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CHALLENGES AND OPPORTUNITIES OF COMPOSTING ORGANIC SOLID WASTE AND ITS IMPLICATION, IN BOLE SUB CITY, ADDIS ABABA, ETHIOPIA

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This is to certify that the research paper prepared by Eyerusalem Degefu **"Challenges and opportunities of composting organic solid waste and its implication in Addis Ababa, Ethiopia" s**ubmitted to Addis Ababa University, College of Development Studies, in partial fulfillment of Master of Arts in Environment and Sustainable Development and meets the requirements of the standard with respect to its original quality.

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Acronyms

AACSBPDA	Addis Ababa City Sanitation, Beautification and Park Development Agency
BOD	Biochemical Oxygen Demand
EPA	Environment Protection Authority
FDRE MoARD	Federal Democratic Republic of Ethiopia Ministry of Agriculture and Natural Resource Development
GHG	Green House Gas
GIS	Geographic Information System
ICL	Integrated crop-livestock systems
LG	Landfill Gas
MSW	Municipal Solid Waste
UNEP	United Nations Environment Program
WHO	World Health Organization

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Abstract

The organic solid waste that is produced and disposed of from households in Addis Ababa accounts for around 60% of the total waste being disposed of, where this is a huge amount of waste that can be composted for agricultural use. It shows a good opportunity to practice organic solid waste composting in order to reduce waste dumped at landfills and provides a sustainable waste management option and translates into economic good through composting for agricultural use in cities. Even though there is a large resource of organic solid waste that can be converted to usable resources through composting, the practice in most cities of developing remains at an infant stage. Therefore, the objective of this study is to discuss the Challenges and opportunities of composting organic solid waste and its implication in Addis Ababa, Ethiopia. In order to achieve the research objective, a cross-sectional study was applied to collect quantitative data from 125 households in Addis Ababa, Bole sub city woreda 01 and 02. In addition, focus group discussions (FGDs) and key informant interviews (KIIs) were conducted with community representatives and government officials, respectively. The quantitative data collected through the survey was analyzed using SPSS 27 to determine and identify the relationship between the variables that influence the practice of composting organic solid waste at the household level. The study indicated that the practice of composting organic solid wastes at the household level is very low. Analysis of the survey data shows only 16% of the respondents in the study used organic solid waste compost as fertilizer in their homes, while the rest claimed they don't use it at all. Therefore, there is a high need for interventions by authorities, agencies, and social communities to promote the practice of composting by providing awareness, technical and skill training and also strengthening the linkage between associations that produce compost and facilities that demand the use of organic compost for better market and environmental protection. The role of composting organic solid waste to improve urban agriculture and soil fertility should be given higher consideration and used to provide a sustainable solid waste management option that is environmentally friendly.

Key words: *organic solid waste, composting, decomposable waste*

CHAPTER ONE

1. INTRODUCTION

1.1. Background

Composting has been a common practice in many parts of the world for centuries. In Ethiopia, composting has a long history that dates back to the preindustrial era. During this time, farmers used simple methods of composting and animal manure to fertilize their crops. This tradition has been maintained through generations, especially through the country's subsistence farming and traditional agricultural systems. For centuries, individuals have been making use of compost to enhance the fertility of their soil and boost crop yield. This natural fertilizer has proven to be an effective way to promote healthy growth and produce more bountiful harvests. Composting is widely practiced in many rural areas in Ethiopia as an integral part of sustainable agricultural practices, as it is simple and effortless, with rapidly increasing awareness among farmers of its benefits (Kassa et al., 2016; Bekele & Menkir, 2004). It also helps reduce soil erosion by conserving fertile topsoil on smallholder farms (Abegaz & Tsegaye, 2019).

Traditional compost piles have been used to add organic matter and nutrients to depleted soils, providing improved food security and livelihoods. Additionally, it is a key component of integrated crop-livestock (ICL) systems – cropping and livestock raising - used to enhance pasture diversity and promote sustainable land use. Ethiopia's farming community has also traditionally practiced composting as part of a more agroforestry-type system, adding nutrient input from the extensive trees they grow. More recently, with high levels of soil degradation across the country, researchers have been increasingly interested in exploring how modern composting technologies could help improve crop yields and reverse soil erosion. (Maleki, Seyed Ali, et al. 2019) The Ministry of Agriculture and Natural Resource Development of Ethiopia has noted that organic nutrient management techniques such as composting can help sustain soil fertility and safeguard soils from degradation (FDRE MoARD, 2018).

Ethiopia has a historical background in waste management, such as collecting and burning all waste on one particular day called "Hedar sitaten," held on12th of Hedar in the Ethiopian calendar. The commemoration and public ritual known as Hedar Sitaten serves not only as a way to remember the past but also to safeguard against future pandemics. Its influence can be seen

throughout our collective narratives, folklore, and literature, leaving a lasting impression on our culture as written by Yayehyirad Kitaw (2018), the result of a one-time practice done during 1918G.C. ordered by the ruler at that time, Emperor Tefri, Mekonene to control a pandemic that was spreading widely due to poor waste management. The practice has continued for a century and passed on to generations. In contemporary times, this custom has been eliminated owing to the realization of the implications of incinerating refuse on the ecosystem, particularly with regard to atmospheric contamination. Since most of the waste is plastic, there is more emission of hazardous gasses that also cause health issues.

The other urban solid waste management practice that has increasingly become a common practice in Addis Ababa has been collecting substantially large amounts of waste in the city and transporting it to a designated dumpsite called *Koshe*. The dumping of waste at *the Koshe* dumping site began in 1964; however, before that time, the site was an unofficial site for burning dead animals (Mahiteme, 2009). The *Koshe* dump site has been present for approximately 50 years and is situated in the Southwest region of Addis Ababa, encompassing the areas of Nifas Silk-Lafto and Kolfe Keranio. It is noteworthy that *Koshe* does not have a fence and lacks a sufficient buffer zone between the dump site and other adjacent land uses like schools, residences, and farming sites. The area poses significant environmental and health risks to its residents, as well as being prone to both temporary and permanent scavenging. The dumping site hosts about 500 scavengers who sell recovered materials from the waste to businesses and farmers (Mahiteme et al., 2010).

Nowadays, this practice of piling at a single site has become challenging as the site has become overloaded. There was a tragedy that occurred in 2017 due to a landslide at Koshe, killing 116 people. Since then, there have been attempts to improve the waste disposal practice into a sustainable waste management system where an energy plant has been established to convert waste into energy sources (UN-HABITAT, 2023).

Composting, as one of the alternatives for managing waste, is currently gaining more attention in Addis Ababa. In recent years, universities and research bodies have been spearheading initiatives to introduce composting methods to tackle organic waste management challenges in the city. The Addis Ababa Waste Management Office, which is responsible for implementing and monitoring solid waste management, has strongly supported these initiatives by creating a conducive environment through grants and internships that raise awareness of compost applications. It also

encourages community-based initiatives such as urban gardening schemes (which use compost) and sponsoring training programs that focus on green waste management techniques. Additionally, community centers have emerged as hubs of environmental education in Addis Ababa, where citizens learn about composting techniques from resourceful persons and develop their small-scale initiatives (Habtam & Khanal, 2019).

For this reason, understanding the challenges and opportunities of composting in Ethiopian cities at the household level should receive an important consideration in the country's development strategy, mainly in relation to creating a safe environment and improving proper uses of resources, i.e., uses of organic solid waste as a source of organic fertilizer for urban agriculture. This study analyzed the challenges and opportunities of composting organic solid waste and the implication in Addis Ababa as a case.

1.2. Problem statement

The rapidly increasing cities population of developing countries such as Ethiopia and the expansion of capital cities such as Addis Ababa directly impact the amount of solid waste generation. There have been several attempts to improve solid waste management. How waste is disposed from cities like Addis Ababa has been causing environmental degradation as a result of poor management and infrastructure. Composting is an important activity when it comes to managing organic waste in an urban environment, as it can lead to economic and environmental benefits. In the context of Addis Ababa, a metropolitan city in Ethiopia, the opportunities and challenges associated with composting can be many. Based on previous studies the composition of solid waste created in Addis Ababa shows that from the total solid waste generated up to 60% is organic and decomposable. This indicates a good opportunity for composting and improving the condition of the natural environment but the practice of composting on the ground is very low. (Jimma et al, 2019).

Composting in cities poses a set of unique difficulties such as lack of suitable space for composting, limited transportations suitable infrastructure and storage to keep compostable waste separate from other types of waste. (Nebiyu and Debela, 2017; Woldegiyorgis et al., 2019). In addition, composting is a labor-intensive process that has a high cost of providing labor and transportation, hence compostable material leads to limitations in the composting process

(Restrepo, et al., 2018). Thus, similarly, infrastructure and cost of composting in Addis Ababa can be difficult to manage and present significant limitations to the composting process.

Cities are increasingly becoming a source of composting material as the need for sustainability becomes more pressing. Composting within a city presents unique opportunities and challenges due to the densely-populated environment. Within cities, restaurants, markets, and other sources generate a tremendous amount of organic material. Gardeners are already working to compost this organic waste, yet much of the available material often goes to waste. Cities have the means to make composting more effective by educating their citizens about composting and its benefits, as well as providing distinct and easily-accessible programs for composting. Additionally, cities can focus on connecting residents to easily-accessible compost bins and providing resources and eventually market access for the finished product (Thimē 2018). To maximize the impact and sustainability of composting, cities should conduct studies to know the existing opportunities and challenges of composting.

According to experts at the sanitation and waste collection management office in Addis Ababa, Bole sub-city, there is very little activity on organic solid waste composting even though there have been some attempts with no success where pilot programs to initiate composting on the *woreda* level have also failed.

Even though composting is an ideal system of processing urban organic waste for reuse opportunities and challenges, the practice particularly at household level is known little. Therefore, this study analyzed the challenges and opportunities of composting organic solid waste and the implication in Addis Ababa, Ethiopia.

1.3. Objectives of the study

1.3.1. General Objective

The general objective of the study is to analyze the challenges and opportunities of organic solid waste composting and the implication in Addis Ababa.

1.3.2. Specific objectives

1. To identify the extent of challenges and opportunities of composting organic waste practiced by households in the study area

2. To analyze the contribution of organic waste composting to urban agriculture
3. To study the implication of organic solid waste composting on the environment
4. To identify the determinants of solid organic waste composting.

1.4. Research questions

The research questions that are asked in order to meet the goal of the research are listed below

- What is the extent to which the composting of organic solid waste is practiced by households?
- What are the challenges and opportunities of organic waste composting at the domestic level?
- What are the implications of organic waste composting on the environment?
- What role can compost have in urban agriculture?

1.5. Significance of the thesis

This study plays a substantial role in identifying issues of organic solid waste composting at the source and the value of sorting organic solid waste to diminish the quantity of waste disposed of. It has analyzed the opportunities and challenges of practicing composting of organic solid waste at a household level and to develop a sustainable waste management system starting at household and community level.

1.6. Scope of the study

The scope of the study focused on Bole sub-city specified *woredas* of contrasting settlement types and composting activities in Addis Ababa, Ethiopia. Moreover, due to time and financial constraints dealing with large study areas for research was not possible.

1.7. Limitations of the study

The study was limited to two *woredas* in Addis Ababa even though several areas practice composting. In addition, organized information and different compiled relevant data on the issue are also limited. Due to time and budget constraint the sample size was limited to 125 respondents as per standard for minimum sample size for such study.

1.8. Organization of the thesis

The contents of this research are structured into five primary sections. The initial chapter covers an introduction that features the background information, the problem statement, the study's objective, and its scope. The second chapter delves into the relevant theoretical literature and provides explanations on the concepts of composting organic solid waste, while the third chapter provides an overview of the study area and methodology, including the data collection and interpretation techniques employed. The fourth chapter presents the research findings and analysis, including discussions of both statistical and qualitative data. Finally, the fifth chapter offers a conclusion and recommendations based on the study's results.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. The concept of compost and composting of Organic Solid Waste

2.1.1. Definition

Compost is a mixture of decayed organic matter and is used for fertilizing and conditioning land. (Merriam-Webster.com Dictionary, Merriam- Webster, https://www.merriam-webster.com/dictionary/compost.Accessed 10 Jun.2023.)

Composting is a process that involves the transformation of organic waste into simpler forms with the activities of microorganisms such as bacteria and fungi. During this process, the carbon found in the waste is utilized by these microorganisms as a source of energy. The degradation of the nitrogen-containing materials results in the breakdown of the original materials into a much more uniform product which can be used as a soil amendment. According to Teinberg (2008), composting involves generating heat to eliminate unwanted organisms like weed seeds and pathogens.

Composting is known to be the most commonly used organic waste recycling method globally, given the various solid waste treatment options available. It is a biological decomposition process psthat is aerobic and leads to the development of thermophilic temperatures due to exothermic heat from the biological organisms involved. (Oazana et al., 2018). Recycling the organic fraction of solid waste through composting is a reliable and beneficial waste treatment option. It can reduce the volume of organic matter entering landfill sites by up to 30%, which is especially important given the already overcrowded nature of these sites. (Khater, 2015).

Domestic solid waste refers to wastes produced from residential areas from day-to-day activities called Organic solid waste or "household" solid wastes (Edward, 2010).

2.1.2. Composting organic solid waste

Composting involves creating a controlled environment with specific temperature, humidity and pH conditions to allow for the aerobic biological breakdown of organic materials. The end result is a nutrient-rich soil conditioner that is highly beneficial for use in landscaping, agriculture and horticultural projects. Given the considerable amount of organic matter in the waste produced by

cities in developing countries (often exceeding 50 percent), composting can be a viable solution to decrease the volume of waste presently being disposed to landfills. This approach may also help to prolong the life of these landfills. Composting conducted in a controlled environment doesn't generate any unpleasant odors or attract flies or other creatures. This process recycles nutrients by returning them to the soil (McHarry, 1993). Requirements of composting process, include

Microbial ecology: Composting relies on the activity of microorganisms, such as bacteria, fungi, and actinomycetes, to break down the organic matter. Microbial ecology is the study of the interactions between microorganisms and their environment, and it plays a critical role in understanding how composting works.

Carbon-to-nitrogen ratio: The carbon-to-nitrogen ratio in composting materials is an essential factor in composting. A balanced ratio of carbon to nitrogen is necessary for the microorganisms to carry out the decomposition process.

Aeration: Oxygen is essential for the microorganisms that carry out the decomposition process. The Aeration process provides oxygen to the compost pile, which can be done by turning the pile or providing air vents.

Moisture: Microorganisms require water to carry out the decomposition process. Composting materials should be moist but not waterlogged to maintain the optimal conditions for decomposition.

Temperature: Composting generates heat as a byproduct of the decomposition process. The temperature of the compost pile is an indicator of the activity of the microorganisms and can be used to monitor the progress of the composting process.

pH: The pH of the compost pile also plays a role in the composting process, as certain microorganisms thrive in specific pH ranges. (Composting Basics for Home Gardeners 2020).

These concepts are essential to understanding the science of composting and the factors that can affect the efficiency and quality of the compost.

Figure 1 shows a general representation of the composting process. In the presence of oxygen, biomass is broken down by microorganisms. This composting process generates compost, as well as carbon dioxide, water vapor, and heat as byproducts.

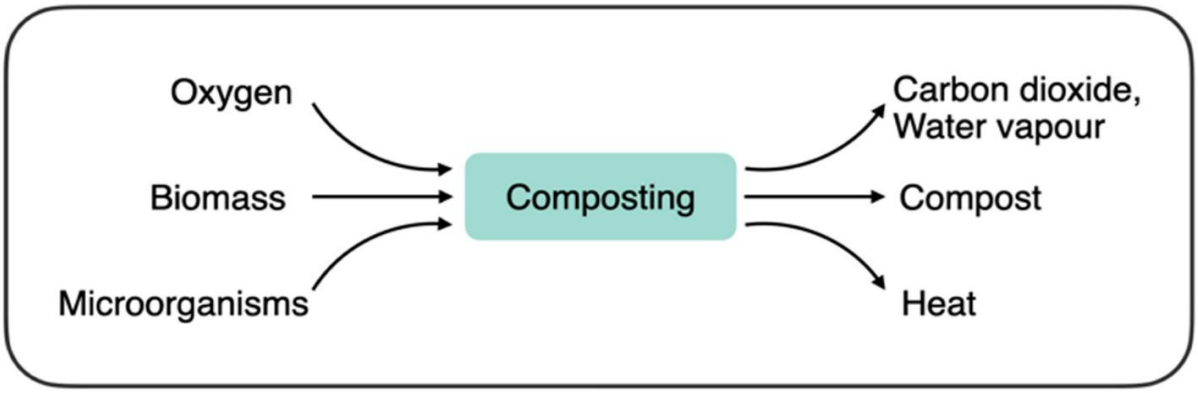


Figure 1: General requirement of composting process

2.1.3. Type of Composting in developing countries

Composting has the potential to reduce significantly the amount of municipal solid waste in developing countries. In fact, over half of the average City's waste stream in these regions can be composted. The composting process is simple and involves natural decomposition to occur, with efforts made to optimize the process, minimize any potential negative impacts, and produce a clean, marketable finished product. Composting is also highly compatible with other forms of recycling. Through the redirection of natural substances, there is a notable increase in the proportion of salvaged materials. In addition, the implementation of effective schemes for reusing common compost pollutants like plastics and glass contributes to a higher standard of the end product. It's worth noting that the classification of household disposables, such as paper, metal, and glass, is already widely adopted in various emerging nations. (Mohana & Yang, 2015).

