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Pre-Extension Demonstration and Evaluation of Vermi-Compost Technology on Maize Production in Selected FSRP Districts of West Wollega and Kellem Wollega Zones

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Abstract | **Original Research Article**

Declining soil fertility and rising input costs have challenged sustainable maize production in Ethiopia. Vermicompost, an organic fertilizer derived from earthworm activity, has emerged as a potential alternative to conventional inorganic fertilizers. This study aimed to compare the agronomic performance, economic returns, and soil fertility effects of vermicompost and inorganic fertilizers in maize production systems. The study was conducted during the 2023/2024 cropping season in selected districts of West Wollega and Kellem Wollega Zones, Oromia Region, Ethiopia. On-farm trials were established using two treatments: (1) recommended rate of NPS + Urea and (2) vermicompost applied based on nutrient equivalence. Soil samples were collected before and after harvest for key fertility parameters (pH, total nitrogen, organic carbon, and organic matter). Grain yield and benefit-cost analysis were calculated. Participatory technology evaluations were also carried out using farmer-defined criteria, including grain yield, soil improvement, labor demand, and sustainability. Maize grain yield was about 10% higher in plots treated with inorganic fertilizer than vermicompost. However, vermicompost significantly improved post-harvest soil organic carbon, organic matter, total nitrogen, and soil PH. Economic analysis showed that vermicompost plots had a higher net return and benefit-cost ratio due to lower input costs. Farmers favored vermicompost based on its contribution to long-term soil health, affordability, and environmental sustainability, despite noting its labor-intensive application. While inorganic fertilizers produced slightly higher yields, vermicompost improved soil fertility and offered better economic returns over the cropping season. The participatory evaluation also confirmed the practical acceptability of vermicompost by smallholder farmers. The study recommends integrating vermicompost into local maize production systems through scaling up farmer demonstrations, capacity-building on composting techniques, and promoting policies that support organic inputs. Further research should focus on optimizing vermicompost rates and labor-saving application methods to enhance its adoption.

Keywords: Benefit-cost analysis, Evaluation, Maize, Organic inputs, Participatory, Soil fertility, Sustainability, Vermicompost.

INTRODUCTION

Traditional agriculture is currently characterized by excessive inputs of chemical fertilizers, pesticides and herbicides and insufficient application of organic fertilizers (Li *et al.* 2007; Gill and Garg, 2014). Ove ruse of agrochemicals and deep tillage caused soil acidity, soil infertility and soil quality contamination which decreased soil organic matter content, biodiversity, and productivity. In underdeveloped nations, these unsustainable farming techniques threaten food security and produce significant economic limitations (Pradhan *et al.*, 2017; Pender, 2009).

Fertilizing crops using organic fertilizer made from organic matter, which has enormous potential to improve soil biodiversity and health, is an alternate strategy for sustainable and commercially viable agricultural production with little environmental contamination. Vermicompost is one of many alternatives and technologies that are frequently employed in sustainable agriculture and one of the stabilized organic fertilizers with a low C:N ratio that contains a variety of nutrients that are available to plants right away (Tufa, 2023). It is produced by feeding earthworms with chopped plant biomass materials mixed with cow dung and water under the shade of trees, especially horticultural trees.

In conjunction with other resources that limit crop growth, organic matter releases several plant nutrients into the soil solution that have a major impact on crop growth rate and yield (Domfnguez *et al*., 2004). Vermi-composting is a method for decomposing organic waste that is both affordable and environmentally friendly (Rekha *et al*., 2018). Based on the source of the vermin worm feed, it is made from various organic material sources and contains various vital plant nutrients (Wako, 2021). It also increases soil organic matter (Domfnguez *et al*., 2004), decreases exchangeable soil acidity (Abafita, 2016), improves the availability of soil nutrients, increases micronutrient levels in the soil, and increases crop yield (Blouin *et al*., 2019; Van Groenigen *et al*., 2014). Vermicompost-based fertilizer boosts soil fertility, the physicochemical properties of soil, and the cation exchange capacity. In addition, vermicompost significantly improves soil structure, porosity, soil temperature, aeration and water retention (Kayabaşi and Yilmaz, 2021).

