Crop Production -Level-IV

Based on March 2018, Version 3 Occupational standards

Module Title: - Planning composting production plan

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LG #34	LO #1- Establish production requirements

Instruction sheet-1

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- **Reviewing raw material supply contracts and receivable data**
- **Identifying Conditions for production requirements.**
- **Estimating Production requirements.**
- **Monitoring environmental *and* occupational health and safety (OHS) impacts**
- **Documenting and submitting production plan**
- **Confirming facilities, personnel, machinery and equipment**
- **Developing and documenting contingency plan**

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Review raw material supply contracts and receivable data,
- Identify Conditions that may affect production requirements.
- Estimate Production requirements
- Monitor environmental *and* occupational health and safety (OHS) impacts
- Document and submit production plan
- Confirm facilities, personnel, machinery and equipment
- Develop and document contingency plan

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

1.1 INTRODUCTION

Compost and composting

Compost is the aerobically decomposed remnants of organic materials (those with plant and animal origins). Compost is used in gardening and agriculture as a soil amendment, and commercially by the landscaping and container nursery industries. It is also used for erosion control, land/stream reclamation, wetland construction, and as landfill cover. Compost is also used as a seed starting medium generally mixed with a small portion of sand for improved drainage.

Composting is the process of producing compost through aerobic decomposition of biodegradable organic matter. The decomposition is performed primarily by aerobes, although larger creatures such as ants, nematodes, and oligochaete worms also contribute**.**

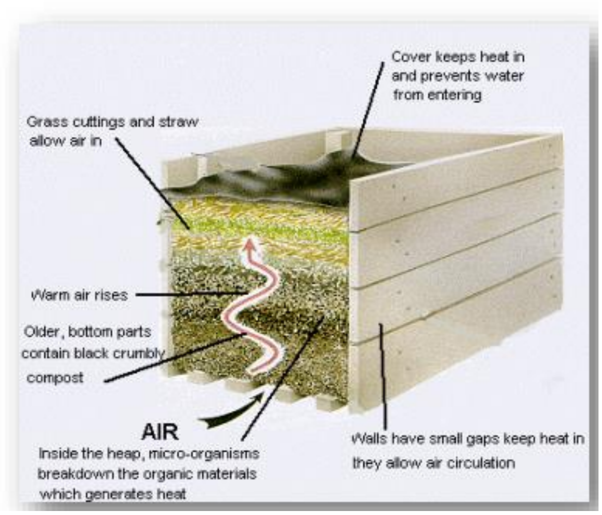

Figure1.1. compost and composting

1.2. Importance of compost

- Reduces waste stream **(**Yard and food scraps = 30% of landfill)
- Improves soil structure
- Retains moisture, slows run-off from rain
- Reduces need for fertilizer

Figure 1.2 Wastes

- Enlarge the air spaces in the soil, improving its permeability for air and water circulation
- Enhances and improves the soil texture
- Lowers the degree of pH
- Helps to retain moisture
- Adds nutrients and trace materials to the soil, stimulating biological activity and encouraging vigorous plant rooting systems
- Helps to bind nutrients, preventing them from being leached out of the soil
- Reduces soil erosion
- Reduces emission of methane (a greenhouse gas)

Benefits of Compost to the environment and agriculture

Environment

- Water and soil conservation.
- Protects groundwater quality.
- Minimizes odors from agricultural areas.

- Avoids methane production and leachate formation in landfills by diverting organics from landfills into compost.
- Prevents erosion and turf loss on roadsides, hillsides, playing fields and golf courses.
- Drastically reduces the need for pesticides and fertilizers.
- Binds heavy metals and prevents them from migrating to water resources, being absorbed by plants, or being bioavailable to humans.
- Off-farm materials can be brought in and added to manure to make compost.
- Facilitates reforestation, wetlands restoration, and wildlife habitat revitalization efforts by amending contaminated, compacted and marginal soils.
- Off-farm materials can be brought in and added to manure to make compost.
- Composted manure weights about one-fourth as much as raw manure per ton.

Agriculture

- Long-term stable organic matter source.
- Buffers soil pH levels.
- Adds organic matter, humus and cation exchange capacity to regenerate poor soils.
- Suppresses certain plant diseases and parasites and kills weed seeds.
- Increases yield and size in some crops.
- Increases length and concentration of roots in some crops.
- Increases soil nutrient content and water holding capacity of sandy soils and water infiltration of clay soils.
- Reduces fertilizer requirements.
- Restores soil structure after natural soil microorganisms have been reduced by the use of chemical fertilizers; compost is a soil innoculant.
- Increases earthworm populations in soil.
- Provides slow, gradual release of nutrients, reducing loss from contaminated soils.
- Reduces water requirements and irrigation.
- Provides opportunity for extra income; high quality compost can be sold at a premium price in established markets.
- Moves manure to non-traditional markets that do not exist for raw manture.

- Brings higher prices for organically grown crops.
- Minimizes odors from agricultural areas.

1.3. Raw materials for composting

- Animal mortalities
- Bio-solids such as sewage sludge
- Crop residuals
- Dairy waste
- Poultry dropping
- Fats and oils
- Food organics such as:
  - food waste
  - kitchen waste
  - food processing waste
  - forestry residuals
  - manures
  - organic sludges
  - other organic waste or by-product of processing
  - paper mill wastes
- Paper-based materials
- Agro-industry by-products
- Plant materials such as:
  - garden organics
  - green organics
  - green waste
  - yard waste
  - sawdust and wood shavings
  - sewage facility grit and screenings
  - Wood and timber (non-treated).
- Vermi-worm
- Soil materials