Poor waste collection is a significant issue in many cities in developing countries. Introducing composting programs and diverting organic waste for composting can help improve the overall waste collection service. To enhance efficiency and reliability, it is recommended to switch to collecting organic waste every two weeks and non-organic waste every week. This will simplify waste management procedures and lead to smoother operations, with variations tailored to the characteristics of each area. By introducing waste diversion for composting, cities have a unique opportunity to enhance their waste collection service (Vanessa, 2020).

There are different levels at which the practice of composting can be applied to be practical and functional depending on the type of society, availability of land, and other infrastructures.

2.1.3.1. Residential Composting

To handle kitchen and garden trash, households might start their composting programs. Composting effectively lowers the amount of garbage that needs to be collected, increasing productivity and lowering expenses. When a substantial percentage of residences have individual or shared yards or gardens, and there is enough space, residential composting should be encouraged (UNEP, 1996). Materials like wood, bamboo, clay bricks, wire mesh, and other items that are readily available locally can be used to create composting units. Rats, insects, and other scavenger animals shouldn't be attracted by the composters' construction or operation. The most straightforward strategy to prevent bugs from the composter is to prevent large quantities of meat, seafood, and fatty meals from going in it.

Public health officials may prohibit residential composting due to alleged health hazards; however, local governments can allay this worry by promoting education about composting processes, offering subsidies for basic composting units, and implementing public awareness campaigns (Cook & Elliott, 2001).

2.1.3.2. Decentralized Community Composting

Small organizations can compost at a reasonably cheap cost through decentralized composting on a neighborhood or community size. Households, businesses (such as small stores or markets), and institutions (such as government buildings, and schools) in a region producing five to fifty tons of organic waste daily can compost on undeveloped ground, next to community gardens, or in public parks. One potential avenue for support in the implementation of the project could be local governments. These entities may be able to provide valuable assistance by educating the public on the benefits of the proposed facility, contributing land for its construction, helping with start-up costs, providing transportation services for waste disposal to nearby landfills, and leveraging the final compost product in public parks. Such support from local governments could prove instrumental in the success of the project and ultimately benefit the wider community. UNEP (1996) suggests the following specifications for the site in order to guarantee that the composting process is both environmentally and socially acceptable:

Ensuring that the proposed facility is easily accessible to all individuals who wish to use it is of utmost importance. To achieve this, clear and understandable signage should be put in place, allowing both users and non-users to easily navigate the site. It is critical that the facility has the

approval of all surrounding land users to avoid any potential conflicts that may arise. Furthermore, adequate measures must be implemented to prevent the site from becoming a dumping ground for local waste, as this could have severe environmental consequences. In addition, the facility must have suitable soil and drainage systems in place to accommodate the leachate and ensure that the site remains safe and secure for all users.

2.1.3.3. Centralized Large-Scale Composting

From 10 tons per day to more than 500 tons per day, centralized composting is possible. Since centralized composting is carried out on a much greater scale, formal considerations for the environment, society, and technology should be made to satisfy the following needs (UNEP, 1996)

It is important to conduct a thorough evaluation of the area's technical specifications, including soil and geographic characteristics, when assessing potential sites. In addition, it is recommended to involve engineering and design professionals during the site selection and facility design process. An environmental assessment of the chosen site should also be conducted to ensure that it meets all necessary standards and regulations.

It is crucial to involve all relevant stakeholders in formal evaluation and site selection processes. To mitigate the negative effects of traffic, odor, leachate, and noise generated by composting operations, a program should be established. Furthermore, a separate collection and/or pre-processing system should be put in place to prevent unwanted materials from entering the composting system, with particular attention given to the informal sector in pre-processing waste and recovering non-compostable materials. A marketing strategy should also be developed for the compost. To ensure the quality and composition of compostable materials delivered to the facility, enforceable protocols must be implemented. All municipalities within the jurisdiction should enter into formal agreements for siting, design, financing, operations, maintenance, environmental compliance, and billing for services and waste delivery. Lastly, designated routes for the delivery of organic materials to the facility should be established.

Even though organic decomposition is a natural process, health and safety issues exist for workers and neighboring residents that need to be addressed. Establishing compost standards and taking precautions in the facility design and operations should assist in the mitigation of any negative health and safety impacts (Otto et al., 2016).

2.1.4. Solid waste management and composting in Addis Ababa

Addis Ababa, the sprawling capital of Ethiopia, covers an area of 540 square kilometers and is home to over 4 million people. The city's population is growing at a rate of 2.1%, making it one of the fastest-growing cities in the region. To manage its size and complexity, Addis Ababa is divided into 1 sub-cities, each of which is further subdivided into 116 districts. This administrative structure helps ensure that the city's residents have access to essential services and resources, such as healthcare, education, and public transportation. (ECSA, 2007; Desta et al., 2014). However, the population record of Addis Ababa is likely to be inaccurate and underestimated due to the city's significant annual growth rate in recent years. The estimated population as of 2017 is nearly 4 million. There are now 11 sub-cities, and the density of the population is estimated at around 5,165 individuals per square kilometer. It is approximated that every individual in the city produces 0.45 kilograms of solid waste on a daily basis. Residential households are responsible for 76% of the entire waste produced, institutions contribute 18%, and 6% comes from the streets. (Mohammed and Elias,2017). Before a national level proclamation was formulated, the city administration incorporated MSEs into solid waste management as a solution to the problem. (Fanta, 2006; Baudouin, 2010). As part of its efforts to improve solid waste management, the city embarked on a comprehensive program that involved dividing it into 549 collection zones, each consisting of 800-1000 households. To ensure the success of the program, micro and small enterprises were assigned to oversee the waste management activities in each zone, with over 524 of these organized enterprises participating in the initiative.

The services provided by these enterprises were diverse and included door-to-door collection and transportation of solid waste to designated collection sites. Additionally, some of the enterprises engaged in material recovery activities, albeit to a limited extent.

As a result of this program, the city was able to expand its solid waste collection efforts to an additional 600,000 households, which led to a significant increase in the collection rate from 60% to 80%. This was a commendable feat that demonstrated the city's commitment to promoting a clean and healthy environment for its residents. (Tessema, 2010; PPIAF, 2011).

Due to inadequate information from the informal sector, it is difficult to accurately determine the amount of waste in Ethiopia that is recycled or composted, making it almost impossible to estimate a recycling rate. Additionally, there is a lack of data on the disposal sites that weigh the

waste that arrives there. (Bjerkli, 2005) suggested through government figures in Addis Ababa that around 15% of waste was recyclable, with an incredibly low 5% actually being recycled, and 60% could have been used for composting though only 5% was. However, these figures should be viewed with caution as they depend on reported quantities of waste which are difficult to come by. Additionally, materials such as metal scraps, old clothes, and shoes are often not considered wastes, so if they were taken into account, it could lead to higher actual recycling rates.

There are micro and small enterprises that are currently giving service in the City of Addis Ababa to provide solid waste management. Some are formally established entities while others are informal small scale. The exact number of these entities is unclear since several of them have failed due to many challenges in the practice of composting in the City and also a lack of market for the finished product.

Collection, Separation, and Transport

The solid waste management services in Addis Ababa have been in place for over 40 years, but they are no longer sufficient to meet the city's changing needs. Unfortunately, the social waste collection service is unsatisfactory, and it's not uncommon to see scattered waste in many areas of the city. (UNDP, 2004). In accordance with the current policy, solid waste disposal is the responsibility of government workers, private entities with contractual agreements, and Micro and Small enterprises. Despite this, the city does not adhere to the principle that waste producers must dispose of their waste in separate containers based on its specific type. (Hayal et al., 2014). There are two sub-stages of waste collection: primary and secondary collection.

Primary collection

Micro and Small Enterprises have formal agreements with the city to collect and dispose of household waste. The collection process involves a door-to-door method where waste is collected from households and dumped in designated containers. These containers are then picked up by secondary collectors, the sub-city, and private companies before being taken to the City's landfill. There are about 750 of these enterprises that are organized to pre-collect waste from households. The collection process involves different types of collection systems, including door-to-door, curbside, set out, block (container) collection systems, and street sweeping. For household waste, the door-to-door collection system is applied, and it is carried out by MSEs who walk short distances from house to house. House owners put their waste in baskets, sacks,

plastic bags, or other suitable materials at their doorstep, so the collectors can pick them up using pushcarts to take them to a common temporary storage area for the trucks to pick up at the disposal site. Storage areas could be street sides and pedestrian walkways. (Sevilla and Iroh-Odod, 2009).

The consistency and frequency of the collection may not be upheld at all times due to the insufficient number of workers who receive low wages. (Hayal et al., 2014). Curbside collection is a widely utilized and practical method for waste disposal. This involves placing containers of varying sizes near street corners and crossings to allow easy waste disposal for householders. The collectors are compensated based on the amount of waste collected, at a rate of 30 birr/m3. Service charges are collected alongside water consumption rates, with residential and commercial houses paying 20% and 42.5% of the total water consumed, respectively. While MSEs play a significant role in waste collection, private companies and employees also participate in the process, although the contribution of private companies is presently lower than that of the government. Unfortunately, the shortage of containers often results in improper waste storage on open spaces and roadsides. (Hayal et al., 2014).

Secondary Collection

The municipality is responsible for overseeing the top-tier waste transportation system, which entails moving solid waste from the containers to the ultimate disposal location. The private sector plays a minor role in this process. Separation of the organic solid waste is barely done at the source in Addis Ababa since there is very minimum awareness. The society is used to just collecting waste from every activity into one space with no regard to the type of waste. In addition, the means of disposing of solid waste in separate disposal bags is a very minimum as there is no proper access. The existing sorting is done by the collectors such as street boys, private sector enterprises, scavengers at landfill sites and Korales (Tesema, 2010).

Processing and Disposal

Until the start of 2016, Addis Ababa relied on an open dumping site at *Reppi* or *Koshe* for all solid wastes. This site, operational since the 1950s, received over 750 tons of waste daily and spans 25 hectares. It is bordered by a ring road and residential areas with no safeguards for humans or animals. he Addis Ababa City Sanitation, Beautification, and Park Development Agency (AACSB PDA) has been responsible for waste disposal management since 2003, utilizing a process of crude open dumping. This process involved the transportation of waste by

truck to a flat land, where a bulldozer would spread and level it, followed by compaction. In 2016, the *Reppi* dumping site was closed and replaced with a new site located in the Kotebe area, north of the city. Unfortunately, this new site did not prove to be a sustainable solution.

Recent data indicates that a significant amount of refuse, approximately 765 tons, is generated on a daily basis with projections indicating an upward trend. Municipal waste accounts for approximately 80% of this waste, with household waste being the primary contributor. Regrettably, organic solid waste separation at the source is not currently being implemented, resulting in a significant portion of the waste being discarded, with only a small percentage being repurposed or recycled. Given that items such as paper, garden, and food waste undergo microbial decomposition once they are disposed of in a landfill, it can be concluded that more than 80% of the waste is biodegradable. (Aliyi et al., 2017).

2.2. Empirical review

Cities threaten the environment due to the estimated 1.7–1.9 billion metric tons of municipal solid waste (MSW) a threat to the environment due to the estimated 1.7–1.9 billion metric tons of municipal solid waste (MSW) that are produced worldwide each year. By 2025, it's anticipated to rise to almost 2.2 billion metric tons annually. 62 million tons per year are produced in sub-Saharan Africa (UNEP, 2013; Hoornweg and Bhada-Tata, 2012). Food and ash wastes, which make up the biggest percentage of municipal solid trash—roughly 75% in developing nations—dominate wastes in lower-income countries (Solomon, 2006). The Addis Ababa city administration estimates that 76% of the total solid waste produced is generated in residential areas, 9% is produced in commercial areas, 6% is produced by street sweeping, 5% is produced in businesses, 3% is produced by hotels, and 1% is produced by hospitals. Solid waste is produced at a rate of 0.45 kg per person per day, totaling 1,020,000 kg (3,063.06 m3) of waste per year and 330 kilograms per m3 per day. Urban garbage generation is increasing by 5% each year (EPA and WB, 2004; AACA, 2009). The city's solid waste collection and disposal system performs poorly despite the volume of waste generated growing (WHO, 1996, Edwars, 2010). It is estimated that approximately 65% of the solid waste generated every day is collected. Unfortunately, only a small percentage of this waste, around 5%, is recycled and composted. The remaining 25% is simply discarded, with open spaces, drainage canals, rivers, valleys, and streets serving as dumping grounds. It is important to note that the physical composition of the garbage

is varied, with 70% of the waste generated originating from households, 9% from commercial areas, 6% from street sweeping, 5% from industrial waste, and the balance from hotels, hospitals, and other sources. The waste itself includes a range of materials, such as 4.2% vegetables, 2.5% paper, 2.3% rubber/plastics, 2.4% bone, 0.9% textiles, and 0.5% glass. Moreover, 15.1% of the waste consists of flammable leaves, 2.5% non-combustible stones, and 65% is made up of all fines. It is clear that there is a pressing need to address this issue and find sustainable solutions to manage the waste generated by our society. (AASBPDA, 2003). However, the contents alter in tandem with the shift in society's socioeconomic conditions and the seasonal volatility (World Bank, 2010).

2.2.1. Challenge of composting activities

A significant portion of the Ethiopian population lacks sufficient knowledge regarding the legal implications of environmental offenses and the importance of reporting such violations to law enforcement authorities. Moreover, only a limited number of environmental-related cases have been adequately processed through the criminal justice system. To tackle this pressing issue, Ethiopia is implementing a series of capacity-building initiatives, including the creation of instructional materials, the launch of public awareness campaigns, the training of trainers, and the provision of necessary equipment. (Girmachew, 2023). Some of the main challenges are discussed further; there is inadequate attention to the biological process requirements, where composting is done with neglect, over-emphasis placed on mechanized processes rather than labor-intensive operations because of the lack of awareness on the opportunities of using labor to keep society active and participating, the lack of vision and marketing plans for the final compost product resulting in being unable to find those in demand ,poor feedstock .The production of poor quality finished compost can be caused by various factors, including contamination with heavy metals, inadequate accounting practices that overlook the economic benefits of composting, difficulties in securing finances due to high processing, transportation, and application costs, and the need for subsidies to support these programs. Municipal authorities may prioritize waste collection over composting, leading to inadequate suppression of pathogens and weed seeds, as well as nuisance potentials like odors and rats. Poor marketing experiences, limited integration with the agricultural community, and perverse incentives like fertilizer subsidies or overemphasis on capital-intensive projects can all hinder the production of high-

quality compost. While land requirements are typically minimal, they can still pose a constraint in some cases. It is crucial to address these issues to ensure the production of high-quality compost. (Daniel et al., 2000).

2.2.2. Benefits of Composting

The main contribution of composting is that it reduces the amount of waste going to be deposited at a landfill, which will reduce a lot of environmental impact. Landfills contribute to gas emissions as a result of the biological activity that occurs when water enters. This produces landfill gas, which contains greenhouse gases such as hydrogen sulfide and methane, that have a significant impact on the environment. (Engel, 1988). Utilizing compost as a fertilizer presents an eco-conscious alternative to the use of synthetic fertilizers. The efficacy of compost in augmenting soil nutrient concentrations is contingent upon the specific type of waste incorporated into the composting process, as well as the treatment methodology employed.

In addition to its effectiveness as a fertilizer, composting offers numerous other benefits. It is an eco-conscious solution that can divert up to 80% of compostable waste from final disposal in low- and middle-income countries. Furthermore, it aids in recycling and incineration efforts by removing organic matter from the waste stream, ultimately promoting environmentally sound practices and reducing methane generation at landfills. Composting also produces a valuable soil amendment that is essential for sustainable agriculture and enhances the effectiveness of fertilizer application. Additionally, it is flexible for implementation at various levels, from household efforts to large-scale centralized facilities, and can be started with minimal capital and operating costs. (Daniel et al., 2000).