In the western Ethiopia, the utilization of organic matter to address the issue of soil infertility, enhance the physicochemical qualities of soil, and establish ideal soil conditions to increase crop yield in acidic soil has been growing (Getahun *et al*., 2020). The rationale behind promotion of this technology is that earth worms can fragment and alter all biological acidity of wastes. Vermicompost has comparative nutrient richness compared with organic manure, improving the growth and productivity of crops and has a lower cost of production (Genet and Mathewos, 2022). Hence, its application for crop production improves overall soil physical and biochemical properties, contributes to crop productivity enhancement and supports the strategy of sustainable agricultural intensification practices of crop production with reduced use of chemical fertilizers.

Maize (ZeamaysL.), the most important major food crop cultivated in Ethiopia is grown on more than two million hectares and ranks second in terms of area coverage among cereal crops (Tubiello*etal*.,2022). Its average total grain production is 4.24t ha−1.Data from the Central Statistical Agency (CSA,2021) shows that 2.5 million hectares, or around 23.97 percent of the total area used for cereal crops are planted with maize. Similarly, in the Oromia region of Ethiopia, maize is a primary crop grown by smallholder farmers in the west Wollega and Kellem Wollega zones. To increase the income and food security of smallholder farmers, it is critical to give the agronomic techniques utilized in the production of maize proper consideration. Even though vermicompost is a very economical and environmentally beneficial fertilizer for growing crops, especially maize, smallholder farmers in Kellem and West Wollega are not very familiar with how to prepare and use it. In light of this, this activity was launched to demonstrate and evaluate vermicompost technology to farmers' methods for producing maize in the Kellem and West Wollega zones.

Objectives

1. To demonstrate and evaluate the productivity and Profitability of maize by using vermicompost technologies
2. To create awareness about the importance of vermicompost application for maize production
3. To collect farmers' feedback for further technology development/improvement

MATERIALS AND METHODS

Description of the Study Area

Kellem Wollega zone

The altitude ranges between 500 meters to 2200 meters a.s.l with three agro-ecological zones 0.2% of highland climatic zone, 20.35% middle land and 79.45% low land climatic zones and annual temperature ranges from 15-25°C. Maize, sorghum, finger millet, teff, haricot beans, beans, peas, and vegetables are the most important crops farmed in the area. Coffee, pepper and sesame are cash crops, while wheat, barley, sweet potatoes, fruit, and Irish potatoes are minor crops in Kellem Wollega zone. The annual rainfall in the area ranges between 1,200 mm and 1,600 mm. Kellem Wollega Zone comprises ten administrative districts, among which Sayo District was purposively selected as the study area due to its agro-ecological diversity and relevance to the research objectives.

Sayo District

Seyo district is located in the south western part of Kellem Wollega Zone & the zonal capital was found in it (Seyo district). Astronomically the district is located between $8^0 12'$-$8^0 44'$ north latitude and $34^0 41'$-$35^0 00'$ east longitude. It is bounded by Gambella Regional State in the south, Ilubabor Zone in the south east, Hawa Galan &Yemalogi Walal district in the north and east and Anfilo district in the west and North West. The district has a total area of 127,800 km^2. The district generally lies within an altitudinal range of 1300-2000 m.a.s.l. The major rainy seasons in the district include spring (April-May), summer (June-August) and autumn (September-November).

