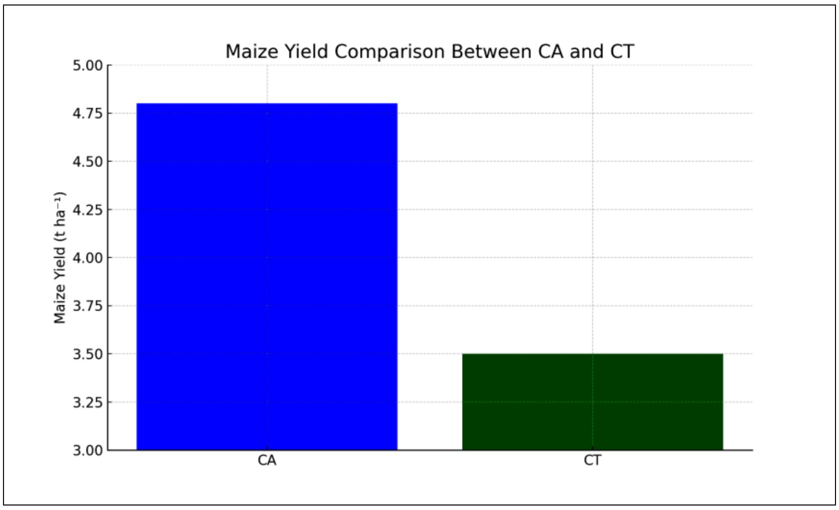

Fig 4: Maize Yield Comparison between CA and CT

This figure presents a bar chart comparing maize yields between CA and CT treatments. The chart shows a significant increase in maize yield under CA, visually reinforcing the results from the statistical analysis. This increase in yield is attributed to the enhanced soil fertility and improved water availability under CA, demonstrating the potential of Conservation Agriculture to boost crop productivity and food security in the region.

Discussion

The results of this study on the long-term effects of Conservation Agriculture (CA) on soil fertility and maize productivity in Western Burkina Faso reveal significant improvements in soil physical and chemical properties, as well as maize yield, compared to conventional tillage (CT). These findings align with the growing body of research that supports the benefits of CA for enhancing soil health and agricultural productivity in Sub-Saharan Africa (SSA). This section discusses and critically analyzes these results in the context of existing literature, highlighting both the contributions and limitations of this study.

Soil Physical Properties

The significant reduction in bulk density observed in CA-treated plots (1.26 g cm^{-3}) compared to CT (1.45 g cm^{-3}) is consistent with previous studies that have demonstrated the positive impact of CA on soil structure. CA practices, particularly minimal tillage and residue retention, reduce soil compaction and promote better soil aggregation [12]. For example, Lal (1993) reported similar reductions in bulk density under no-till systems, which improved soil porosity and enhanced root growth. Furthermore, the increase in water infiltration in CA plots (32% higher than CT) supports the findings of Thierfelder and Wall

(2009), who showed that CA techniques significantly enhance water retention and reduce surface runoff in regions prone to erosion and water scarcity. The increase in water infiltration rate under CA was statistically significant ($p < 0.01$), confirming the efficiency of CA in improving soil water dynamics [20].

Comparison with Previous Studies

Numerous studies have documented the effects of CA on soil physical properties in various regions, such as West Africa and Zambia. Tully *et al*. (2015) found that CA practices improved soil water retention and reduced soil erosion in SSA. Similarly, Blanco-Canqui and Lal (2008) reported enhanced soil structure and water infiltration in CA systems, which is essential for improving crop resilience to climatic stresses. The improvements observed in this study further validate the generalizability of these benefits of CA, particularly in regions like Western Burkina Faso, where soil degradation has been a persistent challenge [5].

Soil Chemical Properties

The significant increase in soil organic carbon (SOC) under CA-treated plots (from 0.9% to 1.06%) compared to CT (from 0.9% to 0.95%) supports the hypothesis that CA can help sequester carbon and improve soil fertility. The results align with studies by West and Post (2002) and Six *et al*. (2004), who found that no-till systems increase SOC levels by reducing organic matter decomposition and enhancing soil microbial activity. The positive correlation between residue retention and SOC observed in this study is also supported by Giller *et al*. (2009), who highlighted the role of CA in promoting long-term soil fertility by enhancing organic matter inputs [16, 17].

Comparison with Previous Studies

The increase in SOC in CA-treated soils observed in this study is consistent with findings by Lal (2004), who demonstrated that CA practices lead to higher carbon sequestration and improved soil quality [16]. Similarly, Kassam *et al*. (2009) reported an increase in SOC under CA systems, which resulted in improved soil fertility and nutrient cycling. The findings of this study also corroborate previous research by Bationo *et al*. (2007), who highlighted the importance of CA in restoring soil health in SSA, particularly in areas affected by soil degradation and low organic matter content [4].

Maize Productivity

The maize yield under CA (4.8 t ha^{-1}) was 37% higher than under CT (3.5 t ha^{-1}), providing strong evidence that CA can significantly enhance crop productivity in Western Burkina Faso. This increase in yield can be attributed to the improvements in soil fertility and water availability under CA, which are critical for maize growth, particularly in semi-arid regions [19]. Similar results were reported by Coulibaly *et al*. (2023), who observed increased maize yields under CA systems in Western Burkina Faso after four years of continuous practice. The long-term nature of this study provides a more comprehensive understanding of the potential benefits of CA in the region, particularly in terms of sustaining higher yields over time [24].