- Shading materials

rickshaw

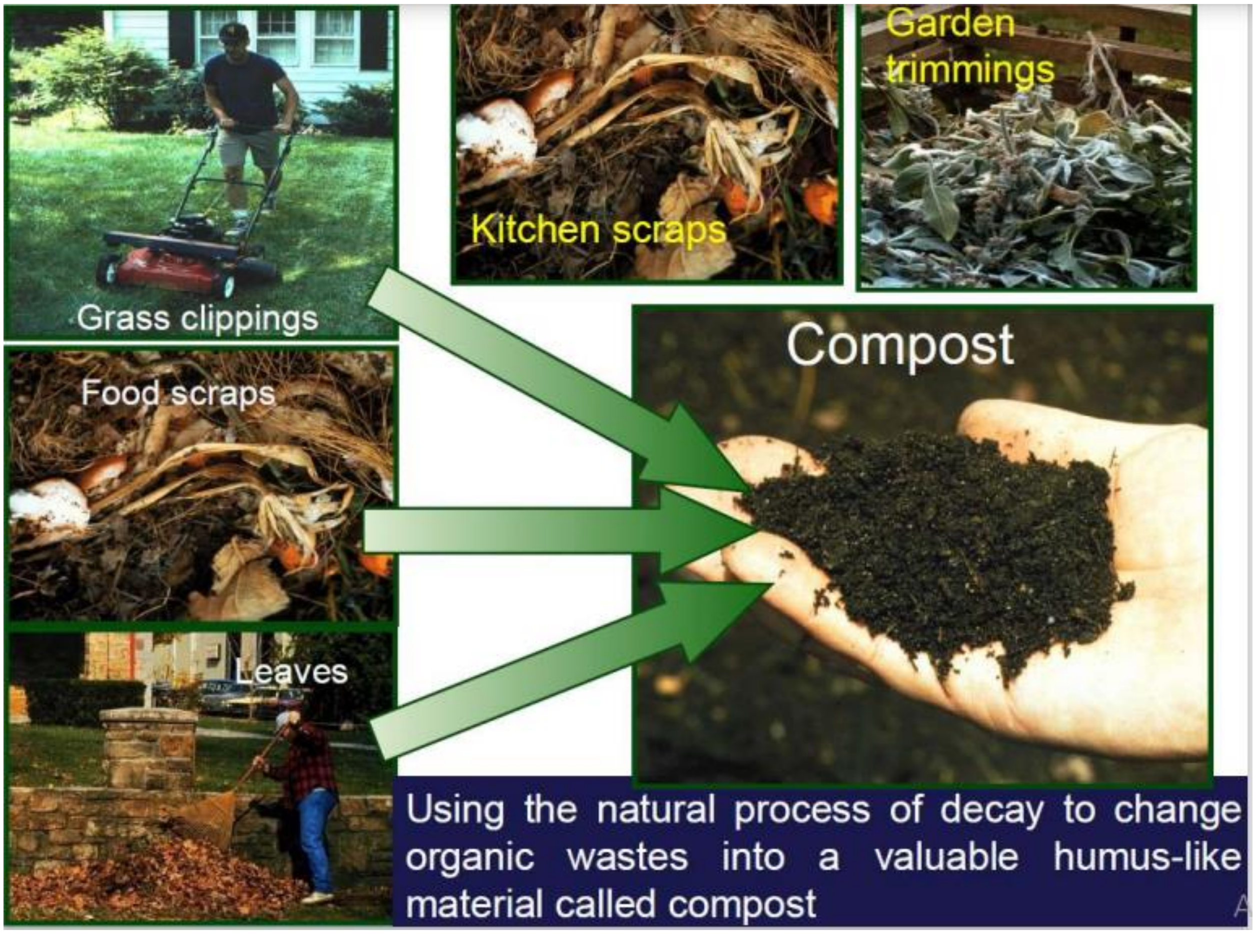

Figure1.2. compost raw materials

1.3. Reviewing raw materials

Source-separated incoming waste after collection from households and markets must be weighed using manual or electronic digital weighing machines. Usually vans or trucks loaded with waste enter the gate and unload the waste in the unloading platform of the compost plant. Depending on the size of the plant weigh bridge, capacity can be from 250-500 kg. During this step, incoming waste can be weighed using 50-100 litre buckets or baskets. Plant operators should note the numbers of the licence plates and register them as incoming weight. It should be noted that keeping a record of incoming waste in a compost plant is required in order to claim in carbon trading as well as important in running the business. The important requirements are that both waste delivery and residual collection is regular and that waste is delivered in a fresh condition.

Figure1.4 Waste collection and weighing

Compost quality is mainly determined by the quality of the input material. Hence, the sorting of the waste plays a vital role. Substances which are not biodegradable need to be separated from the biodegradable fraction. Sorting is especially crucial with regard to hazardous materials. These must be removed before they are loaded in the compost box, or they will contaminate the entire pile and severely compromise the final compost quality

If households are willing to segregate their waste at source, it saves a tremendous amount of time and costs for the composting scheme. Moreover, it increases the quality of both biodegradable waste and recyclables. Hence, the long term goal should be the introduction of source-segregation of waste in households.

Figure 1.5 Sorting of incoming mixed household waste

Table1.1 Waste separation prior to composting

Incoming Domestic Waste			
Suitable for composting	Not suitable for composting		
Biodegradable materials: **Garden waste** • Leaves and grass • Twigs **Food waste** • Vegetables & fruit waste • Leftover bread **Others** • Scrap paper/ cardboard • Straw • Meat (with limitations) etc.	**Hazardous materials** • Cleaning products • Automotive products • Pesticides, chemicals and inflammable products • Used razor blades • Syringes • Broken glass • Screws and nails • Expired medicines, • Batteries • Treated timber etc.	**Residues** • Soiled polythene • Hard leaves • Tree branches • Coconut shells • Bones • Painted wood, Boards etc.	**Recyclables** • Metal • Aluminum • Cardboard • Paper • Plastic scraps • Glass
Composting Process	Transport to Landfill Site		Sell to Recycling Industry

Main technical methods of large-scale composting

Agitated

- Periodic agitation to introduce oxygen, control the temperature and mix the material to obtain uniform product
- Composting period is about 21 – 28 days
- e.g. windrow method

Figure1.6. Composting in rows (agitated by machine), with organic solid waste as a substrate

Static

Air is blown through the static composting material, composting period of 21-28 days, and > 30 days for curing period

- e.g. aerated static pile method

Figure 1.7 Static pile composting

In many countries (rich and poor alike), the process of composting kitchen waste is widely practiced. But not many people add human excreta to their compost heap, even though this would be possible

In-vessel composting systems: Composting is accomplished inside an enclosed container or vessel

Composting of toilet and kitchen waste (outside)

Figure 1.8. Compost vessel with lid and Worm culture, 24 hours active

Composting Methods

Passive composting or piling (Figure 1.9) is simply stacking the materials and letting them decompose naturally. This method is simple and low cost but is very slow and may result in objectionable odors.

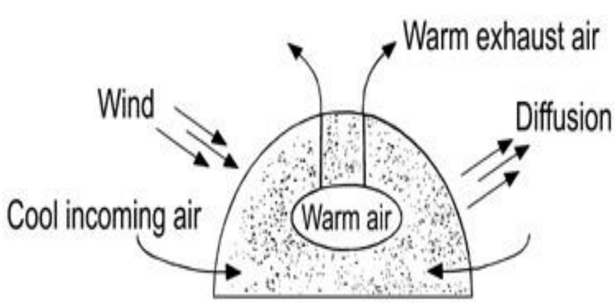

Figure 1.9 Passive composting, or piling.

In **Aerated static piles** air is introduced to the stacked pile via perforated pipes and blowers. This method requires no labor to turn compost but is weather sensitive, and can have unreliable pathogen reduction due to imperfect mixing.

Figure 1.10 Aerated static piles.

Windrows are long, narrow piles that are turned when required based on temperature and oxygen requirements. This method produces a uniform product and can be remotely located. However, turning the compost can be labor intensive or require expensive equipment. Windrows are typically used for large volumes which can require a lot of space. In addition, windrows can have odor problems, and have leachate concerns if exposed to rainfall.

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Figure 1.11 Windrows

Bins

using wire mesh or wooden frames allow good air circulation, are inexpensive, and require little labor. Three chamber bins allow for faster compost production utilizing varying stages of decomposition. Bin composting is typically used for small amounts of food waste.

This three-bin system can handle significant quantities of materials. It also allows staged composting, by using one section for storing compostable materials, one section for active composting, and one section for curing or finished compost. Note: You can use discarded wooden pallets instead of new wood to make a three-bin system.

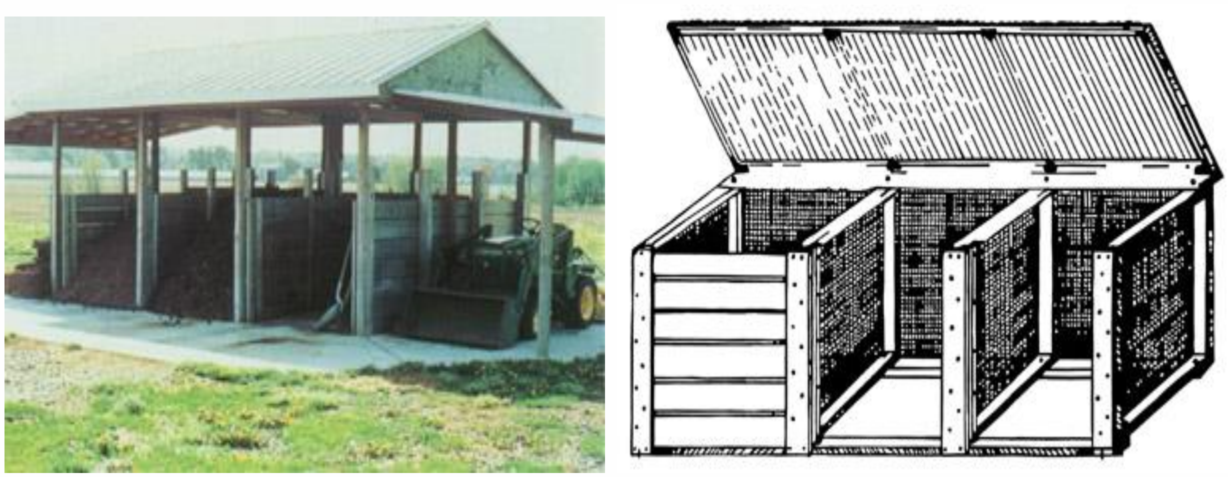


Figure 1.12 Bins.

In-vessel systems using perforated barrels, drums, or specially manufactured containers are simple to use, easy to turn, require minimal labor, are not weather sensitive, and can be used in urban and public areas. The initial investment can be high and handling volumes are typically low.

Figure 1.13 In-vessel systems

Vermi composting

Uses worms to consume the food waste and utilizes its castings as high quality compost. This is usually done in containers, bins, or greenhouses. Typically 1 pound of worms can eat 4 pounds waste per week. Many schools use this type of composting as an environmental education tool. Worm castings bring a premium price but the investment in worm stocking may be high depending on the size of the operation. If too much waste is added anaerobic conditions may occur. In addition, worms cannot process meat products.

