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Household Organic Waste Management and its Contribution to Sustainable Agricultural Productivity in Rural Indonesia: Evidence from Biru Village, South Sulawesi

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A R T I C L E I N F O

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A B S T R A C T

The increasing generation of household waste in rural areas presents both environmental challenges and opportunities for promoting sustainable agricultural development. Organic household waste constitutes a significant proportion of municipal waste streams and possesses substantial potential for conversion into compost as an environmentally friendly agricultural input. This study aimed to examine household waste management practices and evaluate the contribution of compost utilization to agricultural productivity in Biru Village, Tanete Riattang District, Bone Regency, South Sulawesi, Indonesia. A quantitative survey approach was employed involving 120 farming households selected through purposive sampling. Primary data were collected through structured questionnaires and in-depth interviews. Descriptive statistical analysis was used to assess community waste management behavior, while simple linear regression analysis was applied to determine the effect of compost utilization on agricultural productivity. The findings indicate that 65% of households practice waste separation between organic and inorganic materials. However, only 30% actively process organic waste into compost. Regression analysis revealed that compost utilization significantly contributes to agricultural productivity ($\beta = 0.12$; $p = 0.001$), explaining approximately 42% of productivity variation ($R^2 = 0.42$). Households applying compost achieved higher crop yields compared with those relying primarily on chemical fertilizers. The results demonstrate that community-based waste management can function as an effective strategy for enhancing agricultural sustainability while simultaneously reducing environmental burdens. The study highlights the importance of integrating household waste management into local agricultural development policies through community empowerment, composting infrastructure, and environmental education programs.

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INTRODUCTION

The rapid growth of population and consumption patterns has significantly increased household waste generation worldwide (Chen et al., 2020; UNEP, 2024). Organic waste represents the largest fraction of municipal solid waste in many developing countries and is frequently disposed of without adequate treatment. Improper waste management contributes to environmental degradation, greenhouse gas emissions, soil contamination, and declining ecosystem quality. At the same time, organic waste possesses valuable nutrients that can be recycled into agricultural production systems through composting.

Sustainable agriculture has emerged as a critical approach to maintaining food security while preserving environmental quality. Within this framework, compost derived from household organic waste offers a viable alternative to excessive dependence on synthetic fertilizers. Previous studies have demonstrated that compost application improves soil structure, enhances nutrient availability, increases water retention capacity, and supports long-term agricultural productivity (Gliessman, 2018; FAO, 2022). Furthermore, the circular economy concept emphasizes resource recovery and waste valorization, transforming waste into productive inputs rather than environmental liabilities (Kirchherr et al., 2017; Velenturf & Purnell, 2021).

Despite growing attention to waste management, existing studies predominantly focus on urban waste systems, institutional arrangements, and technological innovations. Limited empirical evidence remains available regarding the relationship between household-level waste management practices and agricultural productivity in rural farming communities. This knowledge gap is particularly relevant in Indonesian villages where agriculture remains the primary livelihood source and organic household waste is abundantly generated.

Biru Village, located in Tanete Riattang District of Bone Regency, represents a rural agricultural community where household waste management practices are increasingly important for environmental sustainability. Understanding the extent to which organic waste can be transformed into productive agricultural inputs is essential for developing integrated strategies that support both environmental and economic objectives.

Therefore, this study aims to:

1. Examine household waste management practices in Biru Village.
2. Assess the level of community participation in organic waste utilization.
3. Analyze the effect of compost utilization on agricultural productivity.
4. Evaluate the implications of community-based waste management for sustainable agriculture and circular economy development.

The novelty of this study lies in its integration of household waste management behavior with agricultural productivity outcomes within a rural farming context, thereby contributing empirical evidence to the emerging literature on circular economy implementation in developing-country agriculture.

LITERATURE REVIEW

Circular Economy Theory

The circular economy framework promotes the reduction, reuse, recycling, and recovery of resources to minimize waste generation and maximize resource efficiency. In agricultural systems, organic waste can be recycled into compost, thereby closing nutrient loops and reducing environmental externalities.

According to Kirchherr et al. (2017), the circular economy promotes resource efficiency through reduction, reuse, recycling, and recovery strategies. Similar principles were further emphasized by Velenturf and Purnell (2021).

Sustainable Agriculture Theory

Sustainable agriculture seeks to maintain agricultural productivity while preserving environmental integrity and social well-being (Gliessman, 2018; FAO, 2022).

Organic amendments such as compost contribute to soil fertility improvement and reduce dependency on synthetic chemical inputs.

Community Participation Theory

Community participation plays a crucial role in environmental management initiatives. Effective waste management programs require active involvement of households in waste segregation, compost production, and environmental conservation activities.

METHODOLOGY

Study Area

This research was conducted in Biru Village, Tanete Riattang District, Bone Regency, South Sulawesi Province, Indonesia. The village is characterized by mixed farming systems dominated by vegetable and food-crop cultivation.

Research Design

A quantitative survey design was employed to investigate household waste management practices and their contribution to agricultural productivity.

Population and Sample

The study population consisted of farming households residing in Biru Village. A total of 120 respondents were selected using purposive sampling based on the following criteria:

- Active farming households;
- Permanent village residents;
- Involvement in household waste management activities.

Data Collection

Primary data were collected from March to June 2024 using:

- Structured questionnaires;
- Direct observations;
- In-depth interviews.

Secondary data were obtained from government reports, scientific journals, and relevant institutional publications.

Data Analysis

Descriptive statistics were utilized to analyze household waste management practices.

The regression model employed was:

$Y=\beta 0+\beta 1X+\varepsilon$

Where:

- Y = Agricultural productivity (kg ha^{-1})
- X = Compost utilization (kg ha^{-1})
- β_0 = Constant
- β_1 = Regression coefficient
- ε = Error term

Research hypotheses:

H_0 : Compost utilization has no significant effect on agricultural productivity.

H_1 : Compost utilization significantly affects agricultural productivity.

RESULTS

Household Waste Management Practices

The survey revealed substantial variation in waste management behavior among respondents.

Table 1. Household Waste Management Practices

Waste Management Practice	Number of Households	Percentage (%)
Waste separation	78	65.0
Composting activities	36	30.0
Disposal to landfill	54	45.0
Waste burning	30	25.0

Source: Survey Data (2024)

The findings demonstrate that waste separation has become relatively common among households. However, the proportion of households processing organic waste into compost remains considerably lower. A substantial percentage still rely on landfill disposal or open burning practices, indicating the existence of barriers related to knowledge, infrastructure, and technical skills.

Effect of Compost Utilization on Agricultural Productivity

Table 2. Regression Results

Variable	Coefficient	Std. Error	t-value	p-value
Constant	2.15	0.45	4.78	<0.001
Compost Utilization	0.12	0.03	3.95	0.001

Model Statistics:

- $R^2 = 0.42$
- $F = 15.60$
- $p < 0.01$

Source: Survey Analysis (2024)

The regression model indicates a statistically significant positive relationship between compost utilization and agricultural productivity. The coefficient value of 0.12 suggests that increases in compost application contribute positively to crop yield performance. Furthermore, the coefficient of determination indicates that compost utilization explains approximately 42% of productivity variation among respondents.

DISCUSSION

The findings are consistent with Zhang et al. (2022), who reported that waste separation behavior is strongly influenced by environmental awareness and supporting facilities. Nevertheless, the relatively low participation in composting activities suggests that awareness alone is insufficient to ensure behavioral transformation. Similar conditions were reported by Ferronato and Torretta (2019), who found that limited infrastructure remains a major obstacle to effective waste management in developing countries.

The positive contribution of compost utilization found in this study supports the findings of Ruhimat et al. (2023), which showed significant improvements in plant productivity following compost application. Compost contributes to improved soil structure, enhanced nutrient availability, increased microbial activity, and greater water-holding capacity. These mechanisms ultimately support higher crop productivity and more sustainable farming systems.

The findings also reinforce the principles of the circular economy by illustrating how resources traditionally regarded as waste can be transformed into productive agricultural inputs. These findings also strengthen the village-level circular economy model proposed by Sapanli et al. (2023). Such integration simultaneously addresses environmental protection and agricultural development objectives.

From a policy perspective, local governments should prioritize community-based composting programs and provide technical assistance for organic waste processing. Investments in composting facilities, farmer training, and environmental education may significantly improve adoption rates and contribute to sustainable rural development.

CONCLUSIONS AND RECOMMENDATIONS

This study demonstrates that household organic waste management has considerable potential to support sustainable agricultural development in rural Indonesia. While waste separation practices have been widely adopted, compost production remains limited among farming households.

Regression analysis confirms that compost utilization significantly enhances agricultural productivity, indicating that organic waste can serve as an effective alternative agricultural input. The findings highlight the importance of integrating waste management initiatives into agricultural development programs to improve resource efficiency, environmental quality, and rural livelihoods.

Strengthening community participation, expanding composting infrastructure, and implementing targeted educational programs are essential

policy measures for promoting sustainable agriculture and advancing circular economy objectives in rural areas.

FURTHER STUDY

This study provides empirical evidence regarding the contribution of household organic waste management to agricultural productivity in rural communities. However, several limitations should be acknowledged. First, the study employed a cross-sectional survey design, which limits the ability to capture long-term impacts of compost utilization on soil quality and agricultural sustainability. Second, the analysis focused primarily on compost utilization as the main explanatory variable, while other factors such as farmers' education, farming experience, landholding size, income level, and access to agricultural extension services were not incorporated into the regression model. Third, the study was conducted in a single village setting, which may limit the generalizability of the findings to other rural areas with different socio-economic and agroecological characteristics.

Future research should adopt longitudinal approaches to examine the long-term environmental, economic, and agronomic impacts of household composting practices. Additionally, more comprehensive analytical frameworks involving multiple socio-economic and institutional variables are recommended to better understand the determinants of compost adoption and sustainable waste management behavior among farming households. Comparative studies across different regions may also provide broader insights into the effectiveness of community-based waste management programs under varying local conditions. Furthermore, future investigations should explore the integration of circular economy principles, climate-smart agriculture strategies, and digital extension services to strengthen sustainable agricultural development and rural environmental governance.

Finally, future studies are encouraged to assess the financial feasibility and cost-benefit aspects of household compost production, as well as its contribution to reducing greenhouse gas emissions and improving climate resilience in agricultural systems. Such evidence would strengthen the policy relevance of community-based waste management initiatives and support the achievement of sustainable development goals at the local and national levels.

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Conflict of Interest

The authors declare no conflict of interest regarding the publication of this article.

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