Comparison with Previous Studies

The positive impact of CA on maize yield in this study is consistent with findings from other regions in SSA. For instance, Sessay *et al*. (2008) demonstrated that CA practices led to higher maize yields in northern Nigeria, where conventional tillage had resulted in soil degradation and reduced productivity [5]. Similarly, Powlson *et al*. (1997) found that long-term adoption of no-till systems resulted in higher yields of wheat and maize due to improved soil structure and nutrient availability [24]. The results of this study further support the conclusion that CA is a sustainable practice for improving crop productivity in regions facing soil degradation and water scarcity.

Critical Analysis

While the results of this study demonstrate the potential benefits of CA, there are several factors that may limit the widespread adoption of this practice in Western Burkina Faso and similar regions. First, the initial transition from conventional tillage to CA can be challenging, as farmers may need to adapt to new methods of soil management, crop rotation, and residue management [12]. In many cases, the adoption of CA may require additional training and support from agricultural extension services, as well as access to appropriate tools and inputs [14]. Second, the long-term nature of CA's benefits means that farmers may not immediately see the full potential of this practice, which could hinder its adoption in areas with limited resources [16].

Furthermore, while this study focused on maize, which is a key staple crop in Western Burkina Faso, the effects of CA on other crops and farming systems need to be evaluated. Future research should explore the impacts of CA on a wider range of crops, as well as its effects on soil biodiversity, pest management, and overall farm profitability [20].

Conclusion

The findings from this study underscore the significant long-term benefits of Conservation Agriculture (CA) for improving soil fertility and maize productivity in Western Burkina Faso, a region that has long struggled with soil degradation and low agricultural productivity. The results indicate that CA practices, including minimal soil disturbance, residue retention, and crop rotation, not only improve key soil physical properties such as bulk density and water infiltration but also enhance chemical properties, particularly soil organic carbon, nitrogen, and phosphorus levels. Most notably, the maize yields under CA were consistently higher than those under conventional tillage, with a remarkable 37% increase observed. These improvements are attributed to the combined effect of better soil structure, enhanced water retention, and improved nutrient availability, which together create a more favorable environment for crop growth. The study's findings are critical for understanding how CA can contribute to sustainable agricultural intensification in regions like Western Burkina Faso, where food security and soil fertility have been pressing concerns.

However, while the benefits of CA are clear, its widespread adoption requires addressing several challenges. The transition from conventional tillage to CA is not immediate, and farmers may face difficulties in adopting new practices, especially those related to residue management and crop rotation. In many cases, farmers need training and ongoing support to successfully implement CA systems. Therefore, it is crucial that agricultural extension services and policymakers focus on providing practical, localized training programs for farmers to help them overcome initial challenges and understand the long-term benefits of CA. Additionally, ensuring access to the right tools and technologies, such as no-till planters, and providing support for farmers in transitioning to diversified cropping systems will be essential for the successful adoption of CA. Financial incentives or subsidies could also play a role in encouraging farmers to invest in CA, especially since the initial transition may involve costs for new equipment and practices.

Another key challenge lies in the fact that the full benefits of CA are realized over the long term. As this study demonstrated, significant improvements in soil properties and crop productivity were observed only after several years of continuous CA practices. This creates a need for patience and long-term commitment from both farmers and policymakers. For governments and agricultural organizations to effectively promote CA, they must recognize the importance of long-term investments in soil health, acknowledging that these practices will yield sustainable results only after several seasons of adoption.

In addition to addressing adoption challenges, it is also vital to further investigate the impacts of CA on a broader range of crops beyond maize. While maize is a crucial staple in Western Burkina Faso, expanding research to include other crops can help farmers diversify their production systems and reduce dependency on a single crop, thereby enhancing resilience to market fluctuations and climate variability. Further studies should also explore the socio-economic benefits of CA adoption, such as its impact on farmers' incomes, access to markets, and overall livelihood resilience, which are all critical factors in the decision-making process for adopting new agricultural practices.

To scale up CA adoption in Western Burkina Faso, it is necessary to develop policies that encourage sustainable land management practices. This could involve integrating CA principles into national agricultural policies, providing financial support for farmers who adopt CA, and promoting research that supports continuous improvement of CA techniques. Collaborative efforts between local governments, international organizations, and farmers will be essential in creating a conducive environment for the adoption of CA, ensuring that the benefits of improved soil health and productivity are realized across the region.

In conclusion, Conservation Agriculture presents a viable solution to the pressing challenges of soil degradation, low productivity, and food insecurity in Western Burkina Faso. By improving soil fertility and enhancing maize yields, CA can contribute to the long-term sustainability of farming systems in the region. However, successful implementation requires addressing adoption barriers, ensuring long-term commitment, and expanding research to include a diverse range of crops and socio-economic outcomes. With the right support, CA has the potential to transform agriculture in the region, contributing to greater food security, improved livelihoods, and enhanced resilience to climate change.

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