Table 1.2 Types of Composting Technologies

Type of Composting	Scale	Concerns	Resources required
On-site Composting Composting on premises using either a bin or a pit in the soil	Small	Odor control and vermin	Either a pit or bin
Vermicomposting Composting in bins where worms process organic materials	Small	Sensitive to temperature changes	Worm bins, worms
Aerated Windrow Composting Composting outside with organic materials structured in rows and regularly turned/aerated	Large	Siting requirements, zoning, regulatory enforcement (i.e., contaminant runoff), odor	Land, equipment, continual supply of labor
Aerated Static Pile Composting Composting with static piles of organic materials that are aerated internally with blowers	Large	Siting requirements, zoning, regulatory enforcement (i.e., contaminant runoff), odor	Land, significant financial resources, equipment including blowers, pipes, sensors and fans
In-Vessel Composting Composting via a mechanized machine that processes organic materials and then requires compost to mature outside the machine for two weeks	Medium	Consistent power necessary, financially intensive, technical expertise necessary	Electricity, skilled labor, ongoing financial resources, small facility/land

Main indicators for composting process failure

- Odour
- No temperature rise in compost heap (or only small increase in Operating
- costs for semi-centralised composting processestemperature)
- It depends on the composting technology used and the scale of the process
- In developing countries it may cost only € 15 per ton of input material

Composting cannot be financed by sale of product alone (in most cases) but mostly via a waste disposal fee

1.5. Compost types and effects on plants

Fresh compost or immatured compost: this compost is not yet utilisable by the plants but can easily work it in the top layer of the soil as mulch.

Matured compost is compost that can be utilised by plants. This compost does not have to be soil-like, it can still contain partially-composted parts of plants (or organic matter). Matured compost is rich in soil organisms which can accelerate the decomposition process, and they do not harm the soil or plants.

Complete compost is compost where the decomposition process is totally complete - it ist often called "compost soil". This is the so-called commercial compost - it is less relevant for enriching the soil life (soil microorganisms); often it is amended with nutrients to also have a specific fertilising effect.

1.6. Sales and market trend

1.6.1. Potential customers and competitors

Potential customers must either show a need or a want (or both) for compost, including the ability and willingness to pay for it. A few important questions should be asked to find the market, such as:

- Where could compost potentially be used and for what purposes?

- Who are your potential customer groups and what are their different needs?
- What are the potential quantities each customer group would require (potential market demand)?
- What is the ability and willingness to pay of your potential customers?

1.6.2. Knowing your competitors

In addition to knowing your customers, you must also be informed about your competitors and the competing products on the market. Familiarize yourself with the characteristics of the competing products (quality, price, etc.), the methods used by competitors to sell their products and reasons why customers buy their products.

- It will help you understand not only the needs of your potential customers but also how to establish your marketing plan.

Typical competing products for compost are:

- Fertile soils mined and transported to the end user (peat, red soil, etc.);
- Chemical fertilizers;
- Animal waste (chicken manure, cow dung, etc.);
- Raw municipal refuse;
- Human faecal sludge (from pit latrines and septic tanks) and wastewater sludge;
- Nutrient-rich wastes from industrial processing (neem cake, brewery and distillery waste); and
- Mined, decomposed landfill material.

To compare products, determine the amount of compost required to replace the competing product.

1. Make a list of the competitors
2. Quantify and characterize them
3. Classify them into different categories according to their competing products or targeted customer groups
4. Collect detailed information on them and their products (e.g., products, prices, sales volume, distribution networks, other services)

5. Use direct surveys or collect information indirectly by studying the customers or secondary sources

6. Answer the following questions:

- What advantages do competitors have over your business or project?
- What lessons can you learn from them?
- What advantages do you have over your competitors or competing products?

1.6.3. Develop a marketing strategy

After having obtained a comprehensive view of the compost market demand and condition, it is far easier to develop a marketing strategy. The sale of compost faces several obstacles which threaten the development of a successful overall composting and recycling approach.

- There is an apparent lack of awareness and yet there are numerous reservations regarding compost.
- Compost often has a negative image due to its input material (waste) and sometimes bad quality.
- There is a great lack of knowledge on compost benefits and application.
- The nutrient value of compost is often compared with that of chemical fertilisers.
- Compost has to compete with low-cost traditional products like manure.
- The long distances between production (composting plant) and application (fields and gardens) prevents the sale of compost.
- Inadequate or unfair regulations and policies (e.g., subsidies for chemical fertilisers) hinder the composting approach.

A marketing strategy is needed to tackle these product specific obstacles. The risks and opportunities identified in the "window of opportunity" analysis should be taken into consideration. Marketing professionals focus on four main parameters to attain a successful marketing strategy: Product, Price, Place, and Promotion. These are the so-called "4 Ps" of the Marketing Mix.

Table1.3. Main parameters of marketing strategy

- **Product:** Relates to features, benefits, quality, packaging, presentation, and service and abstract messages such as image or principles.

  Example: *Compost is produced from organic solid waste and is hence an environmentally-friendly and high-quality product. Compost is high in organic matter and, therefore, an important soil amendment for agriculture and horticulture.*

- **Price:** Is dependent on your customers' financial circumstances, on compost demand and the prices of competing market products. However, it is also determined by your production costs and expected profit margin.

  Example: *Compost has to compete with commercial fertilisers and other natural manures. The market price will range somewhere in-between these two products; however, production costs have to be covered.*

- **Place:** Can be regarded as a link between your product and your potential customers.

  Example: *You have decided to market the compost via a retailer who has already established a distribution network for other agricultural products. Customers can purchase the compost locally at low transport costs.*

- **Promotion:** Supports and influences the perceptions and judgements of your potential customers to ensure the sale of your product.

  Example: *Your compost has an official quality label. The customer opts for your product as he/she trusts the label or is aware of your company's good reputation.*

Self-check 1	Written test

Name…………………………………………… ID……………………… Date……

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (4 points)

1. Which one is not raw material for compost?
   A. plant debris
   B. Animal mortalities
   C. Dairy waste
   D. Poultry droppings
   E. Bone

2. A type of compost which is accomplished inside an enclosed container is:
   A. Static
   B. Agitated
   C. Invessel

Test II. Define the following terms (6 points)

1. Compost
2. Composting

Test III. Give short answers (6)

1. List the benefits of compost
   a. For Agriculture
   b. For Environment

You can ask your teacher for the copy of the correct answers.

***Note:* Satisfactory rating - 16 points Unsatisfactory - below 16 points**

Information Sheet 2- Identifying conditions for production requirements

2.1. Introduction

First and foremost, the quality of compost is controlled best by controlling the quality of the incoming waste that is to be composted. Only biodegradable waste should enter the process, to avoid visible pieces of plastic particles or sharp broken glass in the final product. Invisible pollutants, such as heavy metals, must also be avoided. An effective separation of waste before composting facilitates process steps like turning and screening. Hence, if you need to improve quality, start with a better control of the input material and improve the process control.

Secondly process control is a crucial factor for good quality compost. Maintain high temperatures to inactivate pathogens and weed seeds. Optimum moisture content during composting ensures the maturity of compost and its benefit to plant growth. Complete and precise monitoring reports can improve the confidence of inspectors and customers in the quality of the final product**.**

2.2. Factors involved in composting

- Feedstock and nutrient balance
- Particle Size
- Moisture content
- Oxygen flow
- Temperature

Feedstock and Nutrient Balance

- Composting, or controlled decomposition, requires a proper balance of “green” organic materials and “brown” organic materials.
- “Green” organic material includes grass clippings, food scraps, and manure, which contain large amounts of nitrogen.

- "Brown" organic materials includes dry leaves, wood chips, and branches, which contain large amounts of carbon but little nitrogen.
- Obtaining the right nutrient mix requires experimentation and patience. It is part of the art and science of composting.

Table 2.1 C: N ratios of raw materials.

Material	C:N Ratio
Vegetable wastes	12-20:1
Alfalfa hay	13:1
Cow manure	20:1
Apple pomace	21:1
Leaves	40-80:1
Corn stalks	60:1
Oat straw	74:1
Wheat straw	80:1

Particle Size

- Grinding, chipping, and shredding materials increases the surface area on which microorganisms can feed.
- Smaller particles also produce a more homogeneous compost mixture and improve pile insulation to help maintain optimum temperatures.
- If the particles are too small, however, they might prevent air from flowing freely through the pile.

Moisture Content

- Microorganisms living in a compost pile need enough moisture to survive.
- Water is the key element that helps transports substances within the compost pile and makes the nutrients in organic material accessible to the microbes.
- Organic material contains some moisture in varying amounts, but moisture also might come in the form of rainfall or intentional watering.

Oxygen Flow

- Turning the pile, placing the pile on a series of pipes, or including bulking agents such as wood chips and shredded newspaper all help aerate the pile.
- Aerating the pile allows decomposition to occur at a faster rate than anaerobic conditions.
- Care must be taken, however, not to provide too much oxygen, which can dry out the pile and impede the composting process.

Temperature

• Microorganisms require a certain temperature range for optimal activity.

• Certain temperatures promote rapid composting and destroy pathogens and weed seeds.

• Microbial activity can raise the temperature of the pile's core to at least 140° F.