Moreover, composting emerges as a viable waste management solution for numerous developing countries, primarily due to their climatic conditions that favor the process. Furthermore, composting can effectively address major health concerns associated with organic waste, such as the spread of Dengue Fever. It presents an opportunity to improve a city's overall waste collection program and accommodate seasonal waste fluctuations, such as leaves and crop residue. Additionally, composting can integrate existing informal sectors involved in waste collection, separation, and recycling, leading to more efficient and sustainable waste management practices. (Lardinois and van der Klundert, 1994).

2.2.3. Urban organic solid waste composting policy framework:

In order to increase involvement in terms of household waste separation, Plahl asserts that political will must exist to develop and implement policy favoring composting. Thus, when choosing garbage management sites, not in my backyard might be problematic in both wealthy and developing nations. Plahl reiterated that a crucial challenge to sustainability is legislation and its effective enforcement, for which the framework needs to be constructed (Drechsel and Kunze, 2001). The administrative structure and legal framework for proper composting of organic solid wastes should be provided by the municipal authorities. However, there is no rigid policy framework in place in the municipality of Addis that encourages the management of organic solid waste by composting. Because of this, this precious resource is wasted in open areas that are close to residential areas, degrading the surroundings.

2.2.4. Environmental issues

Landfills have been identified as a significant contributor to greenhouse gas emissions, which in turn contribute to global warming and ozone depletion. This is due to the release of landfill gases generated by the decomposition of organic materials, which can occur aerobically or anaerobically. Municipal solid waste (MSW) streams contain varying amounts of carbon, with an average of 0.3 Mt of carbon present in one million tons of unsorted MSW. From this amount, approximately 0.2 Mt will be converted into landfill gases, including 0.09 Mt of carbon dioxide and 0.09 Mt of methane, as well as trace elements. Landfill gas emissions, stemming from this process, are responsible for nearly half of all anthropogenic sources of methane worldwide.

It is worth noting that methane, a potent greenhouse gas, is 19 to 21 times more potent than carbon dioxide. This makes reducing methane emissions from municipal solid waste a crucial step in reducing global greenhouse gas emissions. Despite the potential benefits, methane recovery from landfills has only been partially effective. This is due to the fact that up to 60% of the generated methane escapes through leaks. Given this, avoiding the landfilling of organic waste altogether is a much better option.

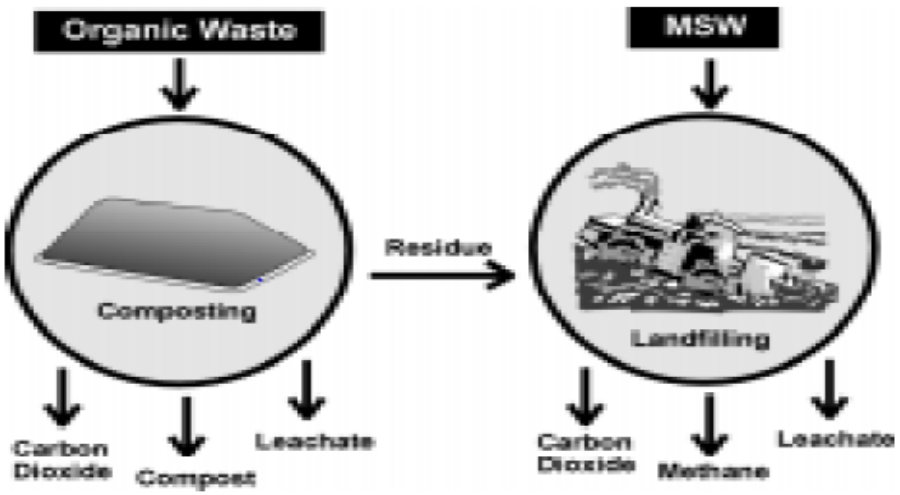


Figure 2: Comparing the Environmental Impacts of Composting and Landfilling.

Composting has proven to be an effective strategy for mitigating methane emissions by diverting organic waste from landfills. While carbon dioxide is released during the composting process, it is considered neutral due to its ability to reduce carbon dioxide levels through photosynthesis. In addition to its environmental benefits, composting can also improve the quality of landfill leachate by reducing levels of BOD and phenols. However, it is important to note that composting can also produce leachate that poses a risk to water bodies. To ensure a safe and efficient composting process, it is recommended to collect and recirculate leachate into active composting piles to minimize any negative effects.

In various developing countries, an extensive amount of municipal solid waste is comprised of organic matter. It is essential to divert these materials from landfills to extend the life of the landfill by reducing the amount of waste that needs to be disposed of. When organic waste is deposited in landfills, it decomposes and produces methane gas, which is a potent greenhouse gas. Therefore, composting is an environmentally friendly method of waste management that has several benefits.

Composting is a natural process that involves the decomposition of organic matter, such as food waste, yard waste, and animal manure. In the composting process, microbes break down the organic matter into a nutrient-rich material called compost. Composting is an effective way of reducing waste and conserving valuable resources.

However, an improperly operated composting facility can produce unpleasant odors. When the compost pile lacks oxygen, anaerobic decomposition occurs, leading to the production of foul-

smelling gases like hydrogen sulfide and ammonia. A well-operated composting facility should produce minimal objectionable odors. The composting process requires proper management to balance the carbon-to-nitrogen ratio, moisture content, and oxygen levels.

The final product of composting is a beneficial soil amendment. It is a dark, crumbly, and earthy-smelling material that is rich in nutrients. Recycling organic matter back into agricultural applications can improve soil conditions by developing and maintaining the soil structure, enhancing physical properties, reducing susceptibility to erosion, encouraging microbial activity, and providing potentially available plant nutrients. Compost can also help to suppress plant diseases and pests, reduce the need for synthetic fertilizers, and reduce greenhouse gas emissions from landfills. (Hesse,1984)

There is often confusion regarding the differences between chemical fertilizers and compost. The key distinction lies in how the nutrients are utilized. Chemical fertilizers offer rapid but incomplete nutrient absorption, while compost provides slow-release nutrients that are stored in the soil for an extended period. (Kumazawa, 1984). There is a common belief that chemical fertilizers are the superior option compared to compost due to their convenience in handling, storing, and application, as well as their economic subsidies from government. However, it is important to note that compost and chemical fertilizers can work together in a synergistic relationship, resulting in greater fertilizer efficiency. By incorporating compost alongside chemical fertilizers, a slow-release of nutrients can be achieved, promoting extended nutrient storage in the soil. (World Bank, 1997).

2.2.5. Compost quality

Composting is best suited to the high organic content of MSW in developing nations. Glass, plastics, metals, and hazardous elements are also present in greater amounts in the urban trash stream and can contaminate the finished compost. It would take more time, work, and space to separate the contaminants from the raw material at the compost site, and it's likely that most of the contamination has already impacted the organic portion. The best strategy to increase the quality of the final compost is typically to separate at source the waste before collection.

Compost standards offer a useful marketing tool in addition to assuring a safe product. Knowing that the product quality is reliable and appropriate for the intended purpose can satisfy the

customer. This is crucial for industrial and agricultural enterprises where repeat business depends on predictable results. Additionally, the compost supply needs to be dependable because failing to fulfill market promises harms customer relations and undermines the program's credibility (Albrecht, 1989).

Table1. Separating waste at the source leads to higher quality compost with lower heavy metal levels. This involves segregating waste into separate containers before disposal.

Table 1: The concentration of heavy metals in different composts

Heavy metal	Source-separated MSW compost: Europe and North America	Source-separated MSW compost: Java, Indonesia	Non-source separated MSW compost: Netherlands	Proposed standards for MSW compost in developing countries
Arsenic	-	0.5	-	10
Cadmium	1.2	0.9	7.3	3
Chromium	27.0	20.0	164.0	50
Copper	59.0	54.0	608.0	80
Lead	86.0	99.0	835.0	150
Mercury	0.9	0.9	2.9	1
Nickel	17.0	50.0	173.0	50
Zinc	287.0	236.0	1567.0	300

Source (World Bank, 1997)

Due to the fact that certain standards are site-specific and might not be appropriate, developing nations should use caution when implementing them. The World Bank (1997) proposed the compost requirements in Table 1 for Indonesia, although they might also be used in other developing nations.

The development of Indonesian composting standards has been driven by the need to adhere to environmental regulations and ensure the safety of compost for public use. These standards have been designed to promote efficient and clean composting practices, while also facilitating market development and minimizing the need for costly testing procedures. To establish high-quality

compost requirements for a range of applications, a variety of variables and assumptions have been taken into account.:

All soil conditions should make heavy metals safe to use. The quality of the compost product must be such that even in acidic soil conditions there will be no heavy metal leaching or plant uptake. To effectively prevent the buildup of heavy metals in agricultural lands near urban areas, it is highly advisable to limit the types of compost used to just one. This is primarily due to the limited availability of laboratory testing facilities, which makes it difficult to guarantee the quality of two compost classes. By confining composting to just one class, the gradual contamination of relatively clean lands can be minimized. It is also of utmost importance to establish sufficient standards for all future land use options, to avoid the need for site-specific controls even after many years of application. This approach can significantly reduce testing costs and ensure the safety of compost for public use. (Martina Grifoni, et al., 2022).

It's important to regularly review the guidelines for MSW composting in various areas every five years. If the regulations are not consistently met, it's crucial to find and address the reasons for exceeding the limits. If the compost is intended for non-agricultural purposes, such as rehabilitating mining sites or covering landfills, heavy metal limits may not be necessary. Nevertheless, it's wise to have a waste management system that can produce high-quality compost with limitless selling opportunities. Most cities can easily meet these standards by giving priority to source separation and compost process control. (Qian and Uchimaru, 2011)

It is of utmost importance to conduct a thorough review of the proposed method to ensure that it effectively controls the spread of pathogens and weed-seeds, just as heavy metal regulations are enforced. Generally, if the compost material is subjected to temperatures exceeding 55oC for three consecutive days, the pathogens will be effectively reduced. Therefore, waste management authorities in less developed countries should prioritize the implementation of a reliable composting process with adequate temperature controls and quality checks. By doing so, the reliance on laboratory testing and restrictions on compost usage can be significantly reduced.

2.2.6. Cost of composting

Composting, while not typically a profitable endeavor on its own, can provide economic benefits on a larger scale when incorporated into a comprehensive solid waste management plan. The

costs associated with composting include basic materials, production, advertising, and hidden environmental expenses, while the benefits include the market value of the compost, savings from avoided waste disposal expenses, and various positive environmental impacts. Given the significant amounts of organic material produced in developing countries, governments can save money by reducing the amount of waste that needs to be collected, transported, and disposed of. (Bryant, & Wilson, 2007).

The savings resulting from composting initiatives are heavily dependent on how the waste management system incorporates them. This includes the elimination of temporary dumping sites, rerouting collection vehicles, and redirecting labor. Unfortunately, traditional cost accounting systems fail to consider the hidden environmental and social externalities associated with composting. This disregard makes it difficult to account for the numerous positive environmental impacts and reduced costs associated with composting.

Table 2: Environmental costs and benefits of composting

Costs	**Benefits**
potential odor emissions improper disposal of rejects	reduced landfill space
	reduced surface and groundwater contamination
	reduced methane gas emissions
	more flexible overall waste management system
	reduced transportation costs
	enhanced recycling of materials such as paper, metal, and glass
	reduced erosion and improved the efficiency of synthetic fertilizers
	reduced air pollution from burning waste

Composting has far-reaching benefits that go beyond just the composting process itself. The positive impacts of composting can greatly improve the health and well-being of society. Water contamination, caused by leachate infiltration or waste disposal in open water bodies, can lead to serious health issues such as infections and diseases. According to the World Health Organization (WHO), around 900 million people suffer from diarrhea or related diseases like typhoid and cholera every year due to contaminated water. By providing alternative waste

management solutions, such as composting, we can significantly reduce the amount of waste that clogs rivers, canals, and drains, thus reducing the spread of diseases like malaria and Dengue fever, which are caused by stagnant water where mosquitoes tend to breed.

The practice of burning waste is commonly observed among residents, particularly in urban settings, and it carries detrimental effects on air quality. The smoke generated through this practice can result in respiratory illnesses such as chronic bronchitis. A study conducted in 1991 by the Indonesian Environmental Control Agency (BAPEDAL) estimated that solid waste burning accounted for a significant proportion of total air pollutants. In the city of Jakarta, for example, approximately 8% of particulate matter and 8% of hydrocarbons were attributed to solid waste burning, while Bandung experienced even higher levels of 20% and 17% respectively. (Kozak and Sudarmo, 1992 Cited in World Bank, 1994).

Many people do not realize that applying compost as an amendment to agricultural land can greatly improve soil properties and reduce erosion. Unfortunately, the costs of soil erosion are often overlooked and are not reflected in traditional economic measures. This is due to the lack of markets for soil resources, the impact of externalities on the true costs of soil erosion, and biased systems of national accounts that treat natural resources as free goods. (Magrath and Arens, 1989).

When engaging in MSW composting, it is vital to consider all the factors that contribute to its success. Focusing solely on the sale of the finished compost as a measure of success can lead to faulty conclusions. In the past, some municipal authorities have made the mistake of using a traditional cost accounting approach, which has resulted in the closure of several compost operations. It is crucial to take a more comprehensive approach that takes into account all the costs and benefits associated with composting, including its ability to improve soil properties and reduce erosion. By fully evaluating the true costs and benefits of MSW composting, we can ensure that it remains a sustainable and effective waste management solution. (Selvam, 1996).

2.2.7. Urban agriculture and composting

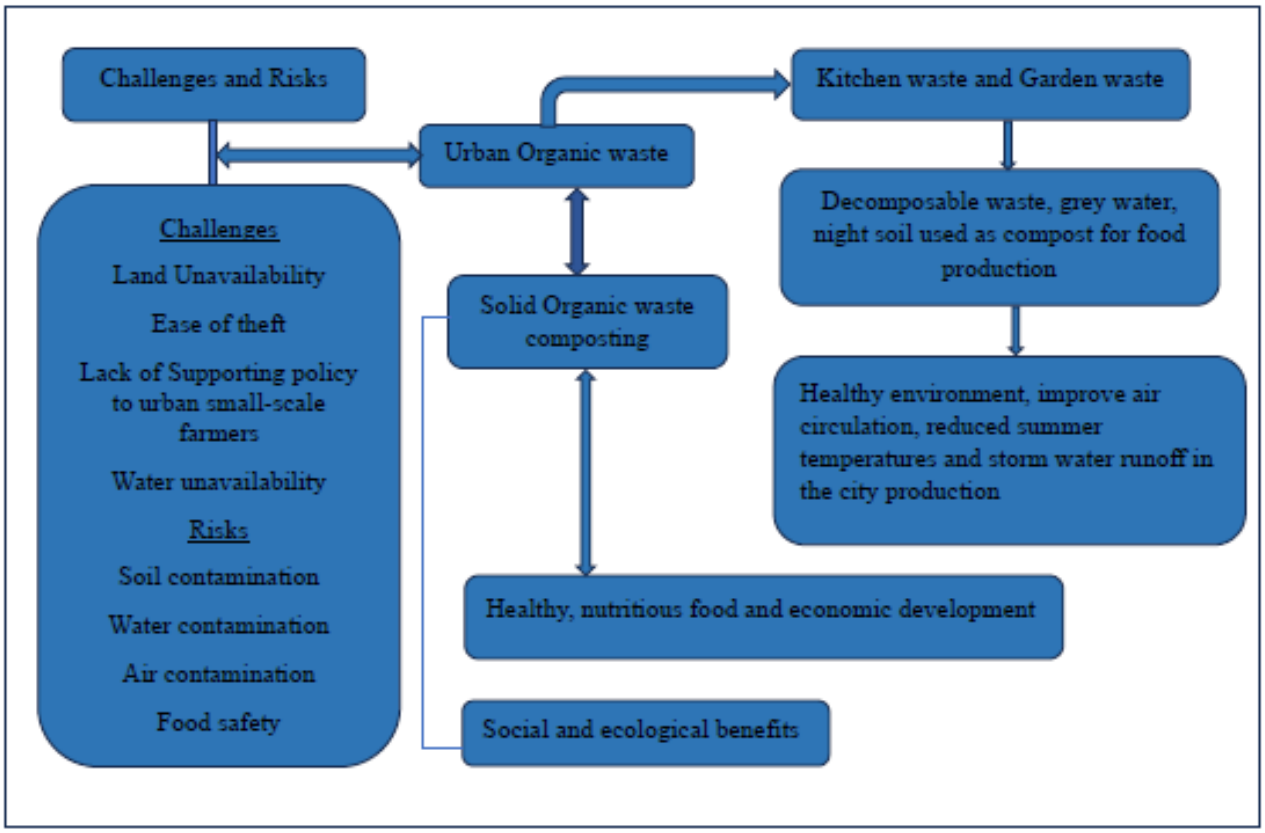
Urban and peri-urban agriculture (UPA) has undergone a significant transformation in recent years, moving from a simple and informal activity to a thriving commercial and professional sector. The recognition of UPA as a critical component of food security strategies was solidified

during the 15th COAG session in Rome in 1999 and reinforced at the World Food Summit in 2002. UPA involves the production of a wide range of agricultural products within or on the outskirts of urban areas, utilizing human, land, and water resources that are readily available.