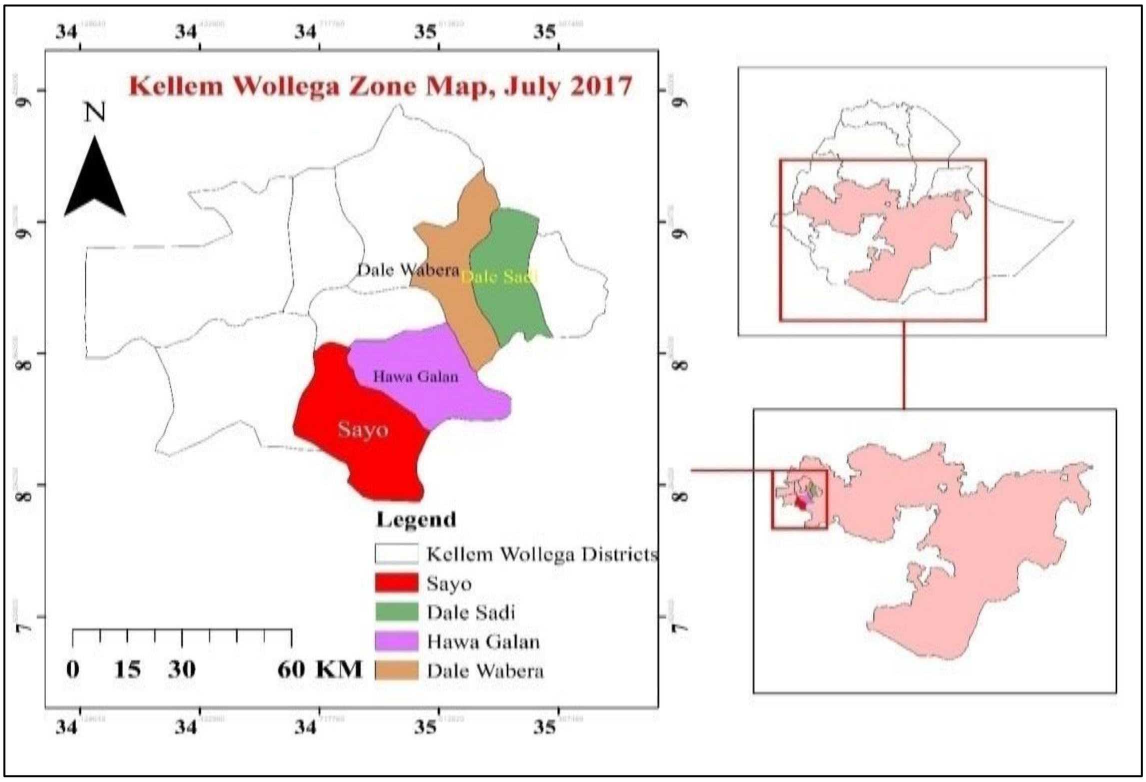

Figure 1: Map of Study area

West Wollega Zone

West Wollega zone is a zone in the western part of Oromia Region, Ethiopia. This zone is named after the former province of Wollega, whose western part lay in the area West Wollega now occupies. West Wollega is bordered on the west by Kellem, on the north by the Benishangul-Gumuz Region, on the east for a short space by East Wollega, and on the southeast by Illubabor. West Wollega Zone comprises eighteen (18) administrative districts. Among these, Lalo Asabi District was purposively selected as the study area based on its agro-ecological diversity, suitability for crop production, and relevance to the research objectives.

Lalo Asabi District

It is one of the 180 districts in the Oromia of Ethiopia. Part of the West Wollega Zone, Lalo Asabi is bordered on the south by Yubdo, on the west by Ayra Guliso, on the north by Boji, on the east by the Benishangul-Gumuz Region, and on the southeast by Gimbi. The administrative center of this woreda is Inango; other towns in Lalo Asabi include Dongoro. A survey of the land in Lalo Asabi shows that 80.39% is cultivated or arable, 5.26% pasture, 9.08% forest, and 5.26% infrastructure or other uses. Coffee is an important cash crop of this woreda. Over 50 square kilometers are planted with this crop.

Site and Farmers Selection

An on-farm evaluation was carried out during the 2024/25 cropping season to assess the productivity of maize using vermicompost technologies under rainfed conditions in western Ethiopia. The study was conducted in two administrative zones—West Wollega and Kellem Wollega. From each zone, one district was purposively selected: Lalo Asabi district from West Wollega and Sayo district from Kellem Wollega. Within these districts, specific trial locations were identified based on their suitability and representation. In Lalo Asabi, the trial was established in Horda Dalati Kebele, while in Sayo, the selected kebeles were Ano Mika'el and Minko.

Prior to the implementation of field activities, experimental farmers were selected following clearly defined criteria. These included their representativeness of typical smallholder farming systems, motivation and willingness to participate, and their potential to disseminate knowledge and practices to neighboring farmers. Attention was also given to gender balance to ensure inclusive participation. To ensure the successful execution of the demonstration, training sessions were organized for all members of the Farmer Research Group (FRG). The training focused on the management, application, and monitoring aspects of vermicompost-based maize production to build the farmers' technical capacity and to strengthen the participatory research process.

Materials Used

The demonstration trial was arranged in a randomized layout, with each participating farmer's field serving as a replication. The BH661 maize variety, known for its adaptability to local conditions, was used for the demonstration. The objective was to compare the effectiveness of vermicompost with the commonly used, but often underutilized, inorganic fertilizers (urea and NPS).

Both treatments were applied to each plot for comparative evaluation. Previous studies in Ethiopia have shown that compost application rates between 5 and 10 t/ha are effective, with the highest yields recorded at 10 t/ha (Ejigu *et al.,* 2021; Abebaw *et al.,* 2025). Since vermicompost generally provides higher nutrient availability and faster decomposition than conventional compost, a moderate rate of 7 t/ha was selected for this study to ensure adequate nutrient supply while maintaining cost-effectiveness. Inorganic fertilizers were applied at 200 kg/ha of urea and 100 kg/ha of NPS, following standard agronomic recommendations. The full dose of NPS was applied at planting, while urea was split into three applications: half at sowing, one-fourth at the 8–10 leaf stage, and the remaining one-fourth at silking. This split application aimed to improve nitrogen use efficiency and ensure nutrient availability during critical maize growth stages.