• If the temperature does not increase, anaerobic conditions (i.e., rotting) occur.

• Controlling the previous four factors can bring about the proper temperature

Table 2.2. Design considerations for composting systems

Item	Comment
Carbon to nitrogen ratio	Initial C/N ratio should be 20:1 to 35:1 by weight*. The ratio reduces during composting process because of carbon loss and nitrogen accumulation
Air requirements	Air with at least 50% oxygen remaining should reach all parts of the composting material
Moisture content	Moisture content of the composting mixture should not be > 60% for static pile and windrow composting and not > 65% for in-vessel composting
pH control	pH should be 6 to 9; optimally 7 to 7.5
Temperature	Temperature should be 50 to 55° C for the first few days and 55-60° C for the remainder of the active composting period
Control of pathogens	To kill all pathogens, temperature must be maintained between 60 and 70° C for 24 hours
Mixing and turning	Material should be mixed or turned on a regular schedule

Possible reasons for process failure

- C/N ratio too low
  - ✓ add carbon source
- Not enough aeration
  - ✓ mix more (turn over more)
  - ✓ use of bulking agent
- Too much moisture
  - ✓ reduce water content of input material
  - ✓ remove leachate
  - ✓ use urine diversion if composting toilet is used
- Not enough moisture
  - ✓ add water (rainwater harvesting or recirculate leachate or add urine)

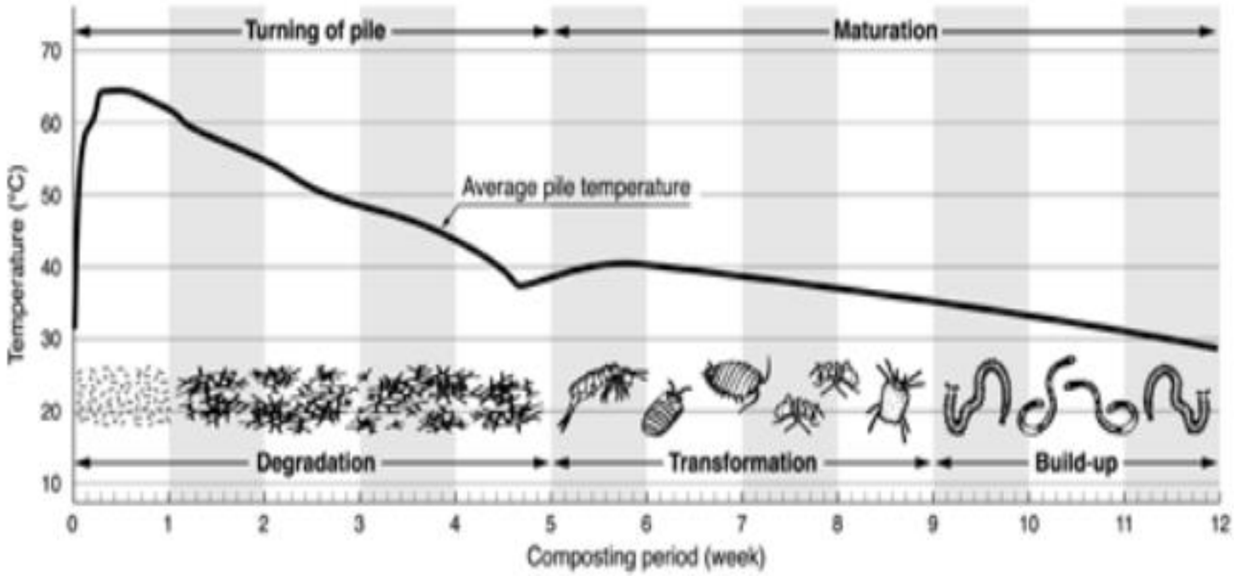


Figure 2.1.Temperature and processes during composting

Self-Check – 2	Written test

Name…………………………………………… ID………………………… Date……

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short answer questions (10 points)

1. Briefly mention the factors which affect composting
2. Why only biodegradable waste should enter the composting process?

You can ask your teacher for the copy of the correct answers.

***Note:* Satisfactory rating - 10 points Unsatisfactory - below 10 points**

Information Sheet 3- Estimating production requirements

3.1. Introduction

If composting activities are based on a business approach with little or no external support, assessment of potential markets and customers are key elements for launching a compost business. A demand for the product should be identified. Before starting compost production, determine for what purpose the compost will be used and decide on the target customers. A market demand study aims at identifying compost customers, usages and their demands in terms of both quality and quantity.

3.1.1 Site of the compost heap

Specific points need to be kept in mind when choosing a good place for a compost heap.

Climate

If weather conditions are mainly dry, the heap must be protected against drying out. A shady place, out of the wind, is ideal. This could be behind a building or behind a row of trees. Moisture in the heap will then evaporate less quickly, yet there will be enough air. A wind-free place also has the advantage that the material is not blown away and the temperature fluctuates less.

A water source near the heap is convenient for sprinkling if too dry. Under wet weather conditions the heap will have to be protected against excess water. Choose a protected and well drained place on a higher part of the land. A compost heap under a shade tree (mango or cashew, for instance) will usually be well protected against excessive rainfall. Both types of weather conditions are likely to play an important role in determining a suitable place for making a compost heap. Putting a simple roof above the place where the compost is made protects the heap against the sun and against the rain. The protection against these climatic influences will improve the composting process. Temperature and moisture level will stay more constant

Since local conditions strongly influence final composting plant design, Local construction experts should be consulted and materials adapted to the local context should be used, but always related to the key functions of each component**.**

A composting plant comprises an operation area and a “green” buffer zone. The buffer zone, formed by a belt of bushes and trees surrounding the operation area, improves the visual appearance of the composting plant. The size of the compost plant shed must be accurately measured. Areas are then demarcated into different zones. It contains space for waste unloading and sorting, composting, maturing, sieving and bagging of the compost, including storage space for compost and recyclables. These zones must be arranged so as to ensure efficient workflow of the composting process. The largest area of the site is used for active composting. Normally 50-60% of the total compost shed is used for composting and maturing of waste

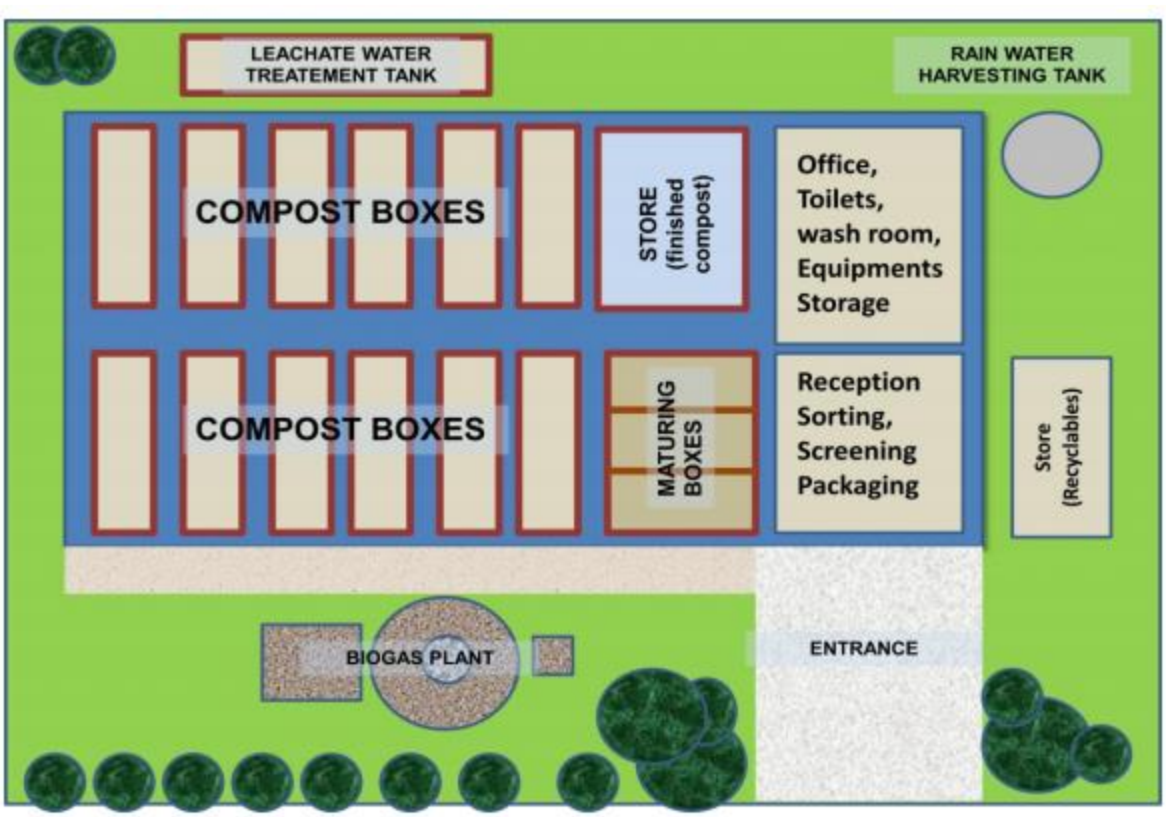


Figure 3.1 Typical schematic layout of box type compost plant

Table 3.1. Percentage of activity area required inside a compost plant

Sl.	Activity Area	Area Covered inside Compost Shed %
1	Reception, Sorting, Screening and Packaging Areas	12
2	Compost Boxes	50
3	Maturing Boxes	10
4	Office, Toilets, Wash room, Equipment Storage	12
5	Store for Finished Compost	10
6	Store for Recyclables	6