Urban agriculture offers a potential solution to the challenges posed by urbanization, such as high unemployment, a growing informal sector, and declining infrastructure. By providing fresh, locally-sourced produce and creating employment opportunities, UP A can help to improve food security and contribute to sustainable urban development. Furthermore, UP A can help to mitigate the environmental impact of agriculture by reducing the distance food travels from farm to table and utilizing composting practices to recycle organic waste back into the soil. Overall, UP A represents a crucial and evolving industry with the potential to address multiple societal and environmental challenges in urban areas (Lizotte et al., 2020).

2.3. Conceptual framework

Composting is an area of environmental studies where a conceptual framework can be particularly useful. This type of framework provides insight into the various aspects involved in composting, the factors they interact with and how they ultimately lead to beneficial results. This framework can include both process inputs (amounts of materials composted, amount of energy spent on decomposition) as well as process outputs (fertilizers produced from composting). Such a framework should also take into account external influences such as climate change or population growth which could potentially alter the results (Kamra & Lalwan, 2020).



Source: adopted from Melusi Sibanda (2020)
Figure 3: Conceptual framework of a sustainable model of utilizing and managing waste through composting

The conceptual framework for composting will help provide a better understanding of effects such as reduced resource use and improved soil fertility. Through this framework we may also be able to identify methods for improving the efficiency and expanding the scope of current composting practices so that more resources and land can be saved from degradation which would result in greater environmental benefits.

CHAPTER THREE

3. MATERIALS AND METHODS

3.1. Description of the study area

Addis Ababa serves as the capital of both the Federal Democratic Republic of Ethiopia (FDRE) and the Oromiya National Regional State Government. Furthermore, it is a diplomatic hub and headquarters for various Regional and organizational organizations. Geographically, Addis Ababa spans an area of 540 km^2 and is situated between 8°50' to 9°06'N latitude and 38°39' to 38°55'E longitude. It consists of 11 sub-cities and boats a population of approximately 4 million people, with a 3.8 percent annual growth rate and a density of 5165/km^2.There are two study areas of contrasting settlement types which are selected to assess the challenges and opportunities of composting organic solid waste in Bole sub-city Woreda 1 and 2.

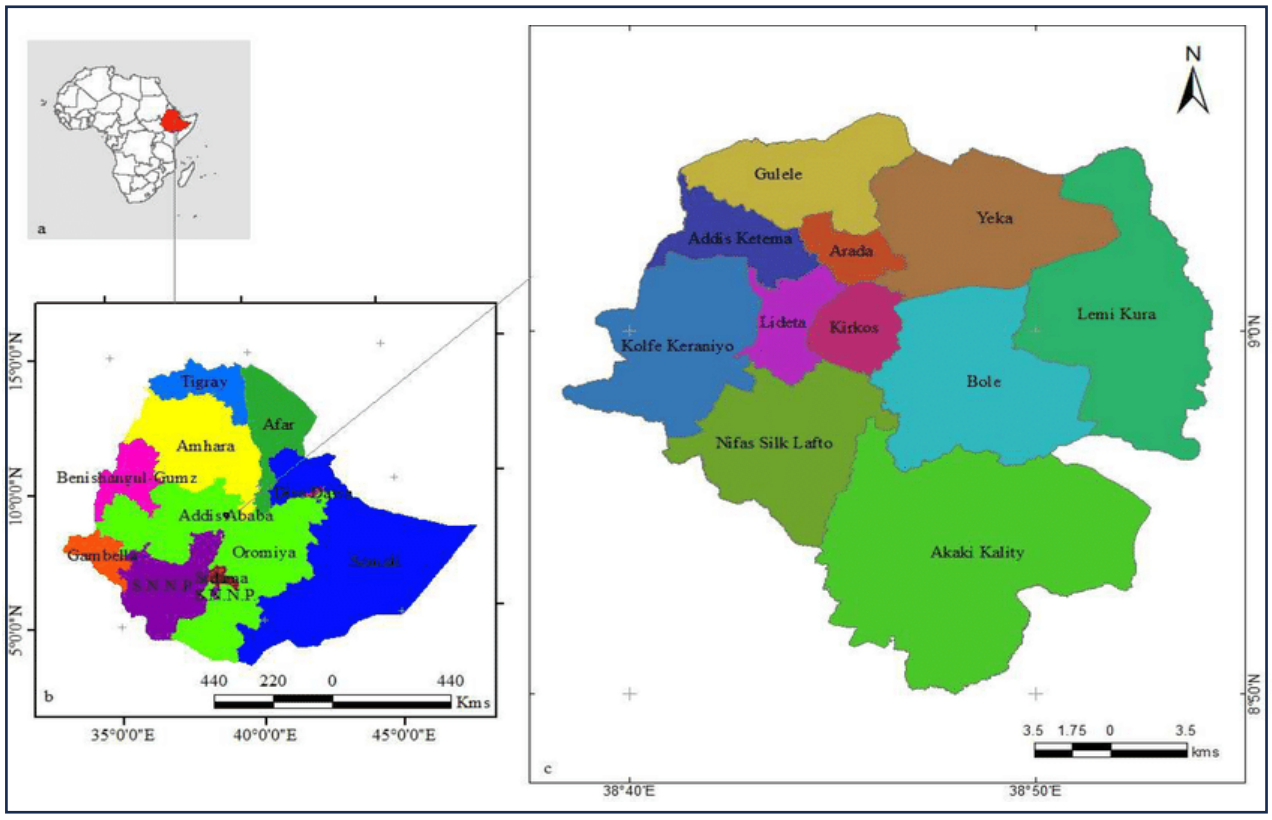


Figure 4: Location Map of Addis Ababa,Source: Ethio GIS (2022)

3.2. Research Methods

3.2.1. Research Methods

In this study, data was collected from the different households in Addis Ababa to examine the challenges and opportunities of organic solid waste composting. A descriptive research design was employed to analyze both primary and secondary data. The research design employed both quantitative and qualitative methods to gain a comprehensive understanding of the issue. Quantitative research generates numerical data, which can be used for statistical analysis, while qualitative research provides an in-depth understanding of motivations, experiences, attitudes, and intentions behind human behavior through observation and interpretation.

3.2.2. Types of Data sources

To conduct a thorough analysis, a variety of data collection methods were utilized, including both primary and secondary sources. Key Informant Interviews (KIIs), Focus Group Discussions (FGDs), household surveys, and field observations were all utilized to gather both qualitative and quantitative data. This comprehensive approach ensured that all relevant information was obtained for the study. These methods provided valuable insights into the experiences, attitudes, and perceptions of individuals in the study area. The primary data were collected through;

1. The key informant interviews

The key interview techniques used were prepared with pre-determined questions and checklists to obtain relevant primary data. Key informant interviews were conducted with officials at both the woreda and administrative agency offices, this ensured consistency in data collection and enabled us to obtain high-quality data. It is worth noting that both the quantitative and qualitative data obtained from primary sources were essential in gaining a better understanding of the study.

2. Focus group discussion

Focus group discussions were held with a select group of association members who were willing to cooperate. As most of the associations had failed, only one was active within the two woredas observed.

3. Household Questionnaire survey

The researcher personally collected the data with the assistance of a team of data collectors.

4. Field observation

Field observation is one of the most realistic methods of getting experience, which gives me firsthand experience for my research. It helps me to observe the composting environment and activities being undertaken. To understand the existing practice of composting and visiting designated sites and MSE that are still open.

5. Secondary data

Secondary data were also collected and analyzed in this study. The existing documentation was used, such as publications, reports, written documents, policies, strategies of the government, and other media sources, which could provide additional knowledge and context for the study.

By utilizing both primary and secondary data sources, the study enabled the creation of a comprehensive dataset that provided a clear picture of the study. This allowed for an in-depth analysis of the research objectives and ensured that the findings accurately represented the experiences and opinions of those affected by the issue under investigation.it is essential to consider a variety of data sources, including both primary and secondary sources, to conduct a thorough and comprehensive analysis. This study provides an excellent example of the benefits of using such an approach.

3.2.3. Population and sampling procedures

Population sampling procedure was conducted by a selected sampling plan based on the household's participation in composting and the input for the research. The population of interest was limited to residents of two *woredas* which were located in Bole Sub-city, specifically *Woreda* 01 and 02. The sample was drawn from all different types of residential housing typologies within the study area. This included households that had previously practiced composting or expressed an interest in composting.

The stratified sampling method was used since the population was heterogeneous, using the formula: (sample size/population size) × stratum size. The sampling procedure involved identifying households that met the inclusion criteria, such as the type of housing which would influence the ability to practice composting and the socio-economic and education levels of residents.

During the study, there was a house-to-house survey of selected households to get consent to make an observation on their practice of waste disposal and identify those that already practiced composting or were willing to start in the future. A pilot test of the stratified sampling plan was conducted to check the feasibility of the sampling plan, and necessary adjustments were made based on the results of the pilot test.

To identify the sampling size the following will be used (Kothari 1990)

$$n = \frac{P*(1.00-p)*Z^2}{e2}$$

Where n is sample size, P is estimated population of respondents., Z is the number of standard errors, E is margin of error.

The total population of bole sub city *worda* 01 according to the Ethiopian statistics and data agency is 3523 from this based on the formula on Kotari 1990 the sample size is calculated to be 320. But due to time constraint this respondent number has been limited to 125.

3.3. Methods of data analysis

To analyze the data obtained from questionnaire surveys, the utilized software was SPSS (Version 27) and categorized the main outcomes and circumstances based on the data type. Prior to analysis, the survey data checked and coded. This task entailed categorizing, identifying, and tagging/coding data with a numeric or character symbol, which could only be done in one pre-coded way. The researcher utilized descriptive statistics to explore the data during the analysis process, which presented in graphical and tabular form of analysis to show the severity and depth of problem observed in the study where major descriptive techniques mainly Chi-square test was used to test the relationship between categorical data (Ugoni et al., 1995).

In this study, the statistical method of chi-square and Pearson correlation was employed to examine the correlation between different variables and organic solid waste composting. The research utilized the p-value measure to determine the probability of obtaining the observed

results. A p-value of less than 0.05 indicates greater statistical significance, implying a strong relationship between the variables.

This data type's nature makes it non-numerical. This kind of information is gathered through methods like focus group discussions, one-on-one interviews, and other similar techniques. This indicates that the data was gathered in the form of sentences and words. Such information typically records sentiments, emotions, or people's opinions about something. Exploratory in nature, qualitative data are primarily focused with learning more about underlying causes and motivations. Additionally, voice recordings and note-taking in sampled regions were done using the data gathered from KII and FDG.

3.4. Ethical consideration

The ethical considerations are of utmost importance when it comes to safeguarding the rights of study participants, upholding the accuracy of research, and preserving academic credibility. It is essential to adhere to ethical standards in order to maintain the integrity of the research process and ensure that the interests of all parties involved are respected. Proper attention to ethical considerations is vital in producing reliable research outcomes that can be trusted by the scientific community and beyond. (Pritha Bhandari, 2021). This is essential in order to obtain authorization and gather the information required to carry out the research. Additionally, it is important to gain the trust of the informants on the ground by taking into account cultural, linguistic, and religious concerns that might exist among participants, whether they are volunteers giving their informed consent or anonymous. Another concern is assuring the participants won't suffer any potential injury. An ethical clearance has also been issued from Addis Ababa University and approved by the advisor and chair of ethical committee to conduct the research.

CHAPTER FOUR

4. RESULT AND DISCUSSION

4.1. Socio demographic character of Respondents

The analysis of the respondents' demographic characteristics includes gender, age, education level, family size, marital status, monthly income, and house ownership conditions. This helps to identify their relation to the challenges and opportunities of composting organic solid waste, which are further discussed below.

Table 3 Demographic characteristics of respondents Gender, Age and Education level

Variable	**Frequency n=125**	**Percentage (%)**
Gender		
Male	65	52
Female	60	48
Age		
18-30	40	32
31-45	48	38.4
46-60	21	16.8
Above 60	16	12.8
Education Level		
No Formal Education	0	0
1-4 grade	0	0
5-8 grade	1	0.8
9-12 grade	15	12
Certificate	3	2.4
Diploma	29	23.2
Degree	56	44.8

Variable	Frequency n=125	Percentage (%)
Second degree and above	21	16.8

To identify the connection between demographic characteristics and organic solid waste composting practices in the study area, major variables such as gender, family size, and marital status of the respondents were assessed and analyzed. As shown in Table 3.1 52% of the survey participants were male, while the remaining 48% were females. The ratio between male and female respondents helps to see the effect on organic solid waste composting practices. The average family size of the survey respondents has wide variation ranging from 1 to 3 members who account for 37.6% having, 44% have 4 to 6 members, and 17.6% having 7 to 10 members. Concerning the marital status of the survey households, the great majorities were married (50.4%) and single (46.4%) and the remaining few were divorced (2.4%), and widowed (0.8%).

The respondents' education level and age range indicate high percentage of literate population. Specifically, the majority (44.8%) are degree holders followed by those educated to Diploma (23.2%), possess a second degree or higher (16.8%), completed 12th grade (12.8%) and hold Certificate (2.4%). This suggests that promoting the practice of organic solid waste composting in the area could be feasible, since education enables people to gain knowledge and skills to enhance themselves (Afsar, 2011). In this case, the education level of respondents shows that they are well-equipped to understand composting and may be willing to do it in the future.

Concerning age structure of the survey respondents, the majority are young people, with age range of 18-30- and 31-45-years accounting 32% and 38.4%, respectively. The remaining 16.8% fall between 46-60 years, while 12% are above 60 years. Thus, the age ranges indicate that the area has a potential source of dynamic and highly active workforce who able to engage in composting.

Table 4 Demographic characters of respondents' Marital status and occupation

Variable	Frequency n=125	Percentage (%)
Marital status		
Single	58	46.4
Married	63	50.4

Divorced	3	2.4
Widowed	1	0.8
Occupation		
Private sector	38	30.4
Civil servant	26	20.8
Business man	47	37.6
House wife	6	4.8
Retiree	3	2.4
Student	2	1.6
Others	3	2.4

The data on the economic status reveals that significant percentage (42.4%) of survey respondents earn a monthly income of over 10,000 Birr. Additionally, 11.2% have an income range of 8,000 to 10,000 Birr while 10.4%, 12.8%, 14.4%, 6.4%, and 2.4% of survey respondents earn between 6,000 to 8,000 Birr, 4,000 to 6,000 Birr, 2,000 to 4,000 Birr, 1,000 to 2,000 Birr, and less than 1,000 Bir respectively. In summary, the results suggest that the majority of the respondents have a relatively sufficient monthly income and tend to rent private houses while a significant portion live in their own private houses. According to KII findings from the *woreda* expert's majority of the residents are well of with privately owned houses and rentals dominating the area. One of the informants highlighted the contrast between closely located housing types and the income level to be very large.

Table 5 Demographic character of Respondents Average monthly income, family size and house ownership

Variable	**Frequency n=125**	**Percentage (%)**
Average monthly income		
Less than 1000	3	2.4
1000-2000	8	6.4
2000-4000	18	14.4
4000-6000	16	12.8
6000-8000	13	10.4
8000-10000	14	11.2

Above 10000	53	42.4
Family Size		
1-3	47	37.6
4-6	55	44
7-10	22	17.6
Above 10	1	0.8
House ownership type		
Kebele Rental house	10	8
Private Rental house	57	45.6
Private house	56	44.8
Condominium	2	1.6

Regarding housing condition of the survey participants revealed that considerably large (45.6%) of respondents reside in rental houses ranted from private house owners and 44.8% live in own private houses, while 8% rent Kebele houses and very few (1.6%) live in condominium housing. Housing condition of community determine their involvement in organic waste management and composting. Particularly, people living in own private and renal kebele houses might have a chance to properly segregate and compost the organic waste either to use the product (composted organic fertilizer) for own crop production or supply to others as they might have some space to make the compost.

4.2. Organic solid waste composting practice

Based on the survey conducted, the awareness of respondents as in Table 6 below indicated that the ratio of awareness of organic solid waste composting is 28.8% to 71.2 % where 28.8 % have No awareness about the practice of composting organic solid waste while the remaining have some awareness regardless of the level of knowledge about the details of organic solid waste composting process.

According to the survey, a significant proportion (71.2%) of the respondents demonstrated an awareness of the significance of composting organic solid wastes, however majority (60%) of the respondents don't perform organic solid waste composting in their gardens and the remaining 40% exercise the practice in their home or garden (Table 6). As per FGD and KII discussants the involvement of those who reported that they engage in the activity (40%), the level to which they

actually practice organic solid waste for compost is still questionable. Thus, from this it can be inferred that more percentage of respondents might not practice composting organic solid waste of those who reported that they do. Among those who compost organic solid waste in their home garden 25.6% claimed that they lack suitable place for processing the organic solid waste into compost as main problems they face. Among those who reported that they engage in the practice, 9.6% of those who attempt to perform composting claimed that they have technical capacity gap to manage the practice well and 3.2% have lack of plot to grow vegetables and apply the compost and the remaining 4% indicated that pathogens and the odor made the experience challenging.

The practice of composting biological compact waste at the source starts by segregating the organic solid waste from the other types of waste generated from the household. In this regard respondents practice of waste segregation was found to be low compared with those who separate organic solid waste from those who don't. A world bank study exposed that waste administration in developing countries is very poor and that the environment is highly affected since it is dumped in open spaces (Plahl, 2002). The current survey shows that almost half (50.4 %) of the respondents don't properly separate the organic solid waste, 49.6% separate the waste before dumping. Out of the 49% of respondents separating the waste 16.8% separate plastic waste only and leave the remaining and only 7.2% separate decomposable from the non-decomposable materials while 10.4% separate the organic solid waste from the rest (Table 6). The remaining 16.8% separate the waste into three components such as decomposable, iron scraps and plastic wastes.

Understanding of respondents concerning process of composting was found very little even though 71.2% of the respondents claim to have some awareness about composting. In connection to this 86.4% survey respondents stated that they didn't attend any training, education or formal information about the process and practice of composting organic solid waste the remaining, whilst 13.6% claimed they have had training due to different opportunities related to their work or education.

From the 86.4% respondents reported did not attend any form of training 65.6% expressed their willing to receive or attend training on organic solid waste composting and the remaining 34.4% are not willing to attend training or education and information about composting.

The practice of organic solid waste composting is influenced by awareness level about the procedure and the benefits it gives to the environment. (Kumar, et.al., 2015). In a study made on the level of awareness and practice of waste segregation in India, the authors found that the level of awareness about organic waste composting was positively related to the practice of source segregation of waste and the overall implementation of organic waste management practices. Additionally, they found that one of the key motivators for residents to sustainably manage their organic waste was their awareness of the environmental benefits associated with composting. As shown in table 4, majority (81.6%) of the participants in the survey were aware of the eco-friendly benefits of the practice of composting organic solid waste even though the number of respondents who practice composting is very low compared to those who are aware of the benefits. A similar study conducted by (Anwar, 2020) in Malaysia found that 60% of the citizens consider composting as not beneficial and a dirty job which is very different from the findings of this survey where people think composting is beneficial but don't practice it.

Table 6: Practice of organic solid waste composting

No	Variable / item	Characteristic	Frequency	Percentage
1	Are you aware of composting organic Solid wastes?	Yes	89	71.2
		No	36	28.8
2	Do you Perform Composting organic solid waste in your home or garden?	Yes	50	40
		No	75	60
3	If you answer to #2 was Yes, do you experienced any problem to prepare compost at your home garden or any place at your vicinity?	No	71	56.8
		Lack of suitable place for composting	32	25.6
		Limited compostable (input) materials generated from the household to prepare compost	1	.8
		Technical capacity problem	12	9.6
		Lack of plot (garden) to produce vegetable (crop) where I can apply the compost	4	3.2
		Problem of pathogens and odor in organic waste compost	5	4
4	Do you separate organic solid waste in your household?	Yes	62	49.6
		No	63	50.4

No	Variable / item	Characteristic	Frequency	Percentage
5	If yes to question #4, which martials you separate	No	61	48.8
		Decomposable from all non-decomposable materials	9	7.2
		We separate organic wastes from others	13	10.4
		Separate plastic martials only	21	16.8
		We separate in to 3 components i.e., decomposable materials, iron scraps and plastic materials	21	16.8
6	Have you ever attained any training, education or information about composting organic solid waste?	Yes	17	13.6
		No	108	86.4
7	If no to question #6, are you willing to get training about the practice and benefits of composting?	Yes	82	65.6
		No	43	34.4
8	Are you aware that composting organic solid waste benefits the environment?	Yes	102	81.6
		No	23	18.4
9	Do you have a garden in your house?	Yes	77	61.6
		No	48	38.4
10	If you answer Yes #9, Do you use organic solid waste for gardening?	No	52	41.6
		Yes, I always use the organic solid waste in the soil	44	35.2
		Yes, I sometimes dump the organic solid waste on the soil	29	23.2
11	How do you use the organic solid waste in your house?	I compost it and use it in the garden as fertilizer	20	16.0
		I just dumb the organic solid waste in the garden as it is	27	21.6
		I don't use it	78	62.4
12	Do you think composting organic solid waste is	Yes	13	10.4
		No	112	89.6

No	Variable / item	Characteristic	Frequency	Percentage
	important?			
13	If your answer for the above question is yes, in your perception what is the importance?	No	11	8.8
		Reduce solid waste collected and improve the environmental sanitation	74	59.2
		Economic benefits	23	18.4
		Other	17	13.6
14	Do you think promoting organic waste composting is key to reducing environmental pollution**?**	No	12	9.6
		Yes	95	76.0
		I don't know	18	14.4

Source: the study survey (2023)

Based on the type of housing the respondents are living in and the opportunities they have to compost, 61.6% households have a garden in their compound while 38.4% do not have any space for garden. From the respondents having garden 41.6% indicated that they were not using the organic solid waste for generated purpose in their household. On the other hand, 35.2% and 23.2% reported that they always and sometimes use the carbon-based solid waste to improve the garden, respectively. When asked how they use the organic solid waste in the household. The survey captured utilization of the organic waste at household level which revealed that majority (62.4%) reported that they don't use it at all, 16% compost the organic solid waste and use it in the garden and the remaining 21.6% just dump the organic solid waste in the gardens without any treatment or composting.

The perception of respondents towards the importance of composting is very biased as the great majority (89.6%) responded that practicing compost at a household level is not that important. But at the same time 76% think that promoting and creating awareness about the reimbursements of composting organic solid waste is important to reduce environmental pollution. From the respondents who believe the importance of promoting composting organic solid waste practice, 59% underlined the practice is valuable to reduce the waste collected and improve the environmental sanitation while 18.4% think it has economic benefit too.

4.3. Challenges of solid organic waste composting

The survey conducted on the challenges of composting solid organic waste revealed that out of respondents who reported practicing composting at household level, 41.6% faced challenges that

hinder the practice. Table 7 shows among the challenges 25.6% claimed that the unpleasant odor was the main issue, 8.8% had lack of adequate knowledge on composting to adopt the practice, 6.4% had inadequate space for composting and 1.6% stated that they had pest control problems which led to abandoning the practice.

The respondents in FGD reported that it is very challenging to conduct organic solid waste composting at household level due to lack of space and their living conditions is not favorable to accommodate the needed elements to compost organic solid waste. In this regard even though most FGD participants think composting is important and useful for soil nutrient improvement, the implementation of such practice is still very poor due to various socioeconomic factors.

4.4. Solutions to minimize challenges of composting

Table 7 provides the respondents understanding on the benefits of composting organic solid waste. Thus, 28.8% survey households reported the practice is useful to provide nutrient rich soil, 26.4% indicated that it is beneficial to decrease waste being dumped at landfills, 18.4% think it helps with environmental protection and 4% claimed it has economic benefit by selling the compost product to the users in the community.

The personal experience of respondents regarding benefit of organic solid waste composting the respondents underlined that it improves soil quality in the garden, increases crop production, reduces the application of chemical fertilizers and reduces the amount of solid organic waste disposed as reported by 20%, 10.4%, 9.6% and 16% respondents respectively

The survey responses suggest that there are several different ways that individuals can be supported and encouraged to start composting at home. One way is through the provision of reading materials on composting, which was identified as important by 17.6% of respondents. This highlights the need for accessible and easy-to-understand information that can help people learn about the benefits of composting, how to get started, and how to maintain a composting system over time.

Another common theme that emerged from the survey was the need for workshops or training sessions on composting, which was mentioned by 32% of the respondents. This suggests that many people would benefit from hands-on guidance and support in order to feel confident about starting their own composting system. According to KII, workshops may encompass diverse

subjects including ways to select a composting technique that meets your requirements, creating and managing a compost pile, and handling frequent challenges while composting.

In addition to reading materials and training opportunities, financial incentives were identified as a potential support measure by 23.2% respondents. This suggests that some people may be more likely to start composting if they receive a financial reward or rebate for doing so. Such incentives could take various forms, such as tax credits, grants, or vouchers that could be used to purchase composting equipment or supplies.

A smaller number (16.8%) of respondents mentioned the provision of composting equipment and tools as a potential support measure to those who practice composting. As per FGDs and KIIs, some people may be hesitant to start composting because they lack the necessary equipment. By providing these resources, local governments or community organizations could lower the barriers of composting. In overall, the survey responses suggest that there are multiple ways that individuals can be supported and encouraged to start composting at home. Offering a range of resources that cater to different needs, whether that be reading materials, workshops, financial incentives, or equipment; it may be possible to promote widespread adoption of composting as a sustainable and environmentally-friendly practice.

4.4.1. Challenges to implement solid organic waste composting

The survey showed that composting of organic solid waste is not a very widely practiced activity among households as only 10.4% reported composting their household generated solid waste on a daily basis, while 14.4% do on a weekly basis, 11.2% on a monthly basis, and 12% doing rarely and 5.6% never composted waste. However significant proportions (46.4%) of respondents were not engaging in this practice. Therefore, the survey highlights the need for more education and awareness about the benefits of composting organic solid waste. It is well known that if more people understand the positive impacts of composting for the environment and its potential economic benefits such as reduced waste management costs and increased soil fertility more households likely adopting the practice.

Based on the results of the survey, it seems that lack of awareness and no proper resources are the biggest challenges to implement widespread organic waste composting at the domestic level. The majority (58.4%) respondents cited lack of awareness among the barriers hindering implementation of organic waste composting, indicating that people are not familiar with the

concept and its benefits. This highlights the need for more education and outreach programs to create more awareness on the importance of organic waste composting. Further highlighting the challenges, 20% of respondents reported that they don't have resource to implement composting, indicating that there is a lack of infrastructure or assistance to initiate composting efforts at the domestic level. This suggests the need for government or other organizations to provide support to promote the widespread adoption of organic waste composting. Interestingly, 16.8% of respondents indicated as they don't know the challenges, which imply lack of information and expertise on the issue. This tells need for improved communication channels to share information and increase access to knowledge about organic waste composting.

Another critical finding from the survey is that only 4.8% of the respondents cited lack of policy implementation as a major challenge, which is lower than expected. It suggests that while policies can be helpful in promoting the adoption of organic waste composting, other factors such as awareness and resources may be more impactful.

It can be concluded that lack of awareness and resources are the primary hurdles in implementing organic waste composting at the domestic level. Educating people about the benefits of composting and providing financial and material support for setting up infrastructure for effective composting are essential steps to make organic waste composting a mainstream practice.

According to the data provided, it appears that a majority of respondents (48%) believe that there are low changes or improvements in the current organic waste composting practices at domestic level. while 13.6% of respondents believe that there are medium-level changes or improvements taking place, and only a small percentage (3.2%) believes that there are high-level changes or improvements happening.

Recent research on challenges and opportunities of composting organic solid waste has brought to light the fact that while composting is an effective method of reducing organic waste and producing nutrient-rich soil for plants, it is not without its challenges (Trivedi and Trivedi, 2019). The authors underlined that the most significant challenges include lack of awareness and knowledge about composting among the general public, which leads to incorrect composting practices, poor quality of input materials, and non-ideal environmental conditions. These challenges can result in issues such as bad odors, presence of pests, and slow decomposition.

One of the key opportunities for improving composting practices is education level of study community. Educating the public on the benefits of composting, how to properly compost, and what materials are suitable for composting can help promote proper composting practices at the domestic level as the study community are well educated (at least literate). The municipalities can provide composting facilities and services to encourage residents to compost their organic waste properly and divert it from landfills.

As per the response of the experts the lack of technological means to simplify the process of composting was one of the challenges. They used windrow method of composting which is done by digging 12m*3m*1.5m. and the process takes about two month on sunny seasons otherwise it was hard to continue during the rainy season since there were no shades provided.

The main complaint is that there is lack of land or proper space designated to practice compost by the associations even if there were some given for this purpose, they were later taken back for other development demands since they have no map or registration it was easy to displace them. The society near by the sites also where among the challenges as they demanded they stop collecting the waste in the living areas and also complained about the smell from the compost being processed.

One of the major reasons for the fall of the associations according to the informants is that after all the time and all the labor they put into the work is the price of the product which is 7 Birr for 1kg which was very discouraging because even though it cost was low the market for it was almost none existent which led to frustration for the members of the association since they had to wait months to prepare the compost and even longer to sell it and gain income that was worth the effort they put into it.

It is recorded that there are currently only 30 active associations left in the entire city from 11 sub cities and the linkages between them and the market that has been arranged by the office of mayor with the greenery and beautifying association didn’t really follow through even though the reports claim to have bought the compost from the MSE in reality they went to nearby county side and bought animal dung for 2birr per kilo which led to putting the composting association out of market.

The interviews conducted both at woreda and administration level had similar responses as discussed above the main issues stated are that there is a high need to practice composting since it is crucial to reduce waste and this is one of the goals of the cleaning and beautifying agencies and the space problems which are still under discussion by the Addis Ababa city land administration office according to the informants.

In conclusion, although some challenges exist for composting organic solid waste, such as lack of knowledge and awareness, there are also significant opportunities for improvement through education and infrastructure development. Therefore, it is important for individuals, communities, and governments to work together to develop and promote sustainable composting practices for the benefit of our environment and future generations.

Table 7: challenges of composting organic solid waste

No	Variable	Character	Frequency	Percentage
1	Have you faced any challenges while composting organic waste at home?	Yes	52	41.6
		No	73	58.4
2	If yes, please specify the challenges you have faced?	No	66	52.8
		Lack of knowledge on composting	11	8.8
		Unpleasant odors	32	25.6
		Pest control problems	2	1.6
		Inadequate space for composting	8	6.4
		Others	6	4.8
3	In your opinion, what are the benefits of composting organic waste at home?	Decreased landfill waste	33	26.4
		Nutrient-rich soil for plants	36	28.8
		Environmental protection	23	18.4
		sell the compost to earn income	5	4
		Others	28	22.4
4	Do you experience any of the	Improved soil quality of	25	20

No	Variable	Character	Frequency	Percentage
	following benefits from composting organic waste at home?	the garden		
		Increased my garden agriculture (vegetable) production and productivity	13	10.4
		Reduced use of chemical fertilizers for my garden	12	9.6
		Reduced household waste	20	16
		Others	55	44
5	Do you think composting organic waste at home should be encouraged by the local government?	Yes	117	93.6
		No	8	6.4
6	What kind of support or resources would be helpful for encouraging composting at the domestic level?	Support on reading materials on composting	22	17.6
		Workshops or training sessions on composting	40	32
		Financial incentives	29	23.2
		Provision of composting equipment and tools	21	16.8
		Others	13	10.4
7	What is the extent to which composting of organic solid waste is practiced by households?	Daily	13	10.4
		Weekly	18	14.4
		Monthly	14	11.2
		Rarely	15	12
		Never	7	5.6
		Unsure	58	46.4
8	Do you face any issues with odor or pests when composting at home?	Yes	66	52.8
		No	59	47.2
9	If your answer question #8 was yes, to what level do you manage them?	No	59	47.2
		Low	22	17.6
		Medium	34	27.2
		High	10	8

No	Variable	Character	Frequency	Percentage
10	In your opinion, what are the biggest challenges to implement widespread organic waste composting at the domestic level?	No resource available	25	20
		No awareness of the need, just dump it with waste	73	58.4
		I don't know	21	16.8
		Lack of policy implementation	6	4.8
11	Are there changes or improvements in the current organic waste composting practices at domestic level?	Low	60	48
		Medium	17	13.6
		High	4	3.2
		I don't know	44	35.2

Source; survey study (2023)

4.5. Contribution of organic solid waste composting to urban agriculture

Composting organic solid waste and urban agriculture have become increasingly popular as ways to reduce waste and produce food in urban areas. Composting solid waste leads to the production of nutrient-rich soil amendment that can be used for urban agriculture. This process plays an essential role in sustainable urban farming by providing a source of natural and affordable nutrients for plants (Bakshi and Chetri, 2017).

According to the given data, 98.4% of respondents out of the surveyed population believe that composting helps in enhancing soil fertility while only 1.6% disagree the idea. This data strongly suggests that composting does indeed help to improve soil fertility, which is a widely accepted fact amongst respondents. As shown in Table 6, out the respondents (54.4%) who believe the function of composting to enhance soil fertility, 41.6% believe the compost improves the workability or the structure of the soil and 3.2% feel that it enhances water retention ability of the soil. The benefits of using compost in the soil are abundant. It is known that organic matter decomposition releases vital nutrients like nitrogen, phosphorus, and potassium, which are crucial components for plants' growth. Therefore, adding compost to the soil increases its ability to retain water, which is beneficial. It promotes the development of healthy microbial populations which contributes to improved soil structure and fertility (Adhikari, 2008).

KII informants indicated that composting organic solid waste has numerous environmental benefits. such as reducing greenhouse gas emissions from decomposing wastes in landfills, reducing water pollution, minimizing the use of synthetic fertilizers and pesticides, and improving soil health. Additionally, urban agriculture also helps to promote local food production and economic development, green space creation, waste reduction, and community empowerment. It also encourages residents to adopt healthy eating habits and lifestyles (Cavigelli, 2015). Composting organic solid waste and practicing urban agriculture play a significant role in promoting sustainable urban farming. The positive effects of compost on soil fertility and other benefits associated with urban agriculture desirable and viable option for food production in urban areas (Zhu, et.,al 2019). Hence, composting should be widely promoted and adopted as an essential component of sustainable urban farming programs.

The surveyed data regarding the relationship between composting and urban agriculture, portrayed that 97.6% affirmative responses and only 2.4% negative responses suggesting that the majority of respondents believe that composting can indeed help in the context of urban agriculture. Out of respondents agreed on importance of compost 33.6% of respondents believed composting improve by more than 50% of urban agriculture, where as 21.6% of respondents suggested composting can contributes improvement of urban agriculture for about 25-50% of production and few respondents (4.8%) believe less than 25% urban agricultural production improvement it contributes, while 40% of the respondents were not sure about the role of composting contribution to urban agriculture.

From the surveyed data, it can be deduced that a significant number of people have some level of awareness on the benefits of composting for urban agriculture. The result suggests that composting has a positive impact on urban agriculture, and it should be promoted for sustainable urban agriculture. Composting is the method of breaking organic matter into nutrient-rich soil. This nutrient-rich soil can be used as a natural fertilizer for crops, which can help reduce the need for synthetic fertilizers, ultimately minimizing environmental pollution. Besides, composting provides an efficient way to recycle organic waste, reducing the amount of waste that ends up in landfills (Bernal-Brooks,et.,al, 2018). In the context of urban agriculture, composting offers numerous benefits aside from providing a natural fertilizer. For example, urban agriculture often faces issues with the lack of green spaces that limit the availability of

adequate space for agriculture purposes (Lemessa,et.,al 2017). Composting provides the opportunity to recycle organic waste materials in urban areas to create a viable growing medium for crops. Furthermore, composting in urban areas can contribute to community gardening, which provides access to fresh produce to those living in urban areas that don't otherwise have access to fresh food.

4.5.1. Relationship between compost and urban agriculture

The above discussed surveyed data indicates that composting is an essential aspect that contributes to urban agriculture, with the majority of the respondents acknowledging its benefits. Thus, the survey's and qualitative (FGD and KIIs) results suggest that more emphasis should be given to promoting composting in urban areas for sustainable cultivation practices and ensuring adequate availability of fresh produce in urban areas, ultimately contributing to healthy communities.

The surveyed data shown on table 6 revealed that there are challenges associated with using compost in urban agriculture as agreed by the majority of respondents who took part in the survey. Out of 125 respondents, 76.8% of them acknowledged existence of the challenges. This suggests that composting faces significant challenges while using the product (compost) for urban agriculture.

Out of the 76.8% respondents who agreed that composting faces challenges in urban agriculture, 20% believed that the challenges do not hinder the practice at all; 19.2% respondents believe that the challenges limit the practice completely which shows the severity of these challenges. Another 34.4% respondents thought that the challenges partially limit the practice, while only 4.8% respondents believed challenges are very small that does not affect the practice much. It's also worth noting that 21.6% respondents were unsure about the extent the challenges hinder the practice, which suggests that more research may need to be done on this topic.

From the responses of the respondents, it can be concluded that there are challenges associated with the use of composting in urban agriculture, and the extent to which these challenges hinder the practice which vary among individuals. Nonetheless, it is vital to address these challenges to promote the use of composting in urban agriculture since it's an essential process that helps reduce waste and improve soil quality. Therefore, stakeholders in urban agriculture should work

together to mitigate these challenges to maximize the benefits of composting in urban agriculture.

The data provided in table 8 reflects questions related to urban composting programs, policies, and community initiatives. The responses reveal important insights on the awareness, knowledge, and opinions of individuals regarding these issues. Regarding the question on successful composting programs in urban areas, only 20% indicated that they have awareness. This suggests that there is a lack of information or publicity among the general population about the importance of the practice for urban agriculture. Therefore, it would be useful to identify and showcase successful examples to promote awareness and encourage the adoption of similar initiatives in other areas.

The question on policies or regulations promoting or hindering the use of compost in urban agriculture showed that 14.4% of respondents were aware of these measures. It is vital to have clear regulations that support and incentivize composting practices as they can result in numerous environmental and economic benefits. However, the low number of people know about such policies indicates the need for more widespread communication and public education on this matter.

Finally, the majority (74.4%) of respondents acknowledged the benefits of community level composting initiatives for urban agriculture. Hence, successful models of such initiatives include decentralized composting systems that allow homeowners and community gardens to produce compost as well as programs that collect organic waste from households and turn them into high-quality soil amendments. These models not only provide a source of nutrient-rich soil for urban agriculture but also promote sustainability and reduce landfill waste.

In conclusion, the data indicate the need for improving awareness and understanding of composting practices, policies, and community initiatives in urban areas in connection with urban agriculture and reduce volume of waste generated which end at dumping sites. Further education and promotion of these programs can result in more widespread adoption of sustainable practices, leading to a cleaner environment and healthier communities.

Table 8: contribution of organic solid waste composting to urban agriculture

No	Variable / item	Character	Frequency	Percentage

No	Variable / item	Character	Frequency	Percentage
1	Do you think that compost help soil fertility?	Yes	123	98.4
		No	2	1.6
2	If yes to question 1, what benefit	No	2	1.6
		Improve soil fertility	68	54.4
		Improve soil workability (structure)	52	41.6
		Improve water retention ability of the soil	4	3.2
3	Do you think composting help urban agriculture?	Yes	122	97.6
		No	3	2.4
4	If yes to question # 3, what percentage does it currently contribute to urban agriculture?	More than 50%	42	33.6
		Between 25-50%	27	21.6
		Less than 25%	6	4.8
		I am not sure	50	40
5	Are there challenges associated with using compost in urban agriculture?	Yes	96	76.8
		No	29	23.2
6	If your answer to #5 is Yes to what extent do the challenges hinder the practice?	No	25	20
		Limits it completely	24	19.2
		Partially limits it	43	34.4
		Very small	6	4.8
		I am not sure	27	21.6
7	Do you know any examples of successful composting programs in Urban areas?	Yes	25	20
		No	100	80
8	Do you know policies or regulations exist that promote or hinder the use of compost in urban agriculture?	Yes	18	14.4
		No	107	85.6

No	Variable / item	Character	Frequency	Percentage
9	Do you think community composting initiatives benefit urban agriculture? and what are some examples of successful models?	Yes	93	74.4
		No	32	25.6

Source; survey study 2023

4.6. Determinants of solid organic waste composting

The researched variables comprised gender, age, educational level, family size, monthly income, type of residence, awareness of composting and training, willingness to use compost, practice of separating solid organic waste, environmental pollution and composting organic solid waste and lastly urban agriculture and practice of composting. All these variables play a crucial role in enhancing solid organic waste composting practices. For instance, educational level and monthly income could impact composting, as individuals with higher levels of education and income tend to have more knowledge and resources to engage in composting.

Moreover, the willingness to take part in solid organic waste composting programs, plays a pivotal role in determining the success of composting efforts. Furthermore, having awareness/training, understanding the role of environmental protection and improved urban agriculture can enhance organic solid waste composting initiatives significantly. Finally, the influence of community solid waste management society can create a positive impact by encouraging people to engage in composting practices.

4.6.1. Gender and organic solid waste composting

Based on the statistical results, the chi- square value for the association between gender and practice of composting organic solid waste as shown in the table 2.137 with a p- value equal to 0.144. Therefore, the statistics shows insignificant relationship between gender and composting organic solid waste. The practice of composting is not influenced by gender of the survey respondents. The Pearson correlation analysis also showed a value of 0.13 which is below 0.3 indicating week correlation between gender and composting.

4.6.2. Age of Respondents and organic solid waste composting

The results in table 9 shows that the chi square value 0.823 and P- value of 0.844 for the association of age with organic solid waste composting practice that means age doesn't significantly affect the practice. Since the majority of respondents in the survey where in the age groups between 18 and45 the results concluded that there is no significant relationship. In convers studies made in central Uganda, urban centers of Kenya and Caribbean islands found that practice of composting and old age ranging between 45 to 60 are more related that the younger respondents found in the age group between 18-30 and 31-45 (Hilbert, 2018). Therefore, the studies show that people with old age have more time to practice organic solid waste composting than the others.

4.6.3. Education Level of Respondents and organic solid waste composting

The data relating to education level has a chi-square value 9.261 with P-value 0.016, thus education has significant (at $p<0.05$) outcome for the association between education level and composting organic solid waste practice. The respondents that account for more than 60% in the study area had an education level above 12 grades. Which means the increased level of literacy contributes to the improved understanding and possibility of organic solid waste composting at household level. And have a positive perspective toward the need and use of organic solid waste composting. Based on a study made on the impact of literacy on organic solid waste composting at household level in urban areas. The results show that increased level of literacy contributes positively to the improved understanding and possibility of organic solid waste composting at household level. Furthermore, literacy has a positive direct and indirect impact on attitudes towards the need and use of organic solid waste composting, which in turn positively influences the actual adoption of the composting practice. The findings suggest that literacy can be a key factor in promoting sustainable waste management practices at household level, and highlight the need for education and awareness-raising campaigns that target different segments of the population. (Abdul, et.,al 2019).

4.6.4. Family size of respondents and organic solid waste composting

Table 9 shows that the chi square value is 17.517 with P- value 0.06 which is $p>0.05$ and Pearson correlation values show -0.073, from this statistical analysis it can be deduced that the family size of a household does not significantly affect the practice of organic solid waste

composting and the Pearson correlation value indicates there is a negative relationship. Which means the number of family members has an insignificant role.

4.6.5. Monthly income of respondents and organic solid waste composting

The data regarding the association between monthly income and composting practice as shown in table 9 can be interpreted as significant since the chi-square is 14.823 with p-value 0.022 as $p<0.05$ and a Pearson correlation value 0.517 indicating a moderately strong correlation between income and possibilities of composting practice. The likelihood of participating in composting activities is higher with households of stable income than those of lower hence the demand for time and labor is affordable rather than those who are dependent on the practice of composting organic solid waste and its product for the monthly income.

4.6.6. Marital status and organic solid waste composting

Table 9 shows a chi square of 3.549 with P-Value=0.315 which is $p>0.05$ which means insignificant association. The Pearson correlation has a 0.022 value; the statistics indicate a very weak correlation between marital status and organic solid waste composting.

4.6.7. House type and organic solid waste composting

According to the results of the statistical analysis chi-square value of 15.094 and P-value of 0.002 shows significant association between house type and composting of organic solid waste practice. It can be concluded that the house ownership and condition influence the chances of performing organic solid waste composting. Studies made on central and eastern African countries conducted in Uganda suggest that house ownership with availability of garden in the spaces significantly increases organic solid waste composting at household level (Hilebert, 2018).

4.6.8. Awareness of respondents on organic solid waste composting

The statistical data analysis depicted in table 9, in relation to awareness of respondents about organic solid waste composting show a significant relationship between awareness and practice with a chi-square value of 8.902 and $P<0.003$. Similarly, study made by Hoornweg and Hoornweg (2016) in Ethiopia suggest that the low level of engagement of composting at households is the result of lack of knowledge on methodological aspects of composting and equipment to use for the process.

4.6.9. Willingness of respondents to practice organic solid waste composting

The chi-square value of willingness of respondents under survey shows as stated in the table 9 below is 2.606 and at P= 0.106 indicates insignificant association between the variables. This show majority of respondents were not willing to practice organic solid waste composting at their homes due to several personal reasons and external constraints such as due to living conditions, labor demands, odor and pest issues and over all interest to be engaged in the practice.

According to the experts and informants at the Addis Ababa cleaning management agency the city produces about 60% organic solid waste and 18% plastic and metal waste. The experts state that the amount of organic waste is more than enough to practice composting at city level. Based on this the agency had started organizing interested individuals to create associations that work to use the organic solid waste in 2013 E.C by providing training and creating capacity for the participants. There has been a production of 1885 tone of compost in the first year alone and 2140 tone in the following year in just nine month which according to the experts is more than enough to cover the cities demand of compost.

4.6.10. Respondents organic solid waste separating practice for composting purpose

Table 9 shows that the respondents practiced segregating organic solid waste from other types of waste. The chi- square value is 25.394 with $P < 0.001$ which means significant association between the practice of segregation and composting organic solid waste. A study conducted by Planning Commission of India (2014) also found that those who segregated waste were more inclined to participate in composting. Waste segregation is recognized to simplify additional treatment procedures such as waste composting, so it's no surprise that those who segregated waste were more probable to engage in composting. According to another study carried out in Indonesia, waste segregation was found to be an essential step that precedes successful composting (Suryanto et al., 2018). The research findings are consistent with the idea that proper segregation of waste materials is crucial to ensure high quality compost that is free from contaminants and pathogens. Effective separation of different types of wastes such as food waste, yard waste, and other recyclable materials helps to maintain the right balance of carbon and nitrogen in the compost heap. This balance is vital for the growth of beneficial microorganisms responsible for breaking down the organic matter and creating nutrient-rich soil

amendment. Therefore, it can be concluded that waste segregation is a vital factor that contributes to the success of any composting program and plays a crucial role in sustainable waste management practices.

Table 9: Relationship between variables and organic solid waste composting

No	**Variables**	**Organic solid waste composting practice**			
		Degree of Freedom (Df)	P-Value	Chi-square	Pearson correlation
1	Gender	1	0.144	2.137	0.131
2	Age	3	0.844	0.823	0.046
3	Education level	5	0.016	9.261	0.214
4	Family size	10	0.064	17.517	-0.073
5	Monthly income	6	0.022	14.823	0.517
6	Marital status	3	0.315	3.549	-0.022
7	House hold type	3	0.002	15.094	0.417
8	Awareness	1	0.003	8.902	0.267
9	Willingness to receive training	1	0.106	2.606	0.144
10	Separate organic solid waste	1	<0.001	25.394	0.451

Source; study survey 2023

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATION

5.1. Conclusion

The need for expanding and rewarding the practice of composting organic solid waste is not an option, rather a crucial issue for waste management enhancement as the landfill sites have reached the maximum capacity and are causing environmental and social hazards to the immediate sites. Composting plays a vital role in reducing the organic solid waste disposed of which according to data by the Government office accounts for above 60% of the waste, which means a large resource of organic solid waste available for composting.

It can be concluded that the challenges and opportunities of organic solid waste composting practice are highly influenced by variables related to demography such as education level, monthly income and household type. Other factors are the availability of resources such as land allocated for the purposes of practicing composting, technical knowledge to perform composting in order to produce good quality compost, awareness of the process and benefits and lack of the government to support such initiatives.

The study analysis found that the challenges of organic solid waste composting exist mainly because enough attention is not given to the practice of composting in urban areas. Even though there have been attempts to encourage the initiative, the actual practice has not lasted long enough to overcome the challenges and pass pilot programs that were conducted.

