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Role of vermicomposting for smallholder farmers in Wondo-genet woreda, Sidama region, Ethiopia: a success story

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A B S T R A C T

Both organic and chemical fertilizers play a vital role in enhancing crop productivity and maintaining soil health. However, inflated prices of chemical fertilizers also reduced their rate of application, hence, reducing crop productivity in Ethiopia. Therefore, to sustain the productivity of lands and crops, there is an urgent need to promote the use of organic fertilizers. Vermicomposting is one method of preparing enriched compost with the use of earthworms. With the support of the second phase of the Agricultural Growth Program (AGP-II), the introduction and promotion of vermicomposting technology were conducted. However, the production status and role of vermicomposting for smallholder farmers in the area are unclear. Therefore documenting the achievement and progress of vermicomposting is necessary. Both primary and secondary data (2018-2021) were collected by using snowball sampling techniques. The descriptive statistics reveal that in addition to potato production, farmers are using vermicompost for chat, enset, coffee, forage and vegetable production. Accordingly, the production, utilization, and sale trend of vermicompost increased from 2018 to 2021. In addition, vermicomposting created an opportunity for farmers to participate in earthworms and vermicompost selling. Due to this, those who had vermicompost in their home garden do not use inorganic fertilizers for any crop production during the last four years. In addition, the average cultivated cropland coverage by vermicompost-based production also increased from 2018 to 2021. Its preparation procedure is also consistent with the manual provided to them. Therefore expanding vermicomposting technology in the area has the potential to enhance sustainable crop and land productivity.

Keywords: Crops, Earthworms, Success-story, Vermicomposting

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Introduction

Agriculture plays a vital role in economy of Ethiopia, and its 94 percent is owned by smallholders and characterized by lower productivity, weak market orientation, and low-value additions (Louhichi *et al*, 2019; Arias-Hidlago *et al*., 2013). Agricultural extension and advice provision was the early strategy to enhance agricultural productivity, but not overcome the productivity bottleneck due to inadequate supply of agricultural inputs like improved seed and fertilizer. Later, agricultural intensification through the integrated use of agricultural inputs (improved seed, chemical fertilizer, pest control mechanisms, and better management practices) was designed and implemented. However, these also do not reach in tackling productivity problems due to lower coverage, poor quality of implementation, weather variability, and poor soil fertility (Kassie *et al*., 2015).

Agricultural Growth Program I and II were designed with aim of scaling up best practices dissemination, specialization on high-value crops, and supporting agricultural research since 2010. Among agricultural research components; evaluation of different soil fertility enhancing mechanisms and promotion of best soil fertility

enhancing technologies are among its sub-components (MoA, 2015). Accordingly, evaluation of vermicomposting for selected crops (potato, barley, tomato and cabbage) productivity is being conducted by Hawassa Agricultural Research Center in Gedeo and Sidama areas with the coordinating unit of the Southern Agricultural Research Institute of Agricultural Growth Program since 2016. This was conducted with aim of evaluating vermicomposting for soil health and crop productivity improvements.

The rationale behind promotion of this technology is that earthworms 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; Abafita, 2016). 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.

Accordingly, evaluating and promotion of vermicomposting for potato production was practiced. However, there is evidence gap of whether farmers are being practicing this technology and challenges that affects the use of this technology in the area is unclear. Thus, this paper documented the role and challenges of vermicomposting for smallholder farmers in the case of Wondo Genet district. Consequently, it will be used for understanding the progress of vermicomposting production over time, provide awareness for decision-makers about its impact, share the best practices of beneficiary farmers, and attract other partners for collaborations.

Methodology

Description of the study area

Wondogenet woreda is one Agricultural Growth Program II supported woreda in Sidama Region, Ethiopia. It is situated in the Hwassa watershed in the East African rift valley zone southeast of the town of Shashemene (7°06'N; 38°37'E) (Dessie and Kunlund, 2008). Aruma kebele is the first location in which this project started. The soils are fertile except for soils in sloppy lands whose fertility is reduced due to low organic matter. Soil exhaustion due to long-continued ploughing, soil erosion losses due to deforestation, overgrazing and extensive farming are some of the causes of loss of fertility in the area (CO-SAERSAR, 1999). The farming system of the area is characterized by perennial-annual-livestock based. The intervention area farming system is the perennial-annual-cereal-fruit-based natural farming system. Specifically, it is chat-enset-coffee-maize-vegetable-based production. The major crops they are producing using this fertilizer are enset, chat, maize, potato, and vegetables. Large and small ruminants and poultry are among the livestock species in the area. With respect to fertilizer usage, farmers mostly use inorganic fertilizers (NPS and Urea) for annual crop production. In addition, animal dung and manure are mostly used organic fertilizers around home garden. However, the preparation and application of those organic fertilizers deviates from recommended method of preparation. Due to this, their contribution to crop and land productivity is minimal.