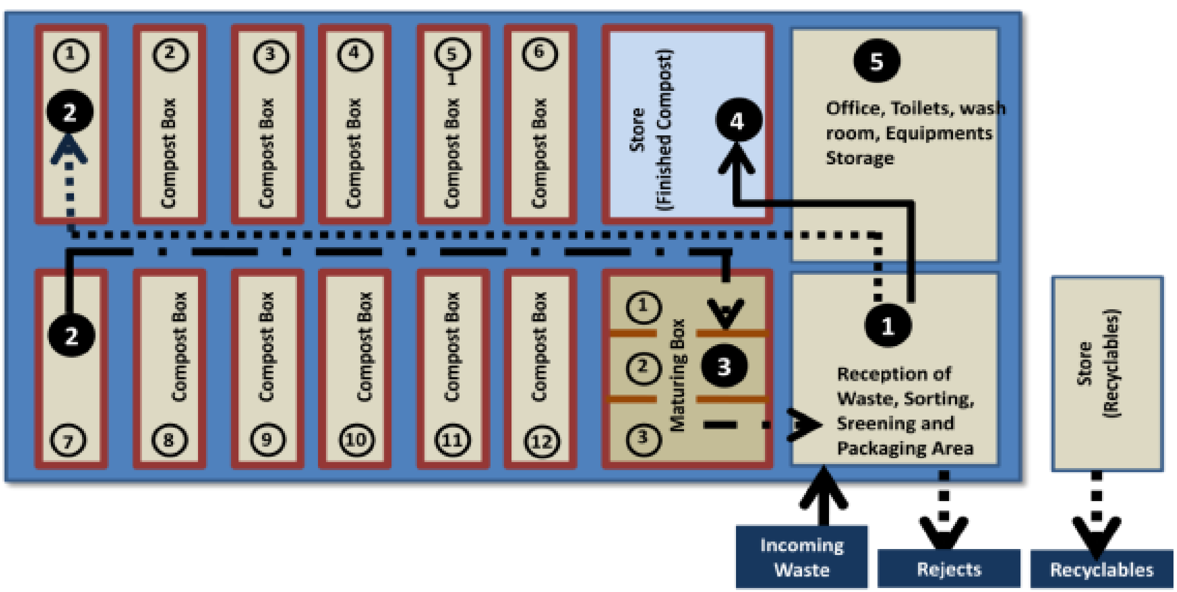


Figure 3.2: Material flow of organic waste input in a compost plant

Table 3.2. Showing the activity areas and description of the process

Location	Activities	Description
1	Reception of Waste, Sorting, Screening and Packaging Area	This is a multipurpose area. Daily fresh incoming waste first comes, usually, in the evening. After sorting and mixing (C/N ratio balance), waste goes to the compost boxes.
2	Composting Box	Waste Input residence time in a compost box is 45-50 days.
3	Maturing Box	After 45-50 days in a Compost Box, waste comes to the Maturing Box, where compost residence time is about 15 days.
4	Finished Compost Storage Additional Storage (if necessary)	After 60-65 days, finished compost goes to the storage area. Additional Storage for recyclables also can be provided in cases where a good amount of recyclables are available.
5	Facilities for office, toilets, washroom, equipment storage, guard room, etc.	An office facility for the manager along with an equipment storage area is provided. Workers toilet, washroom, guard room and change room are provided in the compost facility.

The following steps are recommended for site development:

1. Grade the site to a 2% to 4% slope
2. Slope the site toward a collection pond
3. Add minimal paving under the compost (especially for sludge and municipal solid waste)
4. Build berms around the perimeter to control run-off and run-on
5. Plan areas for raw materials storage, processing, composting, curing, storage, and blending of end product
6. Set up equipment in locations convenient to the process
7. Construct retainer walls for storage piles
8. Develop a screen around the site (fencing/plants/shrubs/trees)
9. Build a fence and gate to control access to the site
10. Install appropriate utilities depending on the method and process (2-inch minimum water main, storage and tool building, office and lab, maintenance shed)
11. Obtain proper permits (this is mandatory)
    - local: zoning, building, land use
    - state: water discharge, composting, transporting, air, health department

Self-check 3	Written test

Name…………………………………………… ID……………………….. Date……

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Give short answers (10 points)

1. What are the suitable site characteristics for composting?
2. Briefly point out the different areas to perform activities of compost preparation

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 10 points Unsatisfactory - below 10 points**

Information Sheet 4- Monitoring environmental *and* OHS impacts

If sufficient land and staff are available, a small plot inside the composting plant can be used as a demonstration unit for organic farming or as a nursery for potted plants. The core idea is to encourage the owner of the composting plant to maintain, as far as possible, the facility as clean and green. A clean and pleasant environment near a composting plant can change negative perceptions of waste treatment and the use of compost can be directly demonstrated to visitors. Furthermore, a nursery creates an additional source of income**.**

Figure 4.1 Composting plant with plants and Organic farming for promotion

The environment should be monitored during and after landfill operations to assess the environmental impacts or to equip the sanitary landfill system from points of environmental conservation and antipollution measures.

Implementation of regular monitoring

Following items should be monitored on a regular basis:

• Landfill layers: the landfill waste will change with the years. Therefore, it is important that a certain specified landfill layer is sampled and analyzed, and its quality change recorded at regular intervals.

• **Leachate and discharged water**: as part of the management and maintenance of a sanitary landfill system, parameters and frequency of testing for the discharged water quality should be carefully examined. In terms of leachate monitoring, the testing should also be done for the water flowing into the leachate treatment facility. The amount of pollutants and harmful substances in the water flowing out of a landfill site, i.e., leachate, should be measured. In addition, the discharged water quality should also be monitored to prevent pollution of water in the areas where treated water is discharged.

Table 4.1 Proposed Monitoring Scheme for Leachate and Discharged Water

Sampling Place	Monitoring Parameters	Frequency
Leachate reservoir pond and discharged water	pH, CN, Pb, T-Hg, Cd, BOD, COD, SS, Color	1/month

• **Ground water:** to check whether or not the natural or artificial liner system in the site is effective; and If the natural or artificial liner system is not effective, to monitor the extent of impacts of pollutants discharged into the groundwater and the lives of inhabitants in the area. Therefore, the monitoring facilities established should enable determination of the possible usage and the quality of groundwater in the areas around the sanitary landfill system.

• **Gas**: when waste with organic substances is buried in a landfill site, monitoring of generated gas will help to determine the decomposition condition of the landfill waste. Even in a landfill that is used for filling mainly of incombustible waste, it is recommendable that composition of the waste carried in is also monitored since the waste may include many organic substances**.**

• **Bad odors**: monitoring points and times for bad odors should be decided taking into consideration the living conditions in the surrounding area as well as the weather conditions. Monitoring of bad odors is usually conducted once a day in every 6 months at 2 or 3 places on the landfill site boundaries

Insect Problems: Insect problems may occur mainly waste are not decomposing timely due to so many reasons. The reasons might be high moisture content of composting materials or inoculums are not used or good inoculums are not used or not well mixed up or bins are placed in dark and damply /moist location, or no good air circulation or wastes are not cut into pieces. Sometimes season itself favors the breeding of insects so insect problems arises.

Solutions:

First of all, all the necessary guidelines or technique has to use for decompositions of waste materials as waste should be cut into pieces, bin should be placed in open (good air circulation area), waste materials should not be too moist, good inoculums has to be used, brown (dry matters) and fresh (green matters) matters should be in good proportion. Wet or moist waste materials are the main reasons for insect problems. Put withered waste (partially dry) materials in bin and use compost or Bokasi in waste materials for quicker decomposition.

Besides the above-stated items, other impacts on the environment like noise, vibrations, fauna and flora should also be considered, if necessary.

