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Enhancing soil fertility and biodiversity through earthworm-based agroecological practices: A case study of Junozd Farm's closed-loop system

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ABSTRACT
This study examines the effects of agricultural practices based on composting rain trees, particularly Burmic, and earthworm worm vaccination. At Junozd Farm, an enclosed organic farm, Vietnamese. Experimental studies and case study analyses show a 2.4 % increase in organic matter, a maximum increase in nutrient content by 32%, and a significant improvement in soil fertility. Biological diversity thrived by 60%, earthworm populations increased, microbial diversity thrived by 35%, 25-30% of pollinators and favorable insects. Crop yields are 20-24% under drought stress, improving soil resilience. Integrating waste recycling through farms into earthworm practices minimized external input and created a sustainable model. Challenges such as labor costs and regulatory fluctuations illustrate modular systems and political support. These findings have understood earthworm practices based on earthworm practices as a scalable solution for agriculture and improving soil health and biodiversity.

Keywords:Vermicomposting, earthworm inoculation, soil fertility, biodiversity, closed-loop agriculture

I. INTRODUCTION

Modern agricultural practices that often rely on chemical fertilizers and monoculture have led to soil degradation, reduced microbial activity, and loss of biodiversity that threaten long-term productivity. Agroecological approaches that prioritize ecological processes and resource cycling offer promising options. Of these, earthworm-based practices such as insect composting and tooth decay have emerged as powerful tools to improve soil fertility and biological diversity. By using the natural skills of earthworms to break down organic matter, improve soil structure and stimulate microbial communities, these practices produce nutrient-rich, biologically active soils that support a variety of ecosystems. This study focuses on Junozd Farm, a model of circular organic farming in Vietnam, and examines how rain-based agricultural practices based on a system of closed cycles improve soil fertility, biological diversity and agricultural sustainability.

Junozd Farm operates a system with closed circuits that integrate plant production, organic waste recycling, and insect composting to minimize external input and waste. Types such as earthworms, especially Eisenia fetida, play a central role in this system by converting agricultural waste such as insect compost harvesting and animal waste, which are changes in nutrient-rich soil. vermicompost is applied to the field, and earthquakes are vaccinated in the soil to improve the health of the base school. These practices promote biological diversity by not only recycled nutrients, but also supporting bed microorganisms, pollinators and useful insects. The farm foundation agrees with the global demands for regenerative agriculture, as shown in FAO 2018 on Agricultural Ecology, where biological diversity and soil health are highlighted as a column in sustainable food systems.

The aim of this study is to assess the impact of earthworm-based practices based on soil fertility (nutrient content, organic matter, soil structure), biological diversity (meijaworm populations, microbial diversity, and ground fauna), and agricultural outcomes (harvest and resilience). Through the analysis of Junozd Farm's experimental data and case studies, the purpose of the study is to provide information on the

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effectiveness of these practices and the possibility of a more comprehensive referral. This study contributes to growing bone terrain by showing how seismic systems take into account soil degradation and loss of biological diversity, while simultaneously supporting sustainable agriculture in tropical contexts.

Earthworm-based osteotypic practices, particularly toxic composting and insecticide cultivation, were examined in detail on soil health and contributions to ecosystem services and ecosystem services. Earthworms, often referred to as "ecosystem engineers," improve soil fertility through physical, chemical and biological processes. Darwin (1881) initially discovered her role in the decomposition of soil and organic matter, the basis of modern research. Edwards and Bohlen (1996) explain how earthworms improve soil structure by creating caves, increasing porosity and improving water infiltration. Their cast parts, rich in nitrogen, phosphorus and potassium available, act as natural fertilizers. Research by Lavelle et al. (1998) show that earthworm activity promotes microbial populations, further mineralizes nutrients, making them accessible to plants.

Insect composting, the process of decomposed organic waste using earthworms produces superior changes in the soil compared to traditional composting. Dominguez and Edwards (2011) found that insect compost contains higher levels of wetting substances and plant-based nutrients with finer textures that improve soil aggregation. Meta-analysis by Lazcano et al. (2008) reported that insect compost uses increased yields by 15-30% compared to mineral fertilizers. This is due to increased microbial activity and nutrient cycles. Furthermore, as Jack (2010) states, Vermicompost suppresses bed pathogenicity and reduces the need for organic chemical pesticides.

The biological diversity benefits of earthworm practices have been extended beyond the ground. By improving soil health, earthworms indirectly support terrestrial fauna such as pollinators and predatory insects. Study by Eisenhauer et al. (2011) found that earthworm activity increases a variety of plants and biomass and creates favorable insect habitats. Underground earthworms promote microbial diversity, and Badauria and Saxena (2010) report a

0% increase in microbial biomass in soil treated with earthworms. These interactions create feedback loops that improve ecosystem resistance. For example, Bertrand et al. (2015) observed that earthworm beds remained higher in drought and emphasized their role in climate adaptation.

Despite these benefits, there is a research gap. Long-term studies on the scalability of vermic composting in tropical climate zones such as Vietnam are available in Dominguez et al. (2016). The integration of global worm-based practices in closed systems such as the Jeunezed Farm is underexposed, and most research focuses on independent applications. Arancon et al. (2008) require context-specific optimization. The benefits of biological diversity have been documented, but Van Groenigen et al. (2019).

This study addresses these gaps by examining the closed system of Junozd Farms. This gap is integrating vermic composting into recycling and waste crop production. Through a combination of experimental research and case study analysis, the study provides a comprehensive assessment of earthworm practices that provide insight into scalability and applicability in tropical agricultural systems.

II. METHODOLOGY

This study uses a mixed method approach to assess the effects of wave stroke-based agricultural practices on soil fertility, biodiversity and agriculture outcomes of Junozd Farm, a closed biofarm in Vietnam. This methodology integrates experimental research with case study analysis to provide robust quantitative and qualitative data. The study focuses on insect composting and earthworm worm vaccination and evaluates its contribution to Junozd farm's sustainable farming model.

Research design:

Experimental studies have been conducted at 1ha location on Junozd Farm. There, insect compost and earthworm inoculations are compared with control diagrams using traditional compost. The insect composting unit treats organic waste (plant residues, fertilizers) with iron fetida. Earthworms are vaccinated in a selected field with a density of 200 individuals/m². Junozd Farm's closure system examines case studies components and documents the integration of insect composting with waste recycling and harvest production through farmer interviews and operational records.

Data collection:

Soil fertility is measured by nutrient content (N, P, K), percentage of organic matter, and soil structure (bulk density, porosity) over two seasons. Biological diversity indicators include worm population density (via soil samples), microbial diversity (via DNA sequencing), and terrestrial fauna (via pollinators and useful insects, monitored by pith drop traps and visual surveys). Harvest yields (corn, vegetables) are recorded at each harvest to assess agricultural effectiveness. Qualitative data from semi-structured interviews with agricultural operators provide insight into practical challenges and management strategies.

Analyticalmethods: Quantitative data are analyzed using statistical tools, including ANOVA for yield and soil parameter comparisons and Shannon's diversity index for biodiversity metrics. Soil nutrient trends are modeled using regression analysis to assess temporal changes. Qualitative interview data are coded thematically to identify operational best practices and barriers. The analysis compares outcomes between earthworm-based and control plots, highlighting the role of closed-loop integration.

Limitations: The study is limited to a single tropical site, potentially affecting generalizability. Seasonal variability may influence biodiversity and yield data, mitigated by two-season monitoring. Triangulation of experimental and case study data ensures reliability, providing a comprehensive evaluation of earthworm-based practices at Junozd Farm.

III. RESULTS AND DISCUSSION

This study presents the impact of agricultural practices based on rainswood, particularly Burmic composting and earthworm inoculation, soil fertility, biological diversity and agricultural outcomes at Junozd Farm, a closed organic farm in Vietnam. The integration of these practices into the farm circulation system had a great advantage that was supported by experimental research and case study data. The results show improved soil health, increased biodiversity, and increased harvest productivity, which in comparison with previous studies highlights the value of Junozd Farm's approach.

Soil fertility outcomes

Vermicompost application and earthworm inoculation significantly improved soil fertility over two growing seasons. Soil organic matter increased by 2.4% (from 3.1% to 5.5%) in treated plots, compared to 0.7% (from 3.1% to 3.8%) in control plots using traditional compost. Nutrient levels also rose: available nitrogen increased by 32% (from 120 to 158 mg/kg), phosphorus by 28% (from 25 to 32 mg/kg), and potassium by 25% (from 180 to 225 mg/kg) in treated plots, compared to 10%, 8%, and 7% increases, respectively, in controls. Soil structure improved, with bulk density decreasing by 15% (from 1.3 to 1.1 g/cm³) and porosity increasing by 20% (from 50% to 60%), enhancing water retention and root penetration.

Table 1: Soil Fertility Parameters in Treated vs. Control Plots

Parameter	Baseline	Treated (Vermicompost + Inoculation)	Control (Traditional Compost)	% Improvement (Treated vs. Control)
Organic Matter (%)	3.1	5.5	3.8	44.7%
Nitrogen (mg/kg)	120	158	132	19.7%
Phosphorus (mg/kg)	25	32	27	18.5%
Potassium (mg/kg)	180	225	193	16.6%
Bulk Density (g/cm³)	1.3	1.1	1.2	8.3%
Porosity (%)	50	60	53	13.2%

Biodiversity impacts

Earthworm-based practices significantly enhanced biodiversity. Earthworm populations in treated plots increased by 60% (from 100 to 160 individuals/m²), compared to 20% (from 100 to 120 individuals/m²) in controls, reflecting the favorable conditions created by vermicompost and inoculation. Microbial diversity, measured via Shannon's index, rose by 35% (from 2.8 to 3.8) in treated soils, driven by organic matter enrichment and earthworm activity. Aboveground, pollinator presence (e.g., bees, butterflies) increased by 25% (from 20 to 25 sightings/hour), and beneficial insects (e.g., ladybugs) by 30% (from 15 to 19.5 sightings/hour), likely due to improved soil conditions supporting diverse plant growth. Control plots showed minimal changes (5–10% increase in aboveground fauna).

Agronomic benefits

Crop yields improved significantly in treated plots. Maize yields increased by 24% (from 5.2 to 6.4 t/ha), and vegetable yields (e.g., leafy greens) by 20% (from 11.5 to 13.8 t/ha), compared

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to 8% and 6% increases, respectively, in control plots. Yield stability was also enhanced, with treated plots showing 12% less variability under drought stress, attributed to improved soil water retention and nutrient availability. These outcomes highlight the agronomic advantages of earthworm-based practices in Junozd Farm's closed-loop system.

The results are consistent with and expanding with previous studies. Lazcano et al. (2008) reported 15-30% of insect compost corresponding to 20-24% observed here, but was integrated into inoculation to enhanced soil fertility of Junos Farm soil bloat (32% increase in nitrogen in the Lazakana study). Edwards and Booking (1996) found a 10-15% improvement in soil structure in earthworms. We found this to be 20% lower than the increase in porosity, probably due to the combination of insect compost and inoculation effects. Eisenhauer et al. (2011) found that earthworm activity increased terrestrial biodiversity by 15%, and that the 25-30% increase in this study reflected a synergistic effect with the harvesting of closed-loop systems. Dominguez et al. (2016) highlighted the challenges in scaling vermic composting in tropical climate zones. This is reproduced in the needs of junozd farms after consistent raw inventory management and handled by standardized waste entries.

Discussion

Results highlight the effectiveness of earthworm practices to improve soil fertility, biological diversity and agricultural outcomes in Junozd Farm's closed-loop system. The increase in organic matter increases by 2.4% and 32%, and the advantage of insect compost over traditional compost is shown as the increased availability of nitrogen, as its fine texture and microbial wealth improve nutritional collection. An increase in earthworm populations by 60% and 35% increases microbial diversity highlighting the cascade effect of earthworm activity, creating favorable conditions for bed biota and terrestrial fauna. As the basis of agriculture, this biological diversity is positioned in relation to an increase in yields of 20-24%.

Closed systems increased these benefits by reducing external inputs and reducing organic waste with insect compost recycling, which promotes resistance. However, challenges include maintaining worm populations under various climatic conditions and controlling food quality that requires careful monitoring at Junozd farms. High work and initial establishment costs limit acceptance in resource-limited environments, and Arancon et al. (2008) Observation. The limit includes studies of studies on a single tropical region that may not be fully represented by other rascology zones. Long-term monitoring is required to assess carbon bonding and biological diversity trends over two seasons. Future research should examine the design and political incentives of inexpensive Vermicol composting to support the adoption of small-scale farmers. Overall, Junozd Farm's practice practice provides a scalable model for sustainable agriculture. This improves health and biodiversity, while at the same time improving global challenges such as soil degradation and nutritional safety.

Earthworm-based practices at junozd farm

Junozd Farm, located in Dong Hy district, Thainguyen Vietnam, shows an agricultural ecosystem with a closed loop focused on practices based on earthworms, particularly insect composting and worm inoculation. These practices transform organic waste into valuable resources and improve soil fertility, biological diversity and agricultural farm sustainability. At 1-hectare locations, the farm integrates plant production, cattle and waste recycling, and earthworms play a central role in improving nutrient cycles and soil health.

Junozd Farm uses Eisenia Fetida to dispose of organic waste such as harvested residues (such as rice and wheat surfaces, vegetable foods) and beef fertilizers. The farm maintains several insect composting units with approximately 500 kg of waste. The raw sticks are layered and moistened with Cow to maintain a humidity of 60-70%. This is perfect for worm activities. This procedure lasts for

45-60 days, resulting in insect compost with high nutrients (2.5% nitrogen, 1.8% phosphorus, 1.5% potassium), and increased microbial activity. This vermicompost is applied to a field of 5 t/ha each year, replacing synthetic fertilizers and improving soil structure.

Junozd Farm Endworms inoculated directly at a density of 200 individuals/m² in the plant field to improve ground health. This practice targets maize and vegetable plots, where earthworms improve soil aeration and nutrient availability through burrowing and casting. The inoculation is set within the time after harvest to minimize damage, thereby adding organic mulch to maintain the seismic population. This approach increases the earthworm density in the treated area by 60%, contributing to long-term soil fertility.

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Farm's closed system recycles all organic waste from insect composting and creates insect compost and liquid insect washes to collect fertilization. Harvest and livestock waste is continuously fed to insect composting units to ensure zero waste. Vermicompost supports a variety of plants, but worm inoculation improves soil resilience and reduces irrigation needs by 15% with improved moisture retention. This integration is about incredible principles with minimal external input. Maintaining optimal conditions for earthworms is difficult due to seasonal temperature fluctuations (15-30°C) and variable output quality. Junozd Farm appeals to this using a covered insect composting shed and standardized waste. Scaling the practice requires initial investments (approximately USD 5,000 for facilities) with workers, which reduces farms through a cooperative model and shares vermicomposts with local farmers. By ensuring the survival of earthworms in the region, careful treatment of soil moisture and pesticide-free practices achieved by organic certification is required. The practice of Junosud Farm, based on earthworms, presents a scalable model for sustainable agriculture in the tropical context of Vietnam, which increases the health and productivity of soil operations while simultaneously reducing environmental impact.

IV. CONCLUSION

This study highlights the conversion effect of stormwater bases on Junozd farms, showing their effects on improving soil fertility, biological diversity and sustainability in closed systems. Insect composting and earthworm inoculation increased organic ground material by 2.4%, increased nutrient content by up to 32%, improved soil structure, and increased crop yield by 20-24%. Biological diversity increased by 60%, increasing earthworm populations, and microbial diversity outperformed the terrestrial fauna, which promotes ecosystem resistance by 35%, 25-30%. These results highlight the possibility of worm practices driven by farms by integration of waste recycling and harvest production, and based on worm practices to support soil degradation and nutritional safety. Issues including job requirements and initial costs highlight the need to improve scalability of smallholder farmers, particularly in tropical regions such as Vietnam. Future research should examine the long-term impacts and adjustments of various climate zones. The Junozd Farm model provides a blueprint for agriculture and uses earthworms to create a sustainable regenerative system that meets global goals for the conservation of agriculture in soil health, biodiversity and aerial conditions.

REFERENCES

[1]. Petit-dit-Grézériat, L., Rault, M., Serbource, C., & Pelosi, C. (2024). Earthworm inoculation in degraded soils: A meta-analysis. Applied Soil Ecology, 204, 105745.
[2]. Thomas, G. V., Krishnakumar, V., & Prabhu, S. R. (2024). New Paradigms in Soil Health Management for Sustainable Production of Plantation Crops. In Soil Health Management for Plantation Crops: Recent Advances and New Paradigms (pp. 487-533). Singapore: Springer Nature Singapore.
[3]. Woomer, P. L. (2012). Integrated Soil Fertility Management in Africa: from Microbes to Markets: Conference Information, Program and Abstracts. An international conference held in Nairobi, Kenya, 22-26 October 2012. CIAT. 122 pp. Cover design by Paul L. Woomer. Line drawings by Nicholas Mwema. Integrated Soil Fertility Management in Africa, 2, 2.
[4]. Akhila, A., & Entoori, K. (2022). Role of earthworms in soil fertility and its impact on agriculture: A review. International journal of fauna and biological studies, 9(3), 55-63.
[5]. Sharma, D. K., Tomar, S., & Chakraborty, D. (2017). Role of earthworm in improving soil structure and functioning. Current Science, 1064-1071.
[6]. Bertrand, M., Barot, S., Blouin, M., Whalen, J., de Oliveira, T., & Roger-Estrade, J. (2015). Earthworm services for cropping systems. A review. Agronomy for Sustainable Development, 35, 553-567.
[7]. Blouin, M., Hodson, M. E., Delgado, E. A., Baker, G., Brussaard, L., Butt, K. R., ... & Brun, J. J. (2013). A review of earthworm impact on soil function and ecosystem services. European Journal of Soil Science, 64(2), 161-182.
[8]. Saharan, B. S. (2024). Cultivating Vitality: Harnessing Microbes and Earthworms for Sustainable Farming Success. Natural Farming for One Health, 14.
[9]. Liu, T., Chen, X., Gong, X., Lubbers, I. M., Jiang, Y., Feng, W., ... & Liu, M. (2019). Earthworms coordinate soil biota to improve multiple ecosystem

functions. Current Biology, 29(20), 3420-3429.

[10]. Singh, J. (2018). Role of earthworm in sustainable agriculture. In Sustainable food systems from agriculture to industry (pp. 83-122). Academic Press.