Sampling techniques

Among non-probability sampling techniques, a snowball sampling procedure was employed to document the role of this technology. This is due to expansion trends of its production are based on farmers to farmers experience sharing. Firstly four early started farmers were interviewed purposefully. Then other farmers who took experiences from those early started farmers were asked about their production status of the vermicomposting by using chain-referral sampling. Finally, only those farmers who have at least one year of experience in its production were considered. But currently, about 45 farmers are producing it in the area. Totally 9 farmers were interviewed for this study.

Data type, method of its collection and analysis

Both primary and secondary data were collected. Totally four years (2018 - 2021) of secondary data on the production status of vermicompost, sold amount of both vermicompost and earthworms, and the area covered was collected. Both focused group discussion and key informant interviews were conducted. During focused group discussion the production status and challenges of vermicompost, the major crops that are produced using vermicompost and the opportunity for its production were identified. Then face to face interview using a structured questionnaire was conducted for documenting farmers' specific achievements and associated challenges of production. Descriptive statistics was employed for data analysis. These are frequencies, means, and standard deviations.

Results and Discussion

Socioeconomic characteristics of households

As indicated in table 1, the average age of respondents is 43.67 years old. This shows that all farmers are in the age of identifying comparative advantage of vermicompost-based production from the use of chemical fertilizer

from their long time farming experiences. The educational level of vermicompost producer sample farmers in the number of grades completed is seven. This implies farmers have good educational status to identify good characteristics of this technology and its experience sharing ability for other farmers who have an interest in production. The average family size of sample households is eight. This shows that the vermicompost production needs some labor time and farmers can able to manage it with the number of family members without any cost. The average landholding of farmers is around 0.69 hectares. This shows that their small land size motivates more for full coverage during crop production. The average experience of vermicompost production is around 4 years, this implies in each year farmers make themselves familiar with this technology in the area and indicates vermicompost production is not infant for the area. Generally, as they informed there are no socioeconomic constraints that affect them in participation and production of this technology. Even it created an opportunity for both genders in households. Currently, in every household, both husbands and wives have their vermicompost bed, which shows this technology motivates them for integrated purposes.

Table 1. Socioeconomic characteristics of beneficiary farmers.

Demographics	Mean	St. Dev
Age	43.67	3.60
Education	7.44	1.06
Family size	7.80	0.68
Land holding	0.69	0.07
Experiences in VC production	3.90	0.70

Source: Author survey, 2022

Crop land covered by vermicompost in the area

Before this technology was introduced in the area, all cultivated land was rehabilitated by using chemical fertilizer for boosting crop yields. In the initial year, only four farmers succeeded in vermicomposting. Then their number increased from year to year. As shown in table 2 below, the numbers of vermicompost producers are 4, 5, 8 and 9, for 2018, 2019, 2020 and 2021, respectively in the area. At the initial time based on secondary information from the area, 25 households took training and started production, but due to household-based inefficiency and other factors, only 4 succeeded in their production. The production created a market opportunity for those at an initial time and crop performance of these farmers' fields also showed good performance, and later the number of participants increased from year to year. This trend of participant expansion is related to study conducted by Yangchan *et al.* (2019).

Due to the increasing number of participants, the average area coverage is also increasing from year to year per sample. At the initial time, the average area of land covered by vermicompost is around 0.35 hectares and after four years, it becomes more than twofold, that is 0.71 hectares. This also reveals an increasing trend of shifting from chemical fertilizer-based to vermicompost-based production. Observing of these achievements, the number of farmers who took experiences from those vermicompost producers is 12, 16, 27 and 45 for 2018, 2019, 2020 and 2021, respectively. This indicates after some years completely the cultivated land area will be covered by this technology.

Chat is the main cash crop in the area. Farmers use vermicompost for it from year to year and the data shows its level of application also increases from year to year. Framers got successive income in each year of vermicompost-based production. This is because, before it, they may lose and get less income from chat using chemical fertilizer and no fertilizer at all due to different factors.

Table 2. Crop land coverage trend of vermicomposting based production.

Identifiers	2018	2019	2020	2021
Number of farmers	4	5	8	9
Total area of land covered by VC	0.35	0.36	0.53	0.71
Experiences shared by farmers	12	16	27	45
Chat average amount of income	47250.00	52400.00	39428.57	39000.00

Source: Author survey, 2022

Major steps followed by farmers for vermicomposting

As shown in the figure, farmers firstly prepare the bed and partially decompose its feed. The size of the bed is around 2.0 m in length and 1.5 m width. This bed is prepared from both timber and concretes. They use different decomposable materials for the preparation of feeds. For instance, the materials they use for the preparation of feed in the area are leaves and stems of enset and banana, dried animal dung, decomposed stem and leaf part of papaya, vegetables that are wasted and any other locally available materials except leaves of eucalyptus and poultry waste. They partially decompose it on the separate bed and after its decomposition, they check temperature normality (because if it is too hot the probability of earthworm dying is high), and edibility easiness for earthworms.

Figure 1. Stage of partial decomposition and earthworms with in Bed.

After that, they insert earthworms into it. After forty-five up to fifteen days, the vermicompost is ready for usage. Then they segregate earthworms from vermicompost using light or sun, due to nature that earthworms do not need any high temperature and sun at all. When they feel the sunlight, they move together to the inside of the bed or more to the area that has lower light. Then farmers easily collect vermin compost and take earthworms back to the bed that is ready for them with partially decomposed feed. Then they took vermicompost to sunny part for purpose of drying and they add it to suck or store they made for it. After that, either they sold or apply for their crops if it is the season of application. All these procedures can be made by using hands without any precautions. This is due to the lack of any side effects from the earthworms as well as the smell of vermicompost.

Figure 2. Extracted compost at drying stage and application for maize production.

Major crops produced by using vermicompost

As farmers explained they only used vermicompost as fertilizer since 2018. Enset is one of the staple foods in the area and before production using vermicompost, they produce it with farmyard manure. Starting from the last four years, they are producing it by using vermicompost and saw effective change in terms of early maturity and enhanced yield. As case farmers informed that before starting this fertilizer for enset, the average year of enset maturity is four to six years. However, as they informed, on average enset can reach maturity within two years. This importance of vermicompost on increasing plant growth and yield is consistent with the finding of Blouin *et al.* (2019). This study is also consistent with Saranraj and Stella (2012), who stated that vermicompost based production, improves the growth and yield of different crops. As they informed they are using vermicompost for enset during planting and after one and two years old. They are not using it after two and more years old enset.

Figure 3. Enset and Desho forage field performance.

As shown in the graph below, the application of compost for enset increased from 2018 to 2020. But showed a decreasing trend in 2021. This implies being perennial, after two years they are not applying vermicompost for it. The average amount of vermicompost applied for enset per household for consecutive four years are 1.56, 1.50, 2.22, and 1.40 quintals for 2018, 2019, 2020, and 2021 years, respectively. Before producing vermicompost, they produce chat using chemical fertilizer. After starting vermicompost production, every year they are using it for chat production and getting a good product that has relatively more preference in the available local and national markets. Vermicompost application for chat increased from year to year. Based on the sample data, the average amount of vermicompost applied for chat production is 2.56, 2.72, 3.28, and 3.83 quintals respectively per vermicompost producers.

Maize is a major crop that is being produced for home consumption. Before vermicompost production, they use chemical fertilizer for maize, however, they currently shifted from chemical fertilizer to vermicompost for maize production in the area. As they stated even if its production is for home consumption, its yield is much better compared to prior chemical-based production. Accordingly, on average, each farmer applied 1.56, 1.50, 1.44, and 2.44 quintals for 2018, 2019, 2020, and 2021 years, respectively. The average yield is around 36 quintals per hectare. In addition, they are producing vegetables, forage, and coffee using vermicompost. The major vegetables are cabbage, tomato, pepper and carrot. In the area, these crops are not largely produced, but play a vital role in the contribution of increasing food diversity for smallholders. Most farmers used vermicompost for vegetable production after 2019. Lastly, some farmers are also using it for potato production.

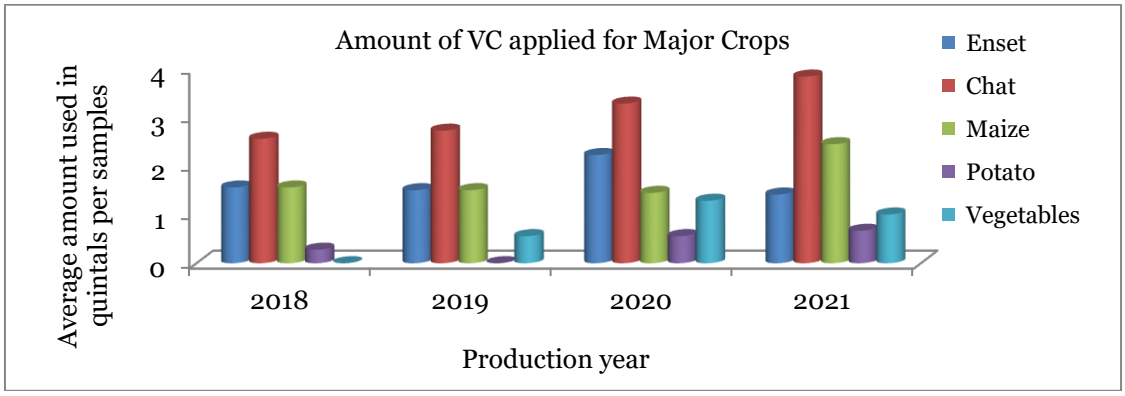

Figure 4. Major crops produced using vermicompost.

Production, utilization and selling trends of vermicompost

According to sample respondents that were produced vermicompost from 2018 up to 2021, the average amount of production is around 9.17, 12.28, 13.23, 16.39 quintals respectively for 2018, 2019, 2020, and 2021, respectively. This shows increasing trends in its production. This is because the technology does not need such significant investment and cost, except for labor time from preparation up to utilization. Regarding the use of it for crop production, on average they applied 5.94, 6.28, 8.78, and 9.36 quintals for 2018, 2019, 2020, and 2021, respectively for crop production on their field for crop types specified before. This trend also reveals that there is an increasing trend of application due to the presence of comparative advantage compared to chemical fertilizers. This expansion also relates to Yangchan *et al.* (2019) finding.

In addition, participation in vermicompost is not only for utilization; however, it created the opportunity to develop the market. Thus, the

purpose of vermicompost production is both for utilization and means of income in the area. During the survey, we observed the recorded amount of vermicompost sold per year per sample producer.

Figure 5. Vermicompost ready for sale and receipt from its sale.

Accordingly, on average they sold 333, 333, 328, and 389 kilograms for 2018, 2019, 2020, and 2021, respectively. Their market participation is not only by vermicompost, but they also sell earthworms to an interested organization. The average price of vermicompost per kg is 10 Birr and earthworm is about 300 – 500 Birr.

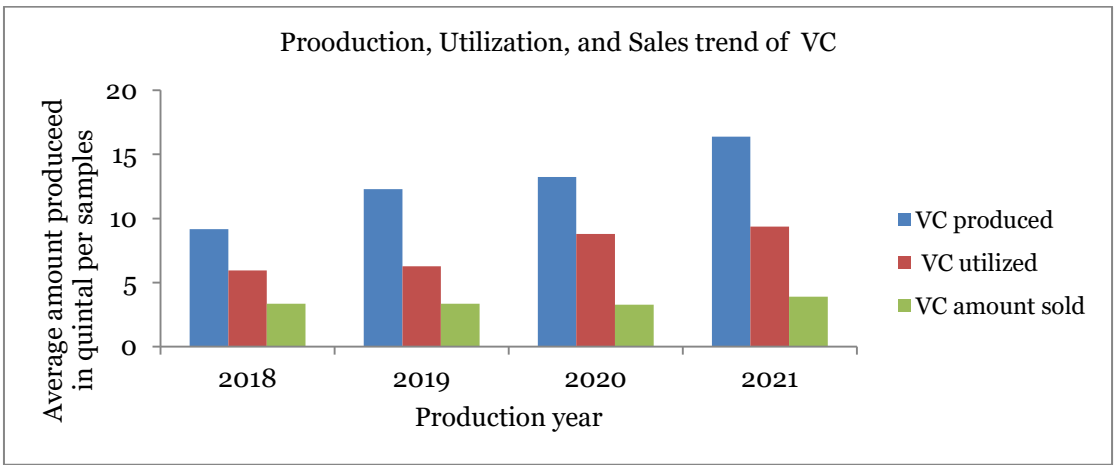

Figure 6. Production status of vermicompost.

Source: Author survey, 2022

Marketing and revenue from earthworm and vermicompost

As indicated earlier both vermicompost and earthworm have a markets value. For the area, these marketing practices are new. The price is mostly determined by farmers during starting year and after the increment of the number of producers, this is being based on individuals' bid assignment per kg for both. Currently, they only supply for organizations and a few private investors. Due to the lack of a local market and its awareness for non-vermicomposting producers in the area, the price that is being attached for them is not sufficient as efforts made for it and its value for crops.

Beginning of the production year, the number of farmers who participated in the selling of both vermicompost and earthworm was only two. After four years the number of market participants increased up to six and nine for vermicompost and earthworm, respectively by end of 2021. These numbers were relatively increased for earthworms than vermicompost. This is due to the market price of earthworms attracting them to participate more. The average price of earthworms is 500.00, 416.67, 372.50, and 416.67 for 2018, 2019, 2020 and 2021, respectively. The declining nature of prices from year to year is that an increasing number of producers increases market supply and declines price according to the amount supplied. The table below also shows that the revenue from earthworms is greater than that of vermicompost. This is motivating the success of this technology introduction to the area.

To sum up, these marketing practices of vermicompost and earthworm created an opportunity for farmers to support their household economy. On average, they gained 40000.0, 3097.1, 12944.4, and 13887.6 for 2018, 2019, 2020 and 2021 respectively per sample in

the area. This shows that the production of this fertilizer is not only for crop production, but it becomes means of revenue for a household with minimum resource utilized for its production that is locally and easily available.

Table 3. Marketing practices of VC and Earthworms.

Years	2018		2019		2020		2021	
	VC	Earth Worm	VC	Earth Worm	VC	Earth Worm	VC	Earth Worm
Participants	2	2	2	3	4	8	6	9
Sold in Kg	1500	80	1500	74.33	737.5	34.75	583.33	33.33
Price per kg	10.00	500.00	10.00	416.67	10.00	372.50	12.83	416.67
Revenue	15000.0	40,000.0	15000.0	30971.1	7375.0	12944.4	7484.1	13887.6

Source: Author computation, 2022. VC implies vermin-compost amount

Challenges of vermicompost production

Currently, farmers are not informed of any challenge that diverts their production participation. But the insect (ant) at midnight affects earthworms and they have not found any solution for them to control easily. In addition, the production is mostly for two months and they have the opportunity to produce six times throughout the year. Then, they reach surplus production and if they want to sell, they are unable to get buyers. The organizational buyer was mostly time-oriented and took a limited amount for their purpose, as a result, farmers are getting the challenge of effective marketing. In addition, the lack of improved earthworm feed chopping material for partial decomposition consumes most time by using locally available instruments like knives. This indirectly affects increasing the number of beds from year to year.

Conclusion

Vermicompost production in the study area was introduced in 2018 by Hawassa Agricultural Research Center, Southern Agricultural Research Institute, Hawassa Ethiopia. The number of vermicompost producers increased in the last four years. At the initial time, only 4 farmers started and succeeded in its production, and currently, their number reached twenty-eight. The purpose of production is both for utilization and sale. The average produced amount of vermicomposts are 910, 1230, 1320, and 1640 kilograms in 2018, 2017, 2020, and 2021, respectively. This shows that the amount of its production increased from year to year. Regarding its application to crops on average, the farmers applied 590, 630, 880 and 940 kilograms in 2018, 2017, 2020 and 2021, respectively. This shows that from total produce they applied 56.0, 51.0, 66.7 and 57.0 percent for last successive four years. In addition, on average, they also sold around 330 kilograms each year. This similar sale trend is due to their market participation is mostly selling of earthworms.

The major crops that are being produced by using vermicomposting are enset, chat, potato, maize, and vegetables. The average amounts of vermicompost used for chat production are 260, 270, 330, and 380 kilograms in 2018, 2017, 2020, and 2021, respectively. The increased amounts of application of vermicompost in the last four years are because of market preference for chat produced from vermicomposting. Similarly, they applied on average 160, 150, 220, and 140 kilograms for enset production in 2018, 2017, 2020, and 2021, respectively. Like the way in four successive years, they also applied around 150 kilograms for maize production. This stagnant amount of application is due to land scarcity and always they are producing maize on the same acre. They also applied on average, more than half and less than one quintal for vegetables and potatoes in the area. To generalize, this shows that being new for this technology; the increased number of applications is one of the successes of research implementation in the area.

Selling of earthworms is also another opportunity for communities. On average farmers sold 80, 74, 34 and 33 kilograms in 2018, 2017, 2020 and 2021, respectively. The decreasing trend implies that at the initial time numbers of the producer were only 4 and they get adequate buyer during 2018 and 2019, however, their trend of selling decreased by around 50 percent. This is because of the inadequate buyer during the last two years and increased number of producers. The average revenue they earned from its sales was 40000.0, 30971.0, 12944.4 and 13887.6 Ethiopian birrs during 2018, 2017, 2020 and 2021, respectively. To generalize, vermicompost has more advantages compared to chemical fertilizer. It reduces the maturity time of crops. The associated constraints of its production are attack of ants at midnight, inadequate market chain, and lack of feed chopping materials. In addition, this study suggests the determination of the optimal rate of application for major crops in the area except potato.

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