The surveyed data can be summarized by identifying the opportunities of performing organic solid waste practices and it shows that 71.2% of respondents are aware of composting practice and its benefit and about 50% already practice separating of organic solid waste from the rest household waste which is the first step towards composting process. The majority of respondents were willing to gain some kind of training or hands on guidance in order to be able to practice composting efficiently. Most of the society is aware that composting organic solid waste helps to reduce waste and help improve environmental pollution as a result of waste being dumped on open spaces.

The study also implies that even though there is a large number of populations categorized as young, educated and energetic that alone is not enough to result in practice of organic solid waste

as discovered during the FGD and KII people are not willing to do anything even beneficial to the environment unless there is some kind of financial or other form of incentive.

The government's role in encouraging the practice of composting is being challenged by the individuals who are given the task to conduct the market linkage between the MSE and the Green and beautifying agencies. The reports made that the compost being bought for the purposes of city beautification are made from the MSE but that is far from reality leading the programs to fail as a result of no market for the product.

The link between urban agriculture and use of organic solid waste compost is something that is being practiced at a very low rate even though there is more than enough resource available to prepare the compost and means to use it in households and small plots within the urban setting the practice is still very poor.

5.2. Recommendation

According to the findings of the research the following recommendations are suggested for the better practice and implementation of organic solid waste composting;

- It is important to provide facilities at neighborhood or community levels in areas where the housing types are condominiums in order to encourage composting practice.
- Improve community awareness on role and significance of composting and use of the compost for effective practice of composting organic solid waste at household level.
- Prepare promotional campaigns to interest the youth and develop strategies to incorporate the practice of composting in the daily lives.
- Provide more market links for the associations to get better economic benefit.
- Encourage model composting practices and provide incentives for the successful ones.
- Improve policy on organic solid waste management in relation to composting and implementation.

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Annex A

Questionnaire

School Of Graduate Studies

College Of Developmental Studies

Center For Environment and Development Studies

Dear respondents,

Hello! My name is Eyerusalem Degefu, and I am a Master's student at Addis Ababa University. I am currently working on my thesis titled "Challenges and Opportunities of Composting Organic Solid Waste in Addis Ababa," and I have prepared a questionnaire to collect data for my research. Your input would be immensely valuable, and I kindly request your participation in answering the questions. Please rest assured that this study is for academic purposes only and has been authorized by Addis Ababa University. Your responses and comments will be treated with utmost confidentiality.

I appreciate your cooperation in providing honest responses to the questions. Thank you in advance for your participation!

Address

Email: Eyerusalem.ds@gmail.com

Mobile: +251911616287

Part 1. Social and Demographic status of respondents

Instruction In order to answer the following questions just circle the number of your answer

1. Sex: 1) Male 2) Female
2. Age: 1) 18-30 2) 31-45 3) 46-60 4) Above 60
3. Education Level: 1) No formal Education 2) 1 – 4 grades
   3) 5-8 grade 4) 9-12 grade
   5) Certificate 6) Diploma
   7) First Degree 8) Second Degree and Above
4. House ownership type
   1) Kebele Rental House 2) Private Rental house 3) Private house
   4) Condominium 5) Informal squatters
5. Family size: _____ 1) Male _____ 2) Female _____
6. Marital Status: 1) Single 2) Married 3) Divorced 4) Widowed

7. Average monthly income (in birr)
   1) Less than 1000 2) 1000-2000 3) 2000-4000 4) 4000-6000
   5) 6000-8000 6) 8000-10,000 7) above 10,000
8. Occupation of household bread winner (Husband)
   1) Private sector 2) civil servant 3) Business man
   4) house wife 5) Retiree 6) Student 7) others
9. Occupation of household bread winner (Wife)
   1) Private sector 2) civil servant 3) Business man
   4) house wife 5) Retiree 6) Student 7) others

Part 2. Practice and challenges of composting solid waste

1. Are you aware of composting organic solid waste?
   1) Yes 0) No

2. Do you perform composting organic solid waste in your home or garden?
   1) Yes 0) No

3. If your answer to #2 was Yes, do you experienced any problem to prepare compost at your home garden or any place at your vicinity (multiple answer possible)
   1) Lack of a suitable place for composting
   2) Limited compostable (input) martials generated from the household to prepare compost
   3) Technical capacity problem
   4) Lack of plot (garden) to produce vegetable (crop) where I can apply the compost
   5) Problem of pathogens and odor in organic waste compost
   6) cultural and social factors (taboo) organic waste composting practices within different communities
   7) limited (low) income from sell of compost

4. Do you separate organic solid waste in your household?
   1) Yes 0) No

5. If yes to question #4, which martials you separate
   1) Decomposable from all non-decomposable materials
   2) We separate organic wastes from others

3) Separate plastic martials only
4) We separate in to 3 components, i.e., decomposable materials, iron scraps and plastic materials

6. Do you ever attained any training, education or information about composting organic solid waste?

1) Yes 0) No

7. If no to question #6, are you willing to get training about the practice and benefits of composting?

1)Yes 0) No

8. Are you aware that composting organic solid waste benefits to the environment?

1)Yes 0) No

9. Do you have a garden in your house?

1)Yes 0) No

10. If you answer Yes, #8. Do you use organic solid waste for gardening?

0) No.
1) Yes, I always use the organic solid waste in the soil.
2) Yes, I sometimes dump the organic solid waste on the soil.

11. How do you use the organic solid waste in your house?

1) I compost it and use it in the garden as fertilizer
2) I just dump the organic solid waste in the garden as it is
3) I don't use it

12. Do you think composting organic solid waste is important?

0) No 1) Yes

13. If the answer for the above question is yes, in your perception what is the importance?

1) reduce solid waste collected and improve the environmental sanitation
2) economic benefits
3) other (specify) _____

14. Do you think promoting organic waste composting is key to reducing environmental pollution?

0) No
1) Yes

2) I don't know

Part 3. challenges of organic waste composting

1. Have you faced any challenges while composting organic waste at home?

0) No 1) Yes

2. If yes, please specify the challenges you have faced:

1) Lack of knowledge on composting
2) Unpleasant odors
3) Pest control problems
4) Inadequate space for composting
5) Others (please specify)

_____

3. In your opinion, what are the benefits of composting organic waste at home?

1) Decreased landfill waste
2) Nutrient-rich soil for plants
3) Environmental protection
4) sell the compost to earn income
5) Others (please specify)

_____

4. Do you experience any of the following benefits from composting organic waste at home?

1) Improved soil quality of the garden
2) Increased my garden agriculture (vegetable) production and productivity
3) Reduced use of chemical fertilizers for my garden
4) Reduced household waste
5) Others (please specify)

_____

5. Do you think composting organic waste at home should be encouraged by the local government?

1) Yes 0) No

6. What kind of support or resources would be helpful for encouraging composting at the domestic level?

1) Support on reading materials on composting
2) Workshops or training sessions on composting
3) Financial incentives
4) Provision of composting equipment and tools
5) Others (please specify)

_____

7. What is the extent to which composting of organic solid waste is practiced by households?

1) Daily
2) Weekly
3) Monthly
4) Rarely
5) Never
6) Unsure

8. Do you face any issues with odor or pests when composting at home?

0) NO 1) YES

9. If your answer question #8 was yes, to what level do you manage them?

1) Low (I barely manage it)
2) Medium (to some extent)
3) High (I manage it very well)

10. In your opinion, what are the biggest challenges to implement widespread organic waste composting at the domestic level?

1) No resource available
2) No awareness of the need, just dump it with waste
3) I don't know
4) Lack of policy implementation

11. Are there changes or improvements in the current organic waste composting practices at domestic level?

1) Low
2) Medium
3) High

4) I don’t know

Part 4: Contribution of organic waste composting to urban agriculture

1. Do you think that compost help soil fertility?
   0) No 1) Yes
2. If yes to question 1, what benefit
   1) Improve soil fertility
   2) Improve soil workability (structure)
   3) Improve water retention ability of the soil
3. Do you think composting help urban agriculture?
   0) No 1) Yes
4. If yes to question # 3, what percentage does it currently contribute to urban agriculture?
   1) More than 50%
   2) Between 25%-50%
   3) Less than 25%
   4) I am not sure
5. Are there challenges associated with using compost in urban agriculture?
   0) NO 1) YES
6. If your answer to #5 is Yes to what extent do the challenges hinder the practice?
   1) Limits it completely
   2) Partially limits it
   3) Very small
   4) I am not sure
7. Do you know any examples of successful composting programs in Urban areas?
   0) NO 1) YES
8. Do you know policies or regulations exist that promote or hinder the use of compost in urban agriculture?
   0) NO 1) Yes
9. Do you think community composting initiatives benefit urban agriculture? and what are some examples of successful models?
   0) No 1) Yes
   Please mention the example

_____

_____

_____

_____

Part 4. Key Informant Interview and focus group discussion Question for MSE and Experts

Interview

1. What is your awareness about organic solid waste composting?
2. In your resident area, how is the practice of organic solid waste composting done?
3. What is your experience on places where organic solid waste is composted?
4. what is your perception on the composting of organic solid waste at households?
5. What is your challenge to compost organic solid waste?
6. Is there any support from Woreda to compost organic waste? If so to what supports and the level of the support?
7. What type of connection is there between Micro and Small Enterprise that practice composting and urban agriculture to create more income?
8. How do you evaluate (low, medium or low) the performance of Micro and Small Enterprise to participate in composting organic solid waste? Why?
9. Are you beneficial through supplying compost products to the communities, urban agriculture, farms?

Part 5. Key informant interview questions for experts (MSE working on composting)

Woreda_____

Name of MSE _____

Position of respondent _____

Challenges and opportunities of composting organic solid waste in Addis Ababa

1. What opportunities exist for improving the composting of organic waste in Addis Ababa?
2. What is the level of awareness among residents of Addis Ababa regarding composting and its benefits?

3. What are the potential health hazards associated with improper handling and management of composted waste in Addis Ababa?
4. How can public-private partnerships be leveraged to improve the composting of organic solid waste in Addis Ababa?

What are the challenges and opportunities of organic waste composting at the domestic level

1. Have you faced any challenges in composting organic waste at home? If yes, please elaborate on those challenges
2. Do you face any issues with odor or pests when composting at home? If so, how do you manage them?
3. In your opinion, what are the biggest challenges to implementing widespread organic waste composting at the domestic level?
4. What changes or improvements would you like to see in the current organic waste composting practices at the domestic level?

What is the extent to which the composting of organic solid waste is practiced by households?

1. What types of organic solid waste are most commonly composted by households?
2. What are the factors that influence households to participate in composting organic waste?
3. What are the socio-economic factors that influence a household's decision to compost organic waste?

The contribution of organic waste composting to urban agriculture

1. How can compost improve soil structure and fertility in urban agriculture?
2. What are some challenges associated with using compost in urban agriculture, and how can these challenges be overcome?
3. What are some examples of successful composting programs in urban areas, and what can we learn from these examples?
4. What policies or regulations exist that promote or hinder the use of compost in urban agriculture?

5. How can community composting initiatives benefit urban agriculture, and what are some examples of successful models?

What are the implications of organic waste composting on the environment?

1. What are the potential risks associated with the presence of pathogens in organic waste compost and how can they be mitigated?
2. How do cultural and social factors impact the adoption and acceptance of organic waste composting practices within different communities?
3. How does the availability of organic waste composting services impact community participation and engagement in sustainability practices?
4. What are the economic implications of diverting organic waste from landfills and the potential for cost savings through composting?

Thank you for your participation!

Annex B

(Amharic Version survey questionnaire)

በአዲስ አበባ ዩኒቨርሲቲ

መካነ-ጥናት ኮሌጅ

የአካባቢና ዘላቂ ልማት ፕሮግራም

የተከበራችሁ ተሳታፊዎች፡-

ኢየሩሳሌም ደገፉ እባላለሁ፡፡በአዲስ አበባ ዩኒቨርሲቲ መካነ-ጥናት ኮሌጅ የአካባቢና ዘላቂ ልማት ፕሮግራም የድህረምረቃ ተማሪ ነኝ፡፡ይህ መጠይቅ የተዘጋጀው “በአዲስአበባ ከተማ የደረቅ ቆሻሻ ለማዳበሪያ መጠቀም ተግዳሮቶች እና እድሎች” በሚል ርዕስ ለምርምር ዓላማ በመሆኑ መጠይቁን በመሙላት እንድትተባበሩኝ በአክብሮት እየጠየቅኩኝ የሚሰጡኝን መረጃዎች ለትምህርት ዓላማ ብቻ እንደሚውል እና ምላሽዎም ምስጢራዊ እንደሚሆን አረጋግጣለሁ፡፡

ለሚኖርዎት ጥያቄዎች ፡-

ኢሜይል፡-**eyerusalem.ds@gmail.com**

ሞባይል ቁጥር: 0911616287

ክፍል አንድ ፡-የተሳታፊው ግለ ታሪክ

የሚከተሉትን መጠይቆች ካነበቡ በኋላ ከተሰጡት አማራጮች መልሰዎን በማክበብ ይምረጡ፡፡

1. የተሳታፊው ፆታ 1) ወንድ 2) ሴት
2. እድሜ ----------(ባዶ ቦታ ላይ በአሃዝ ያስቀምጡት)
3. የትምህርት ደረጃ
    1) መሰረተ ትም/ት ወይም ጎልማሶች ት/ት
    2) ከ1-4 ኛ ክፍል
    3) ከ5-8ኛ ክፍል
    4) ከ9- 12ኛ ክፍል
    5) ሰርተፊኬት
    6) ዲፕሎማ
    7) የመጀመሪያ ዲግሪ
    8) 2ኛ ዲግሪና ከዚያ በላይ
4. የትዳር ሁኔታ

    1) ያላገባ/ች 2) ያገባ/ች 3) የተፋታ/ች 4) በሞት የተለዩ
5. ወረሃዊ የገቢ መጠን----------ብር (ወርሃዊ የገቢ መጠን በሚለው ባዶ ቦታ ላይ በአሃዝ ያስቀምጡት)
6. የአባወራው/የእማወራዋ ስራ ሁኔታ
    1) በራስ አገዝ የሚተዳደር/የምትተዳደር
    2) የግል ድርጅት ተቀጣሪ

3) የቤት እመቤት

4) የመንግስት ሰራተኛ

5) ጡረተኛ

6) ተማሪ

7) ሌላ

7. የቤተሰብ ብዛት----------(የቤተሰብ ብዛት በሚለው ባዶ ቦታ ላይ በአሃዝ ያስቀምጡት)

8. የመኖሪያ ቤት ሁኔታ

1) የመንግስት ቤት ተከራይ

2) የግለሰብ ቤት ተከራይ

3) የግል/የራስ ቤት

ክፍል ሁለት ኦርጋኒክ ደረቅ ቆሻሻ በማፈግ የማቆየት ልምምድ

1. የኦርጋኒክ ደረቅ ቆሻሻ በማፈግ የማቆየትና ለማዳበሪያ የማዘጋጀት ግንዛቤ አለዎት?

ነ) አዎ 2) ግንዛቤ የለኝም

2. በቤትዎ ወይም በአትክልት ቦታዎ ኦርጋኒክ ደረቅ ቆሻሻ በማፈግ ለማዳበሪያ የማዘጋጀት ሥራ ይፈጽማሉ?

ነ) አዎ 2) የማዘጋጀት ሰራ አልፈጽምም

3. ለ2ተኛው ጥያቄ መልስዎ አዎን ከሆነ ኦርጋኒክ ደረቅ ቆሻሻ ለማዳበሪያ የማፈግ ስራ በቤትዎ አትክልት ስፍራ ወይም በአካባቢዎ ሲያዘጋጁ ያጋጠመዎት ችግር ነበርን?

ነ) ኦርጋኒክ ደረቅ ቆሻሻ በማፈግ ለማዳበሪያ ለማዘጋጀት ምቹ ስፍራ እጦት

2) ውስን ደረቅ ኦርጋኒክ ቆሻሻ ከየቤቱ መሰብሰቡ

3) የቴክኒካል እውቀት ማነስ

4) የተዘጋጀውን የቆሻሻ ማዳበሪያ መጠቀሚያ ማጣት

5) በደረቅኦርጋኒክ ቆሻሻ በማፈግ ለማዳበሪያ በማዘጋጀት ወቅት መጥፎ ሽታ መኖር

6) ኦርጋኒክ ደረቅ ቆሻሻ በማፈግ ለማዳበሪያ የማዘጋጀት ተግባር በማህበረሰቡ ባህላዊ አስተሳሰብ እንደነውር መቆጠሩ

7) የኦርጋኒክ ደረቅ ቆሻሻ በማፈግ የተዘጋጀ የአፈር ማዳበሪያ ሽያጭ ዋጋው ዝቅተኛ ና ርካሽ መሆኑ

4. በቤትዎ ውስጥ የኦርጋኒክ ደረቅ ቆሻሻን ከሌላው በመለየት ያስቀምጣሉ?

ነ) አዎ 2) በመለየት አላስቀምጥም

5. ለ4ኛው ጥያቄ መልስዎ አዎ ከሆነ የትኛውን ይለያሉ

ነ) በማፈግ ለማዳበሪያነት የሚውሉና የማይውሉ ደረቅ ቆሻሻዎች

2) ኦርጋኒክ ደረቅ ቆሻሻዎችን ከሌላ እንለያለን

3) ፕላስቲክ ነክ ቆሻሻዎችን ብቻ እንለያለን

4) ብረታብረት ነክ፤ፕላስቲክ ነገሮች፤ኦርጋኒክ ደረቅ ቆሻሻዎችን ለየብቻ እንለያለን

6. ኦርጋኒክ ደረቅ ቆሻሻ በማፈግ ለማዳበሪያ ማዘጋጀትን በተመለከተ ትምህርታዊ ስልጠና ወይም ግንዛቤ ማስጨበጫ ተሳትፈው ያውቃሉን?

ነ) አዎ 2) ምንም አልተሳተፍኩም

7. ለ6ኛው ጥያቄ መልስዎ አልሳተፍኩም ከሆነ ስለኦርጋኒክ ደረቅ ቆሻሻ በማፈግ ለማዳበሪያነት የማዘጋጅት ተግባራት ልምድና ጥቅም ስልጠና ለመሳተፍ ፈቃደኛ ነዎትን?

ነ) አዎ 2) ፈቃደኛ አይደለሁም

8. ኦርጋኒክ ደረቅ ቆሻሻ በማፈግ ለማዳበሪያ ጥቅም ማዘጋጅት ለአካባቢ ጤናማ የአየር ሁኔታ ጠቃሚ ስለመሆኑ ያውቃሉ?

ነ) አዎ 2) አላውቅም

9. በመኖሪያ ቤትዎ የአትክልት ስፍራ አለዎትን?

ነ) አዎ 2) የለኝም

10. ለ9ኛው ጥያቄ መልስዎ አዎ ከሆነ ለቤትዎ አትክልት ስፍራ ለማዳበሪያነት በማፈግ የተዘጋጀ ኦርጋኒክ ደረቅ ቆሻሻ ይጠቀማሉን?

ነ) አልጠቀምም

2) አዎ ሁልጊዜ ደረቅ ቆሻሻን በማፈግ ለማዳበሪያነት ለአትክልት ስፍራዬ እጠቀማለሁ

3) አዎ አንዳንድ ጊዜ ኦርጋኒክ ደረቅ ቆሻሻ አፈር ውስጥ እንዲበሰብስ በማድረግ እጠቀማለሁ

11. በቤትዎ ውስጥ የኦርጋኒክ ደረቅ ቆሻሻን ለማዳበሪያነት እንዴት ይጠቀማሉ?

ነ) ኦርጋኒክ ደረቅ ቆሻሻ በማፈግ ለማዳበሪያነት በማዘጋጅት በአትክልት ስፍራ እጠቀማለሁ

2) ኦርጋኒክ ደረቅ ቆሻሻን በአትክልት ውስጥ ዝም ብሎ በመጨመር እጠቀማለሁ

3) ምንም አልጠቀምም

12. ኦርጋኒክ ደረቅ ቆሻሻ በማፈግ ለማዳበሪያነት ማዘጋጅት እጅግ አስፈላጊ ነው ብለው ያስባሉ?

ነ) አዎ 2) እጅግ አስፈላጊ አይመስለኝም

13. ለ12ኛው ጥያቄ መልስዎ አዎ ከሆነ በእርስዎ መረዳት አስፈላጊነቱ ምንድን ነው?

ነ) የሚሰበሰበውን ኦርጋኒክ ደረቅ ቆሻሻ በመቀነስ የአካባቢ የአየር ሁኔታ ማሻሻል

2) ኢኮኖሚያዊ ጥቅሞች

3) ሌላ ካለ ይግለጹልን_____

_____

_____

14. የአየርንብረት ብክለትን ለመቀነስ ኦርጋኒክ ደረቅ ቆሻሻን ለማዳበሪያነት በማፈግ ማዘጋጅትን ማስፋት ቁልፍ ጉዳይ ነው ብለው ያስባሉ

ነ) አዎ 2) ቁልፍ ጉዳይ ነው ብዬ አላስብም 3) አላውቅም

ክፍል ሶስት ኦርጋኒክ ደረቅ ቆሻሻ በማፈግ ለማዳበሪያነት የማዘጋጅት ተግዳሮቶች እና መልካም እድሎች

1. ኦርጋኒክ ደረቅ ቆሻሻ በማፈግ ለማዳበሪያነት በቤትዎ ሲያዘጋጁ ተግዳሮቶች ገጥመዎት ያውቃልን?

ነ) አዎ 2) አጋጥሞኝ አያውቅም

2. ለነኛው ጥያቄ መልስዎ አዎ ከሆነ እባክዎ ያጋጠሞትን ችግሮች ይግለጹልን?

1) ስለኦርጋኒክ ደረቅ ቆሻሻ ማፈግ እና የማዳበሪያ ዝግጅት እውቀት ማነስ
2) የማያስደስት ከፍተኛ መጥፎ ሽታ መኖሩ
3) የተለያዩ ተባዮችን የማጥፊያ እና መከላከያ ችግር
4) ኦርጋኒክ ደረቅ ቆሻሻን በማፈግ ለማዘጋጀት በቂ ቦታ አለመኖር
5) ልሎች ካሉ እባክዎን ይግለጹልን _____

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3. በእርስዎ አስተሳሰብ በቤትዎ ውስጥ ኦርጋኒክ ደረቅ ቆሻሻ በማፈግ ለማዳበሪያነት የማዘጋጀት ስራ ጥቅሙ ምንድን ነው?

1) አካባቢ የሚያቆሽሸውን የደረቅ ቆሻሻ ክምችት ይቀንሳል
2) በአካባቢ በማዕድን የዳበረ አፈር በቀላሉ ያስገኛል
3) የአካባቢአየር ጥበቃ ይሰጣል
4) ለማዳበሪያ የሚሆን አፈር በመሸጥ ገቢ ያስገኛል
5) ልሎች ጥቅሞች ካሉ እባክዎን ይግለጹልን_____

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4. ኦርጋኒክ ደረቅ ቆሻሻ በማፈግ ለማዳበሪያነት በቤትዎ ውስጥ በማዘጋጀትዎ የሚከተሉትን ጥቅሞች አግኝተዋልን?
   1) በአትክልት ስፍራዎ የተሻለ የዳበረ አፈር
   2) የአትክልት ምርት መጨመርና ልማት መሻሻል
   3) ለማንኛውም አትክልት የኬሚካል ማዳበሪያ መቀነስ
   4) ከቤት የሚወጣውን ኦርጋኒክ ደረቅ ቆሻሻ መቀነስ
   5) ሌላ ሃሳብ ካለዎት እባክዎን ይጥቀሱ _____

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5. የቤትዎ ውስጥ ኦርጋኒክ ደረቅ ቆሻሻ በማፈግ ለማዳበሪያነት መጠቀም በአካባቢው የመንግስት አካላት ማበረታታት አስፈላጊ ነው ብለው ያስባሉ?
   1) አዎ 2) አስፈላጊ አይደለም
6. በቤትዎ ውስጥ ኦርጋኒክ ደረቅ ቆሻሻ በማፈግ ለማዳበሪያነት የማዘጋጀት ሥራን በሚመለከት ከአካባቢ መንግስታዊ አካላት በምን ዓይነት ድጋፍና አቅርቦት መርዳት ይቻላል ብለው ያስባሉ?
   1) በጉዳዩ ላይ እውቀት የሚስጡ የጥበብ ጽሁፎችን መረዳት

2) በኦርጋኒክ የደረቅ ቆሻሻ ማፈግና ለማዳበሪያ ዝግጅት አስፈላጊ የሆኑ የአውደ ጥናቶችና ስልጠናዎችን ማዘጋጀት
3) እንደአስፈላጊነቱ በገንዘብ ድጋፍ ማነቃቃት
4) የኦርጋኒክ ደረቅ ቆሻሻ ማፈግና ለማዳበሪያነት የማዘጋጀት ሥራን የሚረዱ ቁሳቁሶችና መሳሪያዎች አቅርቦት ማድረግ
5) ሌሎች ተጨማሪ ካሉ ይጥቀሱልን_____

7. በቤትዎ ውስጥ የኦርጋኒክ ደረቅ ቆሻሻን በማፈግ ለአፈር ማዳበሪያ የማዘጋጀት ሥራ በምን ያህል ጊዜ ይዘጋጃል ብለው ያስባሉ?
   1) በየቀኑ 2) በየሳምንቱ 3) በየወሩ 4) በጣም አንዳንዴ 5) በፍጹም ማዘጋጀት አይቻልም 6) እርግጠኛ አይደለሁም
8. በቤትዎ ውስጥ የኦርጋኒክ ደረቅ ቆሻሻን በማፈግ ለማዳበሪያ ዝግጅት በሚያደርጉበት ጊዜ የከፍተኛ ሽታ ወይም የተባዮች ችግር አጋጥምዎታልን?
   1) አዎ 2) አስፈላጊ አይደለም
9. ለ8ኛው ጥያቄ መልስዎ አዎ ከሆነ ሁኔታውን እንዴት መቆጣጠርና ማስተካከል ቻሉ?
   1) በጣም በዝቅተኛ ደረጃ ችግሩን ማቃለል ችያለሁ
   2) በመካከለኛ ደረጃ ችግሩን ማስተካከል ችያለሁ
   3) በከፍተኛና በጥሩ ሁኔታ ችግሩን ማስተካከል ችያለሁ
10. በእርስዎ አስተሳሰብ (በከተማ ውስጥ) በመኖሪያ ቤት አካባቢ የኦርጋኒክ ደረቅ ቆሻሻን በማፈግ ለአፈር ማዳበሪያ የማዘጋጀት ና የማስፋፋት ሥራ ከፍተኛ ተግዳሮት ወይም ችግር ምንድ ነው?
    1) ለሥራው የሚያስፈልጉ አቅርቦት ችግር
    2) ስለአስፈላጊነቱ በቂ እውቀት አለመኖርና ከሌላ ቆሻሻ ጋር ማስወገድ
    3) አላውቅም
    4) የአመራርና አፈጻጸም ጉድለት ወይም እጦት
11. በመኖሪያ ቤት አካባቢ ኦርጋኒክ ደረቅ ቆሻሻን የማፈግና ለማዳበሪያነት የማዘጋጀት ሥራዎችና ልምምዶች ለውጥና መሻሻል በምን ደረጃ እየታየነው?
    1) በዝቅተኛ ደረጃ 2) በመካከለኛ ደረጃ 3) በከፍተኛ ደረጃ 4) አላውቅም

ክፍል አራት ኦርጋኒክ ደረቅ ቆሻሻን በማፈግ ለማዳበሪያነት የማዘጋጅት ልምድ ለከተማ ግብርና ያለው አስተዋጻኦ

ı. የኦርጋኒክ ደረቅ ቆሻሻን በማፈግ የማዘጋጅት ልምድ አፈር ለማዳበር ይረዳል ብለው ያስባሉን?
   1) አዎ 2) ይረዳል ብዬ አላስብም
2. ለıኛው ጥያቄ መልስዎ አዎን ከሆነ በምን ይጠቅማል?
   1) የአፈርን ማዳበር ያሻሽላል

2) የአፈርን ለሥራ ምቹነት ያሻሽላል

3) የአፈርን ውሃ የመያዝ ሁኔታ ያሻሽላል

3. የኦርጋኒክ ደረቅ ቆሻሻን በማፈግ ለአፈር ማዳበርያነት ማዘጋጅት ለከተማ ግብርና ይረዳል ብለው ያስባሉ?

   1) አዎ 2) ይረዳል ብዬ አላስብም

4. ለ3ኛው ጥያቄ መልስዎ አዎን ከሆነ በምን ያህል ፐርሰንት ለከተማ ግብርና አስተዋጽኦ ያደርጋል?

   1) ከ50% በላይ 2) በ25%እና በ50% መካከል 3) ከ25% በታች 4) እርግጠኛ አይደለሁም

5. በከተማ ግብርና የኦርጋኒክ ደረቅ ቆሻሻን በማፈግ ለማዳበሪያነት የተዘጋጀውን መጠቀም በተያያዘ ችግሮች አሉን?

   1) አዎ 2) የለም

6. ለ5ኛው ጥያቄ መልስዎ አዎን ከሆነ እስከምን ድረስ ችግሩ የመጠቀም ልምምዱን ያግዳል ወይም ይከለክላል?

   1) ሙሉ በሙሉ ያግደዋል 2) በከፊል ያግደዋል 3) በጣም በትንሹ ያግደዋል 4) እርግጠኛ አይደለሁም

7. በከተማ አካባቢ ውጤታማ ምሳሌነት ያለው የኦርጋኒክ ደረቅ ቆሻሻን በማፈግ ለአፈር ማዳበሪያነት የማዘጋጀት ሥራ ፕሮግራም ያውቃሉ

   1) አዎ 2) አላውቅም

8. በከተማ ግብርና ዙሪያ ይህንን ጉዳይ የሚያነቃቃ ወይም የሚካላከል መማሪያና ደንብ መኖሩን ያውቃሉ?

   1) አዎ 2) አላውቅም

9. የኦርጋኒክ ደረቅ ቆሻሻ በማፈግ ለአፈር ማዳበሪያነት የማዘጋጀት ሥራ በማህበረሰባዊ ማነሳሻዎች ለከተማ ግብርና ይጠቅማል ብለው ያስባሉን? ውጤታማ የሆኑ ሞዴሌች ምንድን ናችው?

   1) አዎ 2) አላስብም

   እባክዎ ምሳሌዎች ይጥቀሱ _____

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ክፍል አምስት ለቃለ መጠይቅ ቁልፍ ሰው ጥያቄዎችና የቡድን ውይይት ጥያቄዎች

1. ኦርጋኒክ ደረቅ ቆሻሻ በማፈግ ለአፈር ማዳበሪያነት የማዘጋጀት ሥራ በተመለከተ ምን ያህል ያውቃሉ ?
2. በእርስዎ መኖሪያ አካባቢ የደረቅ ቆሻሻ በማፈግ ለአፈር ማዳበሪያነት የማዘጋጀት ልምድ ይሰራበታል?
3. ኦርጋኒክ ደረቅ ቆሻሻ ማፈግ ና ለአፈር ማዳበሪያነት በሚዘጋጁበት ሥፍራዎች ዙሪያ የእርስዎ ልምድ ምን ይመስላል?
4. በቤት አካባቢ የኦርጋኒክ ደረቅ ቆሻሻ በማፈግ ለአፈር ማዳበሪያነት የማዘጋጅት ሥራ በተመለከተ መረዳትዎ ምንድነው?

5. በኦርጋኒክ ደረቅ ቆሻሻ የማፈግ ና ለአፈር ማዳበሪያን በማዘጋጀት ዙሪያ የእርሶ ተግዳሮት ወይም ችግር ምንድነው?
6. በኦርጋኒክ ደረቅ ቆሻሻ የማፈግ ና ለአፈር ማዳበሪያን በማዘጋጀት ዙሪያ ከወረዳ ድጋፍ አለ? ካለ በምን ያህል ደረጃ ድጋፍ ይገኛል?
7. በዚሁ ጉዳይ በማይክሮ እና ትናንሽ ኢንተርፕራይዝ በተደራጁት እና በከተማ ግብርና ባሉት መካከል የተጨማሪ ገቢ ማስገኛ ግንኙነት በምን መልክ ተፈጥሮአል?
8. በኦርጋኒክ ደረቅ ቆሻሻ የማፈግ ና ለአፈር ማዳበሪያን በማዘጋጀት በኩል በማይክሮ እና ትናንሽ ኢንተርፕራይዝ አደረጃጀቶች ያለውን ተሳትፎ እንዴት ይገመግሙታል?(ከፍተኛ፤ መካከለኛ፤ ዝቅተኛ) ለምን?
9. ከከተማ ግብርና እና ለማህበረሰቡ በሚደረገው የኦርጋኒክ ደረቅ ቆሻሻ ማፈግ እና ለአፈር ማዳበሪያነት ከሚዘጋጀው አቅርቦት እርስዎ ተጠቃሚ ነዎትን?