Field design

The trial was conducted on selected farmers' fields, where maize variety BH 661 was planted using two different fertility treatments: one with vermicompost and the other with inorganic fertilizers (NPS and urea). The two treatments were established side by side on plots of equal size, each measuring 0.25 hectares, to allow for direct comparison under similar field conditions. Sowing was carried out with a spacing of 75 cm between rows and 30 cm between plants. The design was replicated across the number of participating farmers to ensure representativeness and reliability of the data. A spacing of one meter was maintained between the plots to minimize interference between treatments. A seed rate of 25 kilograms per hectare was used. All other agronomic practices, including weeding, were carried out uniformly and as required to ensure optimal crop growth and fair comparison between the treatments.

Figure 2: During trial establishment

Technology evaluation and demonstration methods

Participatory evaluation Materials and Methods was used to demonstrate vermicompost technology for facilitating their wider dissemination of the selected varieties in the future. The newly introduced and demonstrated Technology was evaluated using PRA tools like Pair wise ranking & direct matrix ranking

Data type and method of data analysis

Data collection focused on several key parameters, including grain yield, production costs and benefits, soil characteristics (before and after the application of vermicompost), farmers' technology preference criteria, and the number of stakeholders who participated in promotional events such as training sessions and field days. These datasets were subjected to appropriate methods of analysis. Descriptive statistics, including mean and percentage, were used to analyze grain yield performance and changes in soil properties resulting from the application of vermicompost. Benefit-cost data were analyzed using a partial budget analysis approach to evaluate the economic feasibility of the treatments. Qualitative data, particularly those related to farmers' criteria for selecting technologies, were analyzed using direct matrix ranking and pair wise ranking methods to capture farmers' preferences and perceptions regarding the demonstrated practices.

RESULT AND DISCUSSION

Training

Practical training sessions on vermicompost production and utilization were organized for Farmer Research Group (FRG) members, development agents (DAs), and agricultural experts from each participating district. The primary objective of the training was to equip participants with the knowledge and skills necessary to produce and effectively utilize vermicompost on their own farms. A total of 153 stakeholders took part in the training, comprising 48 females and 105 males, which represents 31.37% female and 68.63% male participation, respectively.

Through these sessions, farmers gained valuable awareness on vermicompost production techniques and its practical application in their fields. Furthermore, the training helped participants understand the drawbacks associated with the excessive use of inorganic fertilizers and highlighted the role of organic fertilizers in improving and sustaining soil health and fertility over time. This awareness was intended to promote the adoption of environmentally friendly and sustainable soil fertility management practices among smallholder farmers.

Table 1: Training given for farmers, DA's and Experts

District	Participant	Male	Female	Total
Sayo	Farmer	35	17	52
	Expert	9	4	13
	DA'S	13	4	17
L/Asabi	Farmer	27	15	42
	Expert	10	5	15
	DA'S	11	3	14
Total		105	48	153
Percentage		68.63%	31.37%	100%

Source: Own demonstration Data

Yield performance

A comparative analysis was conducted to evaluate maize yield performance under two fertility management practices: inorganic fertilizer and compost (vermicompost). The study was carried out across three locations—Ano Mika'el, Minko, and Orda Dalati—with three replications per site. The yield data were summarized and visualized using a bar chart to highlight both location-specific and overall performance differences.