OHS hazards

- Biological hazards associated with raw materials or Product
- Ergonomic hazards associated with manual handling
- Physical hazards such as:
  - ✓ compressed air and water
  - ✓ dust
  - ✓ hammer mills and grinders
  - ✓ hot or cold weather conditions and noise
- Shredders
- Underfoot conditions
- Vehicles and mobile machinery
- Sharps or other physical contaminants in materials.

Self-check 4	Written test

Name…………………………………………… ID……………………….. Date……

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Give short answers (10 points)

1. What are the environmental and OHS impacts during composting?

You can ask your teacher for the copy of the correct answers.

Plan the required key features

The following key features have to be considered during planning and construction, regardless of the type of composting scheme chosen. On-site water supply is a basic infrastructural requirement on a composting site. Since it is used for hygienic purposes and for watering the compost heaps, a reliable water supply should be ensured, such as a standpipe on the site. An additional water storage tank is, however, advisable if the water supply is not continuous. A further useful feature is a rainwater harvesting system. The roof of the composting shed and other facilities can be specially designed to collect rainwater from the rooftops. During the rainy season, water can be collected in a tank to bridge water shortages during the dry season. The storage volume is dependent on the length of the dry season and daily water demand. Rainwater can be used for the composting process, for cleaning and washing of the composting plant and for watering of the green belt.

Figure 5.1 water storage structures

Specific features of the box composting area

Box composting requires less space but more construction efforts and higher investments. A plant processing three tons of organic waste requires about 12 Compost boxes with a 15 ton capacity per box. The front side of the box is closed by means of removable wood panels, which can be removed to empty the box. The slab on which the boxes are built should be sealed and slope towards one side. Leachate collection channels leading to the edge of the composting floor are located between the boxes and discharge into a central collection point

Recipe

Size and setting up of the heap Size The heap has to conform to a certain size; if too broad or too high, aeration is poor. A good basic size is 2 to 2.5 m wide and 1.5 to 2 m in height. The length depends on the quantity of organic material available, but it is better to make a shorter heap quickly than a longer heap slowly. It is strongly advised to start with a heap greater than 1 m3, otherwise the temperature in the heap remains low and decomposition is too slow and incomplete. During the maturation phase the volume of the heap decreases and the heap sags in, as it were.

Setting up the heap

The compost heap can be above ground or underground in a pit or a trench. Whichever method is used, the heap of organic material has to be set up in a special way. A useful suggestion is to start the heap by a foundation of coarse plant material such as twigs or sugar cane stalks. The outside air can easily flow in under the heap and any excess water flows away more quickly. If the heap is built up in layers, the individual layers should preferably not be thicker than 10 cm for plant material and 2 cm for manure. Apart from the organic material available, the way the heap is made depends also on the individual experience and results.

Covering the heap

In an area of heavy rain the heap will have to be protected against excess water. Preferably it can be kept dry by putting a simple roof above the heap or even simpler.

More precisely this means covering with a layer of leaves, a cloth, jute or plastic etc. If plastic is used then only cover the top, so that the air can penetrate through the sides. Trenches around the heap facilitate the run off of excess rain water. Covering the top with the materials mentioned can also be an advantage in dry areas. It prevents excess evaporation of moisture from the heap and it dries out less quickly.

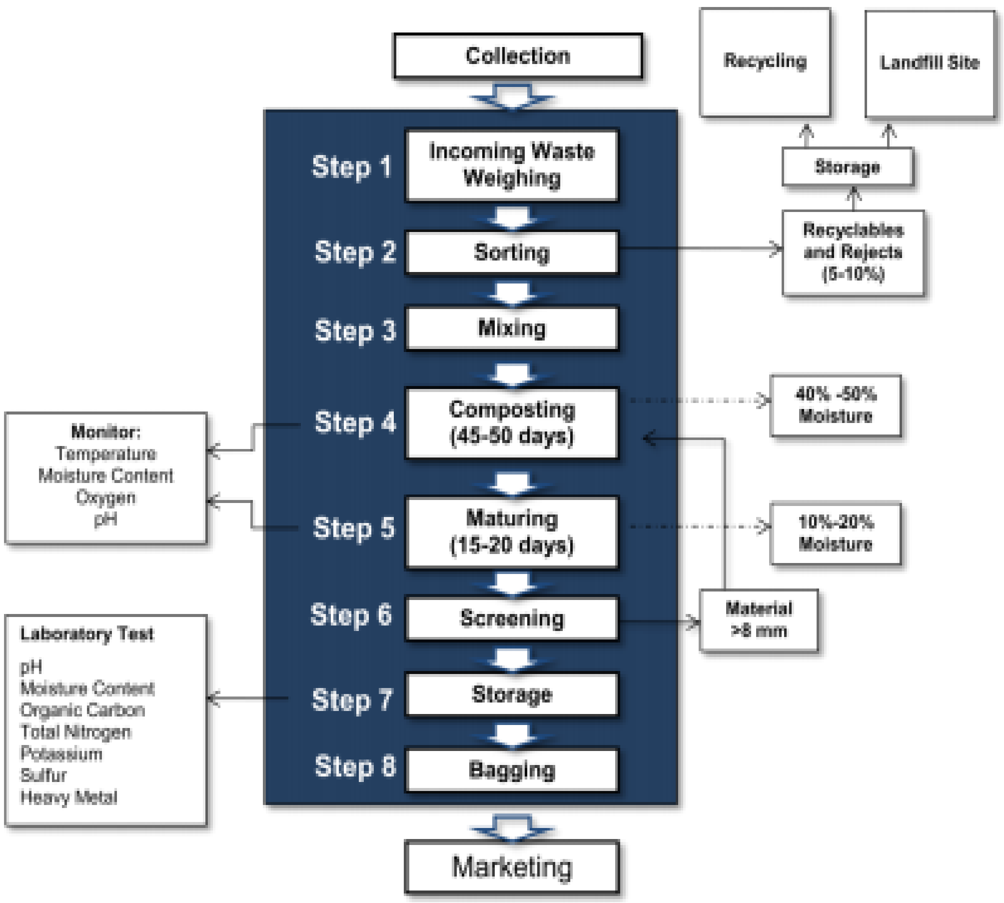


Figure 5.2: Flow Diagram of Composting Activity

Criteria for composting factors

- C: N ratio - 25-35: 1
- Particle size - 50 mm
- Moisture content - 50-60%
- Air flow - 0.6-1.8 m3/day/kg
- Temperature - 55°C - 60°C, for 1st 3 days

- Agitation - Periodic turning at 15 days interval
- Heap size - Any length, 1.5 m high, 2.5m wide
- Activators - Microbial organisms

The three major steps of compost production

Stage 1: Collection of waste

Collection of source-separated fresh organic waste is necessary for the proper composting process. Organic waste is normally collected from communities, markets and other sources of organic waste of a city/town to a compost plant by rickshaw van or trucks.

Stage 2: Composting of organic waste

Eight (8) major steps are shown in this stage of the composting process. During this stage, a small portion of rejects are disposed in the landfill site and sorted recyclables (plastic, tin cans, paper, cardboards, iron, glass, etc.) are stored and sold to recycling industries. During this stage, input organic matter loses a significant amount of moisture from the final produce compost. Also during this stage, temperature, moisture, oxygen and pH need to be monitored for proper composting.

Stage 3: Marketing

A proper compost marketing strategy is necessary to market compost products to farmers and crop growers. Compost can be produced based on local quality standards and enriched with necessary nutrients to meet the demand of different types of soil and crops.

Description of the process	
	Step 1: Spread the organic waste on the sorting platform using rakes. • All organic solid wastes arriving at the plant should be deposited on the concrete platform at the sorting bay. • Record the volume and/or weight of waste. • Remove the bags/sacks which contained the waste. • The height of the waste on the platform should be 10 cm or less to minimize anaerobic conditions and odor generation.
	Step 2: Sorting of the organic waste. • Manually remove nonorganic materials using standard PPE. • Safely collect and dispose of the undesired fractions which should subsequently be sent to the landfill.
	Step 5: Transport to the co-composting area. • Use rakes, shovels and wheelbarrows to collect the organic waste and send it to the co-composting platform.

	Step 3: Dewatering/resting period. • Leave the organic solid waste with high moisture on the platform to be slightly dewatered. • Use a rake/spade to turn lower and upper parts once a day. • The 'dewatering' period ends when there is **no free** moisture visible, which might be after 1-2 days. • Extended exposure to sun (or rain) will negatively affect composting. • Possible leachate might evaporate.
	Step 4: Shredding of organic waste (optional). • Shredding or crushing allows a reduction in particle size of the organic waste. The increased surface area exposed to microbial degradation will reduce the co-composting period. • Shredding can be done mechanically or manually. • The recommended particle size for co-composting is about 5 cm (or 2 inches). • Excessively fine particle size may impede the co-composting process through inhibition of aeration.

	Spread the DFS waste on the co-composting platform using rakes. • If the DFS comes from a store, remove bags/sacks. • Break large lumps of DFS into smaller pieces. Avoid crushing into fine particles or powder, as this will inhibit aeration when the compost heap is formed. • Remove all foreign materials, such as stones, plastics and pads, which could be present in the DFS.

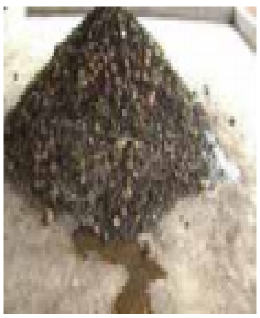
<table>
<tr><td></td><td></td><td rowspan="4">Step 3: Forming the heap.
The heap size should create optimum conditions for air and temperature regulation.
A co-compost heap must be of sufficient size (see photographs) to prevent rapid dissipation of heat and moisture, yet small enough to avoid compaction and limited air circulation.
Optimum heap sizes range from 1.2 to 1.6 m for height and 6-9 m for circumference.
Polyvinyl chloride (PVC) pipes/bamboo poles (with holes) could be mounted in each heap for measuring temperature and to aid aeration.
Each co-compost heap should be labeled indicating the date of formation, volume of water added, next turning date (see below) and expected maturation date.</td></tr>
<tr><td>1. Finalize the heap formation.</td><td>2. Measure the height and validate it is correct.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>3. Measure the circumference and validate it is correct.</td><td>4. Label each co-compost heap.</td></tr>
</table>

	Weighing of waste to ensure adequate proportions are subsequently mixed	Step 1: Mixing the right amounts of DFS and organic solid waste on the co-composting platform. • Initially, a mass ratio should be used to establish the amounts of each material to be added, until staff have sufficient experience. • In the case of a mass ratio, mix 500 kg of DFS with 1,500 kg of organic solid waste to form one 2-MT co-compost heap. • If a scale is not available for weighing materials, it is possible to use a volume ratio. • In the case of a volume ratio, mix (for example) 16 wheelbarrows of DFS with 48 wheelbarrows of organic solid waste to form about 2 MT of co-compost heap. • Use shovels and spades to mix the feedstock thoroughly.
	Waste is applied in layers and the mixing is started	
		Step 2: Adjusting the moisture level. Water is added during the mixing stage and the moisture of the mixture is gradually increased to the desired level. • The moisture content of the newly formed heap should range from 50 to 60%. • Add the required volume of water while mixing the feedstock. This typically corresponds to 30-50 watering cans (13-L capacity each) depending on the initial water content (e.g., dry sawdust, wet market waste).

<table>
<tr>
<td>
× BAD
The compost crumbles (too dry) or water drips out (too wet).</td>
<td>
✓ GOOD
The fist releases a very small amount of moisture and the compost remains compact.</td>
<td>Step 2: Monitoring the moisture level.
Squeeze a handful of co-compost for a few seconds and release the pressure.

• Good: Squeezing releases a little moisture and the compost remains compact (moisture level 60-65%).
• Bad: The compost crumbles. This means that the amount of water is insufficient (<60%).
• Bad: Water drips or filters out of the fist while squeezing the compost. This means that the amount of water is too high (>70%).</td>
</tr>
<tr>
<td colspan="2">
A co-compost heap being turned. The easiest way to do this is by moving the heap from one spot to another just next to it, taking care that outer material will now become inner material.</td>
<td>Step 3: Turning (aeration) and watering the heap.

• To support a good air supply, the heap should be turned during the thermophilic stage at 3-5 day intervals or even earlier in case the temperature drops below approximately 50 °C or starts exceeding 60-65 °C.
• The turning frequency should gradually be reduced to once a week, if the temperature no longer climbs above 45-50 °C even after turning.
• When multiple co-compost heaps are to be turned on a given day, it is best to start turning the most-matured heaps before moving to the least-matured compost, in order to minimize the risks of recontamination of mature compost.</td>
</tr>
</table>

	Addition of water	• It is important to ensure that the co-compost heap remains moist (50-60% moisture content by weight) throughout the co-composting period. Biological activity is inhibited when the heap dries out. • Moistening of the co-compost heap should preferably be done during turning. • Add the required volume of water starting from the top of the co-compost heap. • Water should be sprinkled, preferably from a watering can with a rose. • During moistening, ensure that water is not added excessively to the heap. • On site, treated leachate from the composting area can be used to moisten heaps that are less than a week old. Beyond this time, water reuse should **not** take place to avoid recontamination of the co-compost with pathogens.
	Excess water flowing out of a heap	
Step 4: Moving feedstock from a large compartment to a small one. Given the volume and mass reduction, the co-compost heap may be moved from a large compartment to a smaller one after one month. It is also possible to combine the two reduced heaps initially formed **on the same** day and from the same feedstock composition to build a new heap of more reasonable size.		

Description of the monitoring process (continued)

Step 5: Monitoring of co-compost quality

Table 5 presents typical quality standards that could be considered for the co-compost products in the absence of national standards. The parameters to be analyzed could include the following:

- Macronutrients (e.g., N, P and K) - to establish the nutrient value of the compost, if applied in addition or as an alternative to a fertilizer. Also, to establish the amount of inorganic fertilizer required to enrich the compost to a certain standard.
  Minimum frequency required: Once for each bulk of co-compost to be enriched.
- Pathogens, especially, for example, helminth eggs and *E. coli* - to ensure that the World Health Organization (WHO) guidelines for the safe recycling of waste are met (see Table 5).
  Minimum frequency required: Once for each bulk of co-compost to go through post-processing; twice a year for pellet samples (microbial risks are lower with pellets than with basic compost).
- Heavy metals (e.g., nickel [Ni], chromium [Cr], lead [Pb], mercury [Hg], cadmium [Cd]) to ensure permitted levels are not exceeded.
  Minimum frequency required: Twice a year.
- Germination tests - to ensure the co-compost is mature (no active weed seeds left) but also not toxic to crops (see Boxes 1 and 2).
  Minimum frequency required: Once for each bulk of co-compost to be enriched or bagged.
- pH and electrical conductivity (salinity).
  Minimum frequency required: Once for each bulk of co-compost to be enriched or bagged.

	Step 6: Once matured, spread co-compost to dry and for sieving. • Spread the co-compost thinly on the co-composting platform or designated drying point using washed shovels and spades to avoid contamination. • Turn/stir the co-compost intermittently to facilitate drying. • Dried co-compost should be sieved using a 6-8-millimeter (mm) grid. • The coarse co-compost fraction may be added to a new co-compost heap, mildly ground and added to the compost product or be discarded (for example, non-composted fruit parts). • Record the final weight of the co-compost produced.

Table 5.1 **handling and pre-processing requirements for raw materials**

Compost quality criteria can be divided into visible and easily controlled quality criteria or invisible criteria difficult to assess by the customer. Table 5.2 contains selected quality criteria classified into customers' assessments.

Table 5.2. Compost quality criteria and the possibility to be assessed by customers

Factors possible to be assessed by customers	Factors impossible to be assessed by customers
▪ Colour ▪ Smell ▪ Visible foreign matter (plastic, glass, wires) ▪ Degree of maturity assessed by colour and smell	▪ Nutrient content (NPK) ▪ Degree of maturity in terms of chemical constituents ▪ Suitability for plants (pH, salt content) ▪ Inactivation of weed seeds ▪ Freedom from pathogens ▪ Heavy metal content

Since the customer is not in a position to assess the most important compost quality criteria (e.g., nutrient content) by its appearance, he/she has to trust the information provided by the producers. Ways to gain customer confidence include intensive process monitoring and quality control conducted by independent laboratories. A compost quality label can also generate customer confidence. However, it will have to be introduced and awarded by an independent regional or national organization acting as a control institution.

Depending on your customers, you might store compost in bulk or pack it in bags of different volumes. If compost reheats above ambient temperature after the screening process, it still is not completely mature. In this case, sprinkle a little water and let the compost rest for another week. Check the temperature again before you start bagging it. The compost should be relatively dry when it is bagged to avoid transporting large amounts of water with the compost (moisture content < 40 %).

Figure 5.3 Compost Bagging

Self-Check – 5	Written test

Name…………………………………………… ID……………………….. Date……

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short answer questions (4 points)

1. What are the three major steps of compost production
2. Reason out why compost should be relatively dry when it is bagged

Note: **Satisfactory rating - 4 points Unsatisfactory - below 4 points**

You can ask your teacher for the copy of the correct answers.

Information Sheet 6- Confirming facilities, personnel, machinery and equipment

6.1. Introduction

A composting facility is a structure or device that uses controlled aerobic decomposition to transform waste organic material into a biologically stable product that can be used as a soil amendment.

6.2. Plan staffing requirements

Generally, composting plant staff needs to be willing to work with waste. Such a commitment ensures long term capacity building and increases know-how within the plant. Selection of staff strongly depends on local habits and values (culture, religion, gender, perceptions) and has to be discussed in detail (e.g., if women can be involved in waste handling). Experience reveals that composting plants often provide interesting job opportunities for underprivileged and poor people.

Formalised waste collection, sorting and composting ensures long-term employment and the opportunity to get trained on the job and specialised in composting. However, some of the workers should be literate, as the composting process requires reliable monitoring and recording activities (e.g., temperature, weight and moisture measurements). Furthermore, the composting business also offers jobs for dedicated engineers, which have the overall responsibility of management and operation. A typical small to medium scale compost plant consists of a Plant Manager, Assistant Plant Manager, Supervisor, and Plant Workers who take care of the operation of the compost plant. They are also responsible for data management of the overall composting process**.**

Equipment for processing yard trimmings after they arrive at their destination for composting must be planned in conjunction with collection equipment. Factors affecting equipment choices include the quantity, composition, and timing of yard trimmings generation, the structure and route allocation of the existing hauling infrastructure, and market specifications for the final compost product.

Table 6.1 Equipment used for the collection of yard trimmings.

General gathering	Material-specific	Transport
• Front-end loader • Mechanical claw truck	• Leaf vacuum truck • Mobile chipping unit for wood waste	• Dump truck • Rear-loading packer truck • Semi-automated rear-loading truck • Automated or semi-automated side-loading truck

6.3. Main equipment used for the decomposition process

Machinery suitable for turning and material manipulation such as a wheel loader; a turning machine is recommended for dynamic windrows or for facilities with throughput higher than 5.000 t/y including significant amounts of food waste .Devices for temperature measurements such as manual probes. Devices for maintaining the optimum water content. Often, turning machines are equipped with water sprinkling function active during the turning operations; otherwise, manual irrigation with a simple irrigation hose can fit for purpose.

Front-end loader

For efficient yard trimmings collection, the front-end loader is usually adapted with an oversized bucket (i.e., greater than 4.5 cubic yards). It is particularly efficient for collecting leaves where leaf fall is heavy. This type of operation typically involves one loader operator, one or two laborers as rakers, and two or more dump trucks for transport.

Mobile chipper

Mobile chipping units are typically used by public works crews and private firms involved in tree trimming. They are also useful for collection of special materials (e.g., Christmas trees).

Rear-loading packer truck

This truck is commonly used to collect garbage, and generally ranges from 16 to 25 cubic yard capacity. It is also efficient for collecting yard trimmings materials in bags, largely because it compacts the material

Automated side-loader

This truck has a fully automated loading mechanism. The mechanism grabs a container and hoists above a hopper into which the material is dropped for compaction. The operator can stay in the cab throughout the process.

Semi-automated rear-loading truck

With this truck, an operator positions a cart for a lifting mechanism (e.g., a bar lift) to hoist into a hopper at the rear (with some models, on the side) of the truck. The operation may require a crew of two, one to drive the truck, the other to handle the container. Alternatively, one operator can perform the entire operation, but at a slower rate.

Table 6.2. Tools for composting

Tools	
Spade/shovel	To collect and handle the organic waste
Wheelbarrow	To transport the waste
Weighing scale	To quantify the required amount of waste
Waste container (30 L)	To hold the waste during quantification
Watering container	To add water to the heap
Watering hose	To distribute water
Notebook, pens	For record keeping
240-L dustbin	For unwanted waste collection
Broom	For cleaning
Graduated wooden rod (long measuring stick)	To measure the height of the heap
Flexible measuring tape/rope	To measure the circumference of the heap

6.4. Safety first (measures and compliance)

Handling fecal sludge (FS) and other organic waste sources demands strict compliance with safety regulations. The main risks identified in the Fortifer co-composting process are:
1. FS contains pathogens that may pose health risks to humans if safe handling and processing procedures, including hygiene standards, are disregarded.

2. Environmental risks from poor treatment of the drainage water derived from the FS drying beds, such as eutrophication of water bodies, or an increase in antimicrobial resistance.

3. Organic wastes from markets may contain pathogens, but also other contaminants like glass, which may have harm handlers if safety measures are neglected.

4. Operations related to drying beds, composting and machinery usage may expose workers to potential occupational risks, including dust and odor.

Under these circumstances, staff must:

- Wear suitable personal protective equipment (PPE).
- Wash their hands with soap during breaks and immediately after work or take a bath/shower.

Supervisors must provide:

- Well-fitting PPE, hand washing facilities, soap, towels, sanitizers, and separate shower places and toilets for workers of different gender.
- Incentive systems for safety compliance that can include rewards (e.g., best worker of the month) as well as a two-to-three step warning and fine system for disregarding regulations.
- A cool working space with shade and sufficient ventilation because wearing PPE can be uncomfortably hot.

Table 6.2 PPE for composting

PPE	Risks addressed	When/where	Recommended attire
 Wellington boots	Feet contact with pathogens/ liquid waste/dangerous materials.	All locations on site.	
 Goggles	Eye contact with particles, dust and or liquids generated by machinery or through laboratory operations.	All sites near machinery or compost piles; use goggles which fit over spectacles.	
 Hand gloves	Manual contact with pathogens, sharp objects.	All locations on site.	
 Overalls	Bodily contact with pathogens, dirt.	All locations on site.	
 Face mask	Inhaling particles, dust and odor.	All locations on site.	
 Helmet	Injury from falling objects.	Where heavy equipment is being used.	

Self-Check – 6	Written test

Name…………………………………………… ID……………………….. Date……

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Write True for correct statement and false otherwise (4 points)

1. Composting plant staff needs to be willing to work with waste
2. Operations related to drying beds, composting and machinery usage may expose workers to potential occupational risks, including dust and odor.

Test II Choose the best answer (4)

1. Factors affecting equipment choices include the following except
   A. The quantity, composition, and timing of yard trimmings generation,
   B. The structure and route allocation of the existing hauling infrastructure,
   C. Market specifications for the final compost product.
   D. None
2. To avoid potential occupational risks staff must:
   A. Wear suitable personal protective equipment (PPE).
   B. Wash their hands with soap during breaks and immediately after work or take a bath/shower.
   C. Get incentive for safety compliance
   D. All

Note: **Satisfactory rating - 8 points Unsatisfactory - below 8 points**

You can ask your teacher for the copy of the correct answers.

Information Sheet 7- Developing and documenting contingency plan

The best way to minimize the impacts of unexpected waste management service disruption is to plan for them.

Steps to Prepare Contingency Plan

A. Assign responsibility for developing / managing the Contingency Plan.

- Delegate / assign responsibility for developing and managing the Contingency Plan.

B. Define the critical waste management services.

- This would include services such as:
- Collection services:
- Curbside waste collection, depot waste collection
- Receiving Facilities:
- Transfer stations, depots
- Blue Box Material processing services

C. Identify the likely disruptions.

- Consider what are the likely sources of disruption to the critical services. These may include:
- Labour action.
- Inability of contractor to provide the service.
- Equipment malfunction or damage.
- Local or broad-scale disease outbreak.
- Natural disaster, etc.

D. Identify alternatives for delivery of critical services

This would include:

- ✓ Alternative collection options or depot drop-off locations
- ✓ Alternative transfer and/or processing facilities

E. Develop a Contingency Plan for both short and long term service disruptions.

• Short term disruptions

These include disruptions that typically will occur over one day to several months.

- ✓ Minor loss of facility use (e.g., small fire, equipment failure for which parts could take several days/weeks to obtain;
- ✓ Minor fleet fire (impacting a single collection unit);
- ✓ Multi-day weather related impact to collection;
- ✓ Multi-day support facility loss (e.g., maintenance facility); or,
- ✓ Labour disruption (e.g., one to two week walk-out), for example.

• Long term disruptions for facilities

These include service disruptions that have long term impacts or extend for a prolonged period of time. These include:

- ✓ Large scale fleet fire; o Large scare facility issue involving the loss of the use of the facility for an extended period of time (e.g., catastrophic fire event);
- ✓ Perpetual route incompletion due to equipment or labour resource shortfalls;
- ✓ Local or broad-scale disease outbreak; or
- ✓ Contractor bankruptcy and force majeure

• Long term disruptions for collection services

F. Consult with the MECP during the development of the Contingency Plan

The local branch of the Ministry of Environment, Conservation and Parks (MECP) should be consulted during the development of your Contingency Plan. