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Impact of Organic Farming on Soil Quality, Microbiology, and Crop Productivity in Coastal Andhra Pradesh, India

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Abstract

Aim: In contrast, organic farming practices—including the application of compost, green manure, and biofertilizers—are recognized for improving soil fertility, enhancing biological activity, and promoting ecological sustainability.

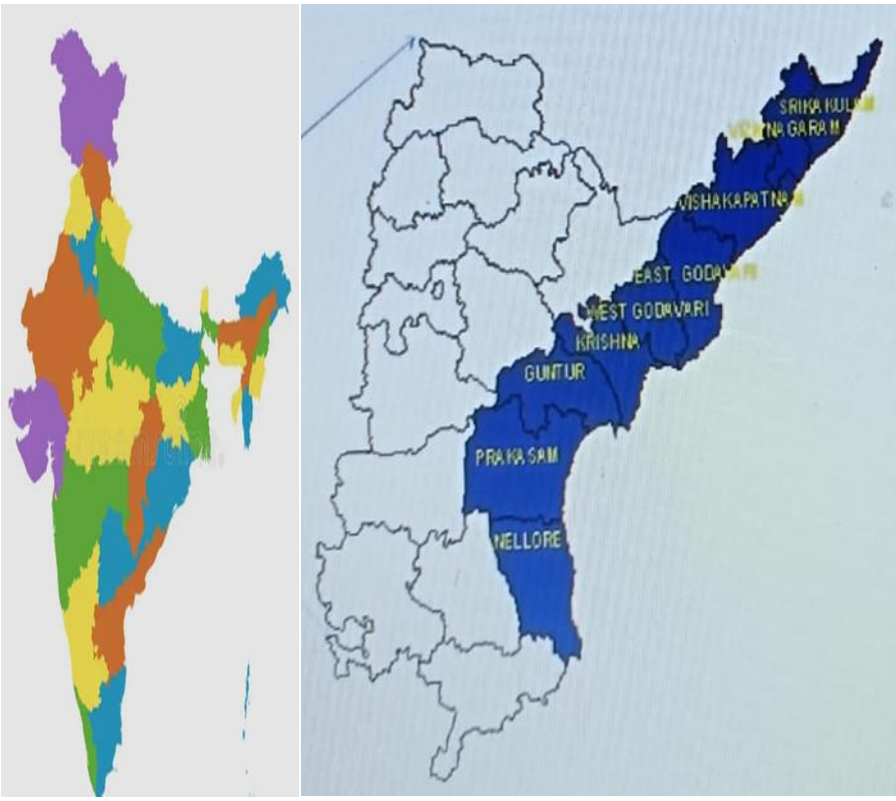
Methods: This study investigates the effects of organic versus conventional maize (*Zea mays*) cultivation on soil physicochemical properties, microbial biomass carbon, nutrient availability, and crop productivity across selected coastal districts of Andhra Pradesh, including East Godavari, West Godavari, and Krishna. Experimental plots were established using a randomized block design, with conventional plots receiving standard NPK fertilizers and organic plots managed with compost and green manure. Soil samples (0–15 cm) were collected pre- and post-harvest and analyzed for pH, electrical conductivity, soil organic carbon (SOC), available nitrogen (N), phosphorus (P), potassium (K), and microbial biomass carbon (MBC). Maize grain yield was recorded at maturity.

Results: Organic management significantly increased SOC by 146%, available nitrogen by 36%, and phosphorus by 76% compared to conventional practices. Microbial biomass carbon was approximately doubled in organically managed plots, indicating enhanced soil biological activity. Maize yield under organic treatment was 5.00 t/ha, a 13.6% improvement over conventional plots (4.40 t/ha), suggesting that improved soil quality translates to higher crop productivity. Statistical analysis using one-way ANOVA confirmed the significance of these differences ($p \leq 0.05$).

Conclusion: The potential of organic farming to restore soil health, promote sustainable nutrient cycling, and maintain or improve crop productivity and it could provide a long-term solution for smallholder farmers in the coastal agro-ecosystems of Andhra Pradesh.

Keywords: Coastal Andhra Pradesh, organic farming, soil organic carbon, microbial biomass, maize productivity, soil fertility.

Field map-I : Study area map along with crop field areas of conventional and organic crop.



1. Introduction

Agriculture is the backbone of the Indian economy, providing livelihoods for millions and contributing significantly to national food security. In particular, **Coastal Andhra Pradesh**, encompassing districts such as East Godavari, West Godavari, and Krishna, is one of the most productive agricultural regions in India due to its fertile alluvial soils, tropical climate, and extensive irrigation networks. The region supports intensive cultivation of crops such as paddy, maize (*Zea mays*), pulses, and horticultural crops, forming a critical component of the local economy. However, the intensive adoption of conventional farming practices, characterized by heavy reliance on synthetic fertilizers and pesticides, has resulted in progressive **soil degradation**, depletion of soil organic matter, reduced microbial activity, and environmental pollution.

Soil health is increasingly recognized as the foundation of sustainable agriculture. **Soil organic carbon (SOC)**, a key indicator of soil quality, plays a central role in maintaining soil structure, water retention, nutrient availability, and microbial biodiversity. Conventional farming systems often accelerate SOC loss, adversely affecting nutrient cycling and long-term fertility. In contrast, **organic farming systems**, which incorporate compost, green manure, vermicompost, and bio-fertilizers, aim to improve soil health, enhance microbial populations, and reduce dependency on chemical inputs. Such systems not only contribute to sustainable crop production but also mitigate environmental degradation and promote resilience against climate variability, which is particularly relevant in coastal regions prone to salinity intrusion and erratic rainfall patterns.

Recent studies have shown that organic amendments enhance soil microbial biomass, nutrient mineralization, and crop productivity in various Indian agro-ecosystems. Microbial biomass carbon (MBC) is considered a sensitive indicator of soil biological activity and is strongly influenced by organic matter inputs. Improved microbial activity facilitates nutrient cycling, which in turn supports higher crop yields and sustainable production. Despite the documented benefits of organic farming in different regions, there is limited systematic research on its effects in the **coastal districts of Andhra Pradesh**, where the interaction between saline soils, monsoon-dependent rainfall, and intensive cropping poses unique challenges.

Given these concerns, this study was designed to evaluate the impact of organic versus conventional maize cultivation on soil physicochemical properties, microbial biomass carbon, nutrient availability, and crop yield in selected districts of coastal Andhra Pradesh. The study aims to provide **region-specific evidence** that supports sustainable agricultural practices, informs policy interventions, and guides smallholder farmers toward management strategies that balance productivity with environmental conservation.
This research aims to:

1. Compare physicochemical soil properties in organic vs. conventional maize plots,
2. Assess microbial biomass activity as a biological indicator,
3. Evaluate crop yield responses,
4. Highlight the implications for sustainable agriculture in costal Andhra Pradesh.

2. Materials and Methods

2.1 Study Area

The field study was conducted across selected coastal districts of Andhra Pradesh: **Srikakulam, Vizyanagaram, East Godavari, West Godavari, and Krishna**. The region is characterized by: **(Field map-I)**

- **Tropical climate with high humidity**
- **Average rainfall:** 900–1200 mm (primarily pre and post monsoon)

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- **Soils:** Alluvial, coastal sandy loams, and clay loams

These conditions make soil quality maintenance vital for sustained productivity.

2.2 Experimental Design

Table:1: A randomized block design was used with two treatments:

Treatment	Description
T1 (Conventional)	NPK chemical fertilizers
T2 (Organic)	Compost @ 5 t/ha + Green manure

Maize (*Zea mays*) was sown during the Kharif season in plots of 20 m × 20 m, replicated thrice.

2.3 Soil Sampling & Analysis

Soil samples (0–15 cm) were collected before sowing and after harvest. Parameters analyzed included:

- **pH and EC**
- **Soil Organic Carbon (Walkley-Black)**
- **Available N (Kjeldahl)**
- **Available P (Olsen)**
- **Available K (Flame photometer)**
- **Microbial Biomass Carbon (Fumigation–Extraction)**

2.4 Crop Yield Measurement

Grain yield (tone/hectare) was recorded at maturity and standardized to moisture content.

2.5 Statistical Analysis

Data were analyzed using one-way ANOVA with LSD post-hoc ($p \leq 0.05$).

3. Results

3.1 Soil Physicochemical Properties

Table:2: soil organic carbon, NPK and ph result between Conventional and Organic forming:

Parameter	Conventional	Organic	% Change
pH	7.5	7.3	**-2.67%**

Parameter	Conventional	Organic	% Change
EC (dS/m)	1.10	0.75	**-31.82%**
Soil Organic Carbon (%)	0.65	1.60	+146%
Available N (kg/ha)	140	190	+36%
Available P (kg/ha)	17	30	+76%
Available K (kg/ha)	180	225	+25%

Interpretation: Organic amendments significantly increased SOC and available nutrients.

3.2 Microbial Biomass Carbon

Table:3: Microbial Biomass Carbon development

Treatment	MBC (mg/kg)
Conventional	170
Organic	340

The organic system showed approximately **100% higher microbial biomass carbon**, indicating enhanced soil biological activity.

3.3 Crop Yield

Treatment	Maize Yield (t/ha)
Conventional	4.4
Organic	5

Organic plots produced **13.6% higher maize yield** than conventional plots, indicating stronger soil–plant performance integration.

4. Discussion

4.1 Improved Soil Quality

Organic treatments significantly increased SOC, consistent with studies showing carbon sequestration through compost use (Lal, 2004)(3). Higher SOC improves soil structure, moisture retention, and nutrient availability (1). Organic farming is improve the soil quality, water storage and aeration (Reganold, J. P., & Wachter, J. M. (2016)(5). The maize yield productivity is increase more than 15% comparison to the conventional forming Singh (R. P., & Singh, D. (2019)) (7). The present study says 13.6% improvement than the conventional forming. crucial in coastal agro ecosystems prone to salinity and shallow groundwater. Soil organic carbon highly improved (1.6%) comparison to conventional forming (0.65) (**Figer:1)** may have it is one of the reason for the improvement of the crop productivity. Macro nutrients improvement is gradually increasing in a given sample results Nitrogen development from conventional to organic forming 140 to 190 kg/hectare fallowing the phosphorus 17 to 30 and potassium 180 to 225 the results shown in the (**Figer:2).** The overall crop crop productivity calculations shown in the

4.2 Enhanced Biological Activity

The doubling of microbial biomass under organic farming aligns with research demonstrating greater microbial diversity and activity in organically managed soils (Mäder et al., 2002). The organic forming is improve soil symbiotic fertility and soil strengthen at the costal Andhra soils. (Joshi, P. K., & Sharma, S. (2018)(13). Enhanced microbial populations accelerate cling and strengthen soil resilience. Organic farming may have increasing the soil fertility with the consent reactions such as green manure, decomposition, vermicompost. According to the above reactions healthy microbial organisms will increase and support to the strengthen of the soil fertility. Finally crop yield production should increase the feature crop rotation as well as decrease the soil mortality.(**Figer:3)** . The old study of Sahu, D. R., & Swain, P. (2019) **Microbial Biomass Carbon development is most effective result 112% better than conventional forming. The present study deference between conventional to organic forming 100% improvement is shown (Table:3).**

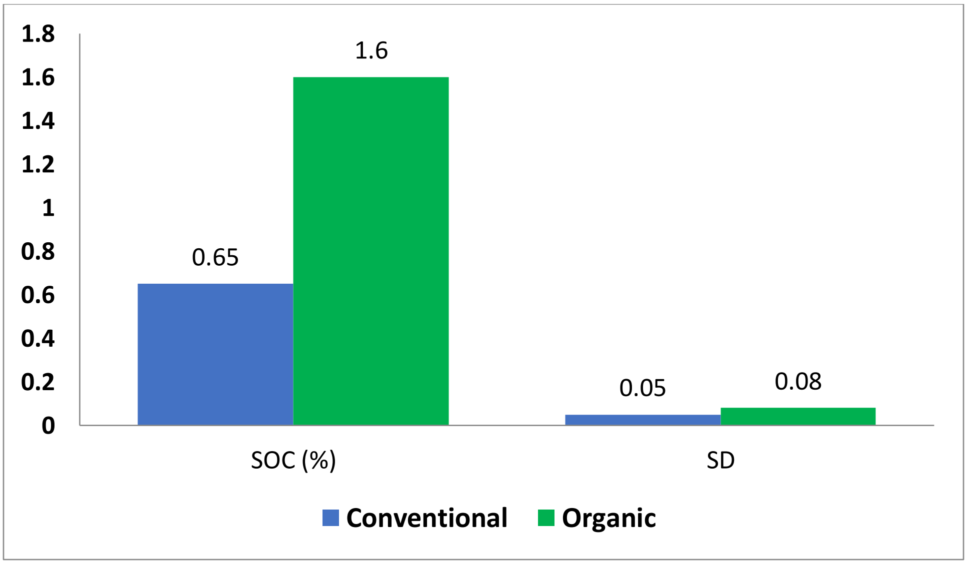
4.3 Increased Crop Productivity

The markedly higher yields recorded in the organic plots indicate that enhanced soil health plays a crucial role in improving nutrient availability, uptake efficiency, and overall plant vigor, even under the constraints of challenging coastal soils. Healthier soil structure, greater microbial activity, and improved organic matter content likely contributed to stronger root development and more efficient nutrient cycling.

Acceding to **Choudhary, R. S., & Sharma, A. (2020)** the organic forming is only best source to improve the soil fertility as well as yield production.

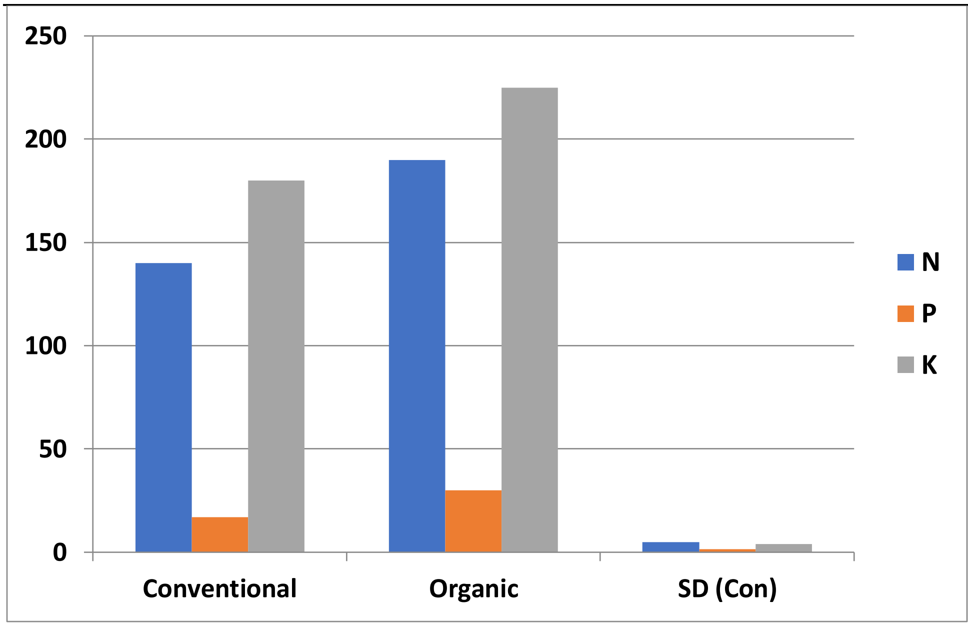
These findings question the common perception that conventional fertilization practices inherently guarantee higher productivity. Instead, the results demonstrate that well-managed organic systems can not only match but potentially surpass conventional methods in terms of crop performance, highlighting the long-term agronomic benefits of sustainable soil management practices. Comparison from conventional to organic forming yield productivity fallowing to 4.40 to 5.0 that is **13.64% may have by the organic forming the soil fertility is gradually increase and its improve the yield productivity and economic levels of the formers as well as it will become a backbone of the Indian economy.(Figer:4).** According to Ramesh, P., & Singh, N. (2016) by the natural forming Nitrogen (35%), Phosphorous (74%), Potassium (27%) percentage is increase comparison to conventional forming. The present study Nitrogen (36%), Phosphorous, (76%), Potassium(25%) may have similar to above result.

Figer:1 Soil Organic Carbon (%)



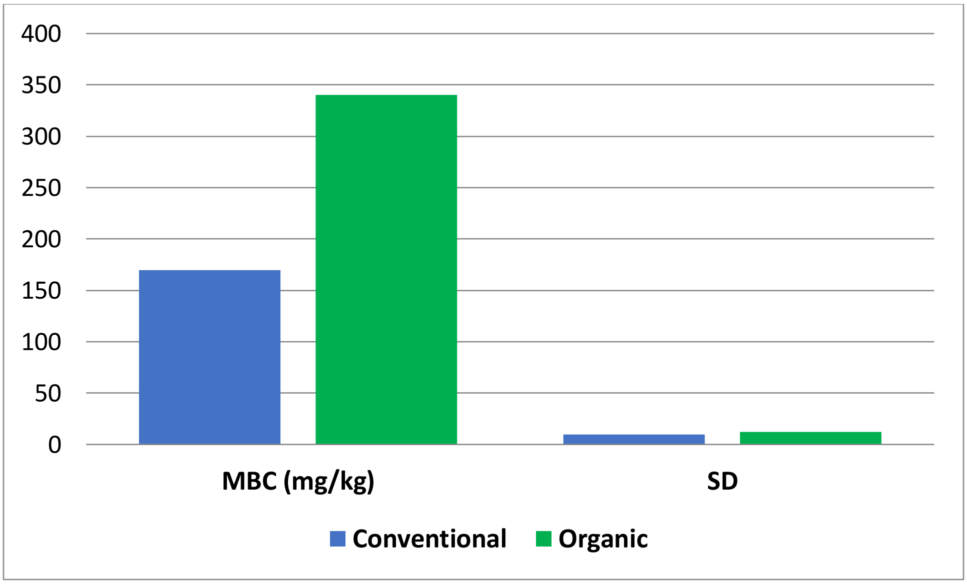
Soil carbon improvement between the conventional and organic forming

Figer:2 Available Macronutrients (N, P, K in kg/ha)



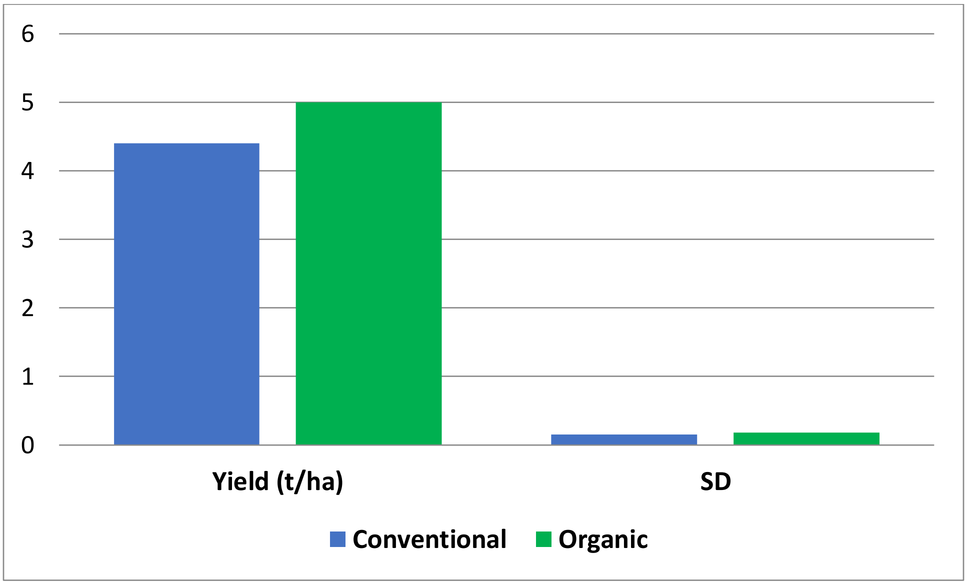
Micro nutrients Nitrogen, phosphorus, potassium improvement between the conventional and organic forming

Figer:3 Microbial Biomass Carbon (mg/kg)



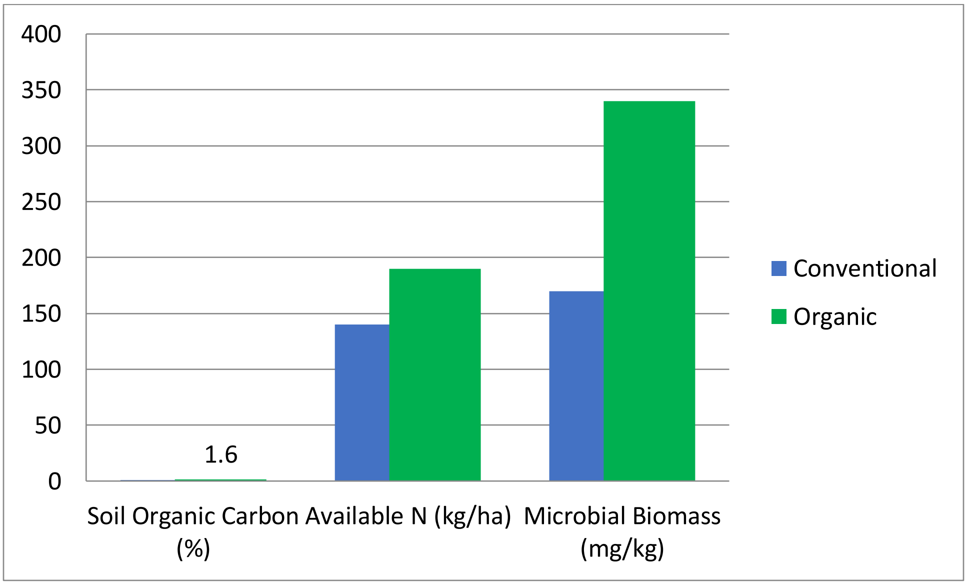
Microbial biomass carbon improvement between the conventional and organic forming

Figer:4 Maize Yield (tone/hectare)



Maize (*Zea mays*) yield production between conventional and organic forming

Figer:5 Composite Soil Health Index



Composite soil health index comparing organic and conventional Maize crop

Composite soil health index comparing organic and conventional maize systems in Coastal Andhra Pradesh. Organic management improved soil quality across all indicators.

5. Conclusion

In coastal Andhra Pradesh, organic farming improved soil quality and enhanced maize productivity compared to conventional practices. The significant increases in SOC, nutrient availability, and microbial biomass suggest that organic amendments can help address soil degradation and promote sustainable agriculture in coastal regions. The organic forming have been continue may have decrease soil pollution and erosion should and improve the soil fertility and improve the crop production and human life span. Comparison to conventional forming organic forming is best results and it is improve the sustainable bio diversity for the present and feature generations as well as the present expensive expenditure it is best opportunity to the small hold formers. The second way it is highly reduce the soil and water pollution and improve the soil fertility.

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