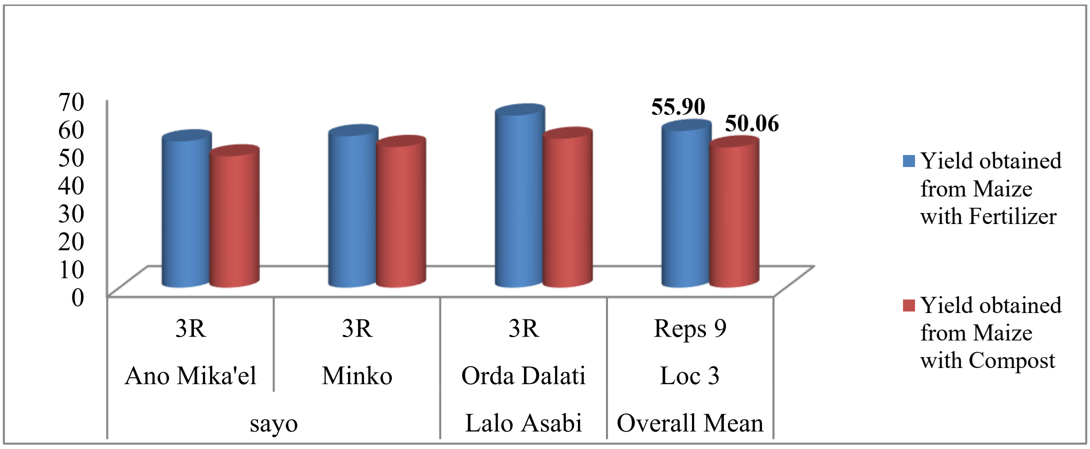

Figure 3: Yield obtained over location in qt/ha (2024/25 G.C.)

The results revealed that, across all locations, inorganic fertilizer consistently resulted in higher maize yields compared to compost. In Ano Mika'el, the yield obtained from fertilizer treatment exceeded that of compost, though the difference was moderate. A similar trend was observed in Minko, where the yield advantage of fertilizer over compost was slightly narrower. However, in Orda Dalati, a more pronounced difference was observed, with fertilizer significantly outperforming compost in terms of grain yield.

When the data were aggregated across all sites and replications, the overall mean yield from maize treated with inorganic fertilizer was 55.90 quintals per hectare, while the mean yield from maize treated with compost was 50.06 quintals per hectare. This shows a yield difference of 5.84 quintals per hectare in favor of inorganic fertilizer, equivalent to approximately 10.4% higher productivity.

These results suggest that while inorganic fertilizer provides a higher yield advantage, compost also supports reasonably good maize production. Given its additional benefits such as improving soil structure, enhancing microbial activity, and contributing to long-term soil fertility, compost can be considered a sustainable and locally appropriate alternative, particularly for resource-constrained smallholder farmers. Therefore, with proper training and awareness, compost-based soil fertility management could complement or, in some cases, substitute inorganic fertilizer, especially where input costs or environmental concerns are high.

Soil Properties

Table 2: Soil Properties Before and After Vermicompost Application

No	Soil Property	Average Before	Average After	Change
1	PH (H_2O)	5.33	5.51	Slight increase
2	Organic Carbon (OC, %)	3.81	5.24	Increased significantly
3	Organic Matter (OM, %)	0.24	0.28	Increased
4	Total Nitrogen (TN, %)	0.22	0.27	Increased
5	Available Phosphorus (ppm)	35.62	36.14	Slight increase
6	Cation Exchange Capacity (CEC)	26.54	17.32	Decreased
7	Exchangeable Potassium (K^+) (cmol/kg)	1.43	1.50	Slight increase
8	Exchangeable Sodium (Na^+) (cmol/kg)	0.28	0.31	Slight increase

Source: Own computation 2024

The application of vermicompost resulted in noticeable changes across several soil chemical properties, indicating its beneficial effect on soil fertility and productivity potential in maize production systems. Soil pH showed a slight increase from 5.33 to 5.51, suggesting a reduction in soil acidity. Even this modest shift is significant in acidic soils such as those in the study area, as it improves the availability of essential nutrients like phosphorus and promotes better root development. This aligns with studies by Agegnehu *et al.,* (2016), which showed that organic amendments buffer soil acidity and improve nutrient uptake efficiency.

Organic carbon (OC) increased substantially from 3.81% to 5.24%. This indicates a strong contribution of vermicompost to organic matter buildup, enhancing soil structure, microbial activity, and long-term nutrient retention. Likewise, total nitrogen (TN) rose from 0.22% to 0.27%, reflecting the slow-release and mineralizable nitrogen content of vermicompost. These results reinforce findings by Azeez and Van Averbeke (2012), who reported that vermicompost boosts nitrogen availability while improving soil biological processes. Organic matter (OM) content increased from 0.24% to 0.28%, further supporting improved soil physical properties such as moisture retention and aeration. This is essential for maize root development and resilience to dry spells.

Available phosphorus (P) increased slightly from 35.62 ppm to 36.14 ppm. Though the increment was small, it is agriculturally relevant because phosphorus is often limiting in Ethiopian soils. Vermicompost likely enhanced P solubility and availability through microbial activity and improved soil pH, as supported by earlier studies indicating enhanced P uptake under compost-amended soils (Edwards *et al.,* 2011). Exchangeable potassium (K^+) and sodium (Na^+) levels increased slightly from 1.43 to 1.50 cmol/kg and 0.28 to 0.31 cmol/kg, respectively. The increase in K^+ is particularly beneficial for crop metabolic functions and drought resistance. Although the rise in Na^+ is minimal, it remains within safe limits and is not expected to pose a salinity risk under the current management conditions.

An unexpected outcome was the decline in cation exchange capacity (CEC) from 26.54 to 17.32 cmol/kg, despite the rise in organic matter. This is contrary to the general expectation, as increased organic matter usually enhances CEC by providing more exchange sites. The decline may be attributed to variations in sampling depth, soil type heterogeneity, or short-term measurement variability. Similar inconsistencies have been noted in other short-duration vermicompost studies, where long-term application was necessary to observe consistent gains in CEC.

Overall, the results indicate that vermicompost significantly enhances several soil fertility parameters critical for maize production. Improvements in soil pH, organic carbon, total nitrogen, and phosphorus availability suggest that vermicompost can be a sustainable alternative or supplement to chemical fertilizers. These findings highlight its potential role in restoring soil health, improving nutrient use efficiency, and promoting environmentally friendly agricultural practices among smallholder farmers.

Economic Analysis of the Demonstrated Technologies

Table 3: Benefit-Cost Analysis

Item	Inorganic Fertilizer (ETB/ha)	Vermicompost (ETB/ha)
Yield (quintals/ha)	55.9	50.06
Price per quintal (ETB)	2800	2800
Gross Income	156,520	140,168
Seed Cost	3000	3000
Land Preparation Cost	10800	10800
Fertilizer Cost (NPS + UREA)	24600	0

Vermicompost Cost	0	6500
Application Cost (labor)	2000	2500
Weeding/Pesticide Cost	2300	1700
Harvesting/Threshing	4000	4000
Total Cost	46700	28500
Net Benefit	109,820	111,668
Benefit-Cost Ratio (BCR)	**3.35**	**4.91**

Source: Own computation 2024

The economic evaluation of maize production under two different fertilizer treatments inorganic fertilizer (NPS + UREA) and vermicompost was conducted using a benefit-cost analysis framework. The findings revealed notable differences in both yield and profitability between the two treatment methods. In terms of yield, the plot treated with inorganic fertilizer produced 55.9 quintals per hectare, while the vermicompost-treated plot yielded 50.06 quintals per hectare. Despite the higher yield from the inorganic fertilizer, the gross income difference was marginal. With a market price of ETB 2,800 per quintal, the gross income amounted to ETB 156,520 for the inorganic fertilizer treatment and ETB 140,168 for the vermicompost treatment.

However, a significant variation was observed in the total production costs. The total cost for the inorganic fertilizer treatment was ETB 46,700 per hectare, primarily driven by the high cost of chemical fertilizers (ETB 24,600), while the total cost under the vermicompost treatment was considerably lower at ETB 28,500. Although the vermicompost treatment incurred additional costs for compost application and production (ETB 6,500 for compost and ETB 2,500 for labor), these were still substantially lower than the costs associated with inorganic fertilizers. When net benefits were calculated by subtracting the total costs from gross income, the vermicompost treatment yielded a higher net benefit of ETB 111,668 per hectare, compared to ETB 109,820 from the inorganic fertilizer treatment. Furthermore, the benefit-cost ratio (BCR), which indicates the return per unit of investment, was significantly higher for the vermicompost treatment at 4.91, as opposed to 3.35 for the inorganic fertilizer.

These results suggest that while inorganic fertilizers may boost yield slightly more than vermicompost, the latter proves to be more economically viable due to its lower cost and higher benefit-cost ratio. The vermicompost treatment offers a better return on investment, making it a more sustainable and profitable option for maize production, particularly for smallholder farmers seeking cost-effective and environmentally friendly farming practices.

Participatory Variety Selection (PVS)

Farmers Evaluation of Technology

An important component of this research was the participatory evaluation of the demonstrated technologies by the farmers themselves. Farmers actively engaged in assessing the technologies by setting their own selection criteria and applying them to identify the most suitable option based on their local knowledge and priorities. For this study, the criteria identified by farmers included grain yield, soil health improvement, cost effectiveness, residual effect, labor efficiency, and the extent to which the technology was farmer-friendly and locally sustainable.

Based on these parameters, the majority of farmers preferred vermicompost over inorganic fertilizer in all aspects except grain yield and labor intensity. While inorganic fertilizer was favored for its higher immediate yield and ease of application, vermicompost was highly valued for its long-term benefits to soil fertility, cost savings, environmental safety, and compatibility with local practices. These findings underscore the importance of integrating farmers' perspectives and preferences into the technology selection and dissemination process.

Therefore, taking into account both objectively measured agronomic performance and farmers' subjective evaluations; vermicompost was identified as the preferred option and is recommended for further scaling up and dissemination within the target communities.

Table 4: Participants of Participatory technology selection in Sayo and Lalo Asabi

Participants	**Sex**		**Total**
	Male	**Female**	
Farmers	36	21	57
DAs	12	4	16
Experts	1	1	2
Total	49	26	75
Percentage (%)	65.33%	34.67%	)

Figure 4: picture taken during PV

Table 5: Pair wise ranking of traits

Traits	GY	CE	RE	SHI	LS	FFLST	Frequency	Rank
GY	X	GY	GY	GY	GY	GY	5	1st
CE		X	CE	CE	CE	CE	4	2nd
RE			X	RE	RE	RE	3	3rd
SFI				X	SHI	SHI	2	4th
LS					X	LS	1	5th
FFLST						X	0	6th

Source: Own computation 2024

GY=Grain yield, SHI=Soil fertility improvement, CE=cost effectiveness, RE=Residual effect, LE=labor Saving, FFLST=farmer-friendly and locally sustainable technology

In the pair wise ranking exercise, farmers compared six key traits of agricultural technologies to identify which characteristics they value most. The traits included: grain yield (GY), cost effectiveness (CE), residual effect (RE), soil health improvement (SHI), labor saving (LS), and farmer-friendly and locally sustainable technology (FFLST).

The ranking of farmers' trait preferences was determined based on the frequency with which each trait was chosen over others during pair-wise comparisons. The results revealed that grain yield was the most preferred attribute among farmers, consistently ranked first in all comparisons. This underscores the central importance of productivity for smallholder farmers, as yield remains the primary indicator of a technology's success and its direct impact on food security and income.

Cost effectiveness was the second most valued trait, selected in four out of five comparisons. This reflects farmers' strong interest in technologies that not only enhance output but also help minimize input costs, thereby improving overall profitability. Following that, residual effect ranked third, indicating growing awareness among farmers about the long-term benefits of certain technologies—such as improved soil fertility—that extend beyond a single growing season.

Soil health improvement was placed fourth in the ranking. Though not among the top immediate priorities, it still holds importance for farmers who recognize the role of soil quality in sustaining agricultural productivity over time. Labor saving was ranked fifth, pointing to some concern about the burden of manual work, particularly in areas facing labor shortages or high opportunity costs of farm labor.

Surprisingly, the trait farmer-friendly and locally sustainable technology ranked last, receiving no top preference. This may suggest that while concepts like sustainability and user-friendliness are acknowledged in theory, they are often de-prioritized when farmers are faced with more immediate, tangible considerations such as yield and cost.

The ranking clearly shows that productivity (yield) and economic returns (cost effectiveness) are the primary concerns for farmers. While environmental and sustainability aspects like soil health and residual effects are recognized, they are considered secondary priorities**.** This finding suggests the need to integrate sustainability traits into high-yield and cost-effective packages to increase their adoption.

Ranking of Technology

A direct matrix ranking was conducted with 48 farmers to evaluate and compare vermicompost and inorganic fertilizer based on six important selection criteria: Grain Yield, Cost Effectiveness (CE), Residual Effect (RE), Soil Fertility Improvement (SHI), Labor Saving (LS), and Farmer-Friendly & Locally Sustainable Technology (FFLST). Each farmer scored both technologies based on how well they performed in each category. The total scores across all criteria were then calculated to determine overall preference.

Table 6: Direct matrix ranking of Technology

No	Criteria(N=48)	Technologies demonstrated	
		Vermicompost	**Inorganic fertilizers (NPS and UREA)**
1	**Grain Yield**	13	35
2	**Cost Effectiveness (CE)**	48	0
3	**Residual Effect (RE)**	48	0
4	**Soil Fertility Improvement (SFI)**	23	0
5	**Labor Saving (LS)**	0	48
6	**Farmer-Friendly and Locally Sustainable Technology (FFLST)**	48	0
	Total	180	83
	Percentage	68.44%	31.56%
	Rank	1 st	2nd

Source: Own computation 2024

As shown in the above table Farmers were asked to score each technology under every criterion based on their experiences and perceptions during the demonstration. The results revealed that vermicompost received a total score of 180, while inorganic fertilizer scored 83, accounting for 68.44% and 31.56% of the total responses, respectively.

Among the six evaluation criteria used in the direct matrix ranking, vermicompost was rated highest in four categories by the participating farmers. It received a full score (100%) for cost effectiveness, indicating that all farmers considered it to be more economical than inorganic fertilizer. This preference suggests that vermicompost reduces input costs while still supporting crop production. Additionally, vermicompost also scored 100% in terms of its residual effect**,** highlighting the farmers' recognition of its long-lasting benefits on soil fertility and its contribution to sustained productivity over time.

Furthermore, all farmers (100%) identified vermicompost as a farmer-friendly and locally sustainable technology**,** primarily due to its local availability, safety in handling, and compatibility with traditional farming practices. It was also preferred for soil health improvement**,** receiving 23 out of 48 votes (47.9%), indicating that nearly half of the farmers appreciated its contribution to improving soil structure and fertility.

In contrast, inorganic fertilizer was more favored in only two of the six criteria. It received the highest number of votes for grain yield, with 35 out of 48 farmers (72.9%) selecting it as the better option in terms of producing higher immediate yield. This shows that many farmers still trust inorganic fertilizer for its fast and visible results. Moreover, inorganic fertilizer was overwhelmingly preferred for labor saving, with all 48 farmers (100%) choosing it due to its ease of application and minimal time requirement compared to the more labor-intensive preparation and use of vermicompost.

Overall, while inorganic fertilizer continues to appeal to farmers seeking quick results and less labor, vermicompost was the most preferred technology when broader agronomic, economic, and environmental factors were considered.

CONCLUSION AND RECOMMENDATIONS

Conclusion

This study demonstrated that vermicompost technology has substantial potential to enhance sustainable maize production in the FSRP districts of West Wollega and Kellem Wollega zones. Although inorganic fertilizer treatments produced about 10% higher maize yields, vermicompost significantly improved critical soil chemical properties such as organic carbon, organic matter, total nitrogen, and soil pH, which are essential for maintaining long-term soil fertility and productivity. The slight yield difference is outweighed by the long-term soil fertility benefits associated with vermicompost application.

Economically, vermicompost treatment outperformed inorganic fertilizer in profitability, registering a higher net benefit and benefit-cost ratio primarily due to its lower input costs. This indicates that despite the lower yield, vermicompost provides a more sustainable and economically attractive option for resource-constrained smallholder farmers.

Farmers' participatory evaluations revealed a clear preference for vermicompost based on criteria beyond immediate yield, such as cost-effectiveness, residual soil fertility improvement, and environmental sustainability. However, labor intensiveness and immediate grain yield remain significant considerations, highlighting that farmers balance short-term productivity needs with longer-term sustainability benefits.

The findings emphasize that vermicompost technology is not only a viable alternative but also a complementary approach to conventional fertilizers, offering a pathway toward more sustainable maize production by enhancing soil health, reducing chemical inputs, and improving farm profitability in the study areas.

Recommendations

- **Promote Vermicompost Adoption through Demonstrations and Farmer Engagement:** Given the positive economic returns and soil fertility improvements, scaling up vermicompost use via participatory demonstration plots and farmer field schools should be intensified to increase adoption among smallholder farmers.
- **Enhance Training Programs on Vermicompost Production and Application:** As farmer training significantly improved awareness and practical skills, continued and expanded training efforts targeting farmers, development agents, and local experts should focus on efficient vermicompost production methods and timely application to maximize benefits.
- **Encourage Integrated Soil Fertility Management (ISFM):** Since inorganic fertilizers provided higher immediate yields but vermicompost improved soil properties and profitability, combining vermicompost with reduced rates of inorganic fertilizers should be investigated and promoted to optimize yield and soil health simultaneously.
- **Develop Labor-Saving Innovations in Vermicompost Use:** Given that vermicompost preparation and application are labor-intensive, research and extension should focus on introducing labor-efficient technologies or practices to reduce the labor burden and increase the attractiveness of vermicompost to farmers.
- **Support Policy and Institutional Frameworks:** Encourage policymakers and local institutions to provide incentives, subsidies, or support mechanisms for organic fertilizer production and use, considering vermin compost's proven benefits in enhancing soil fertility and farm profitability in the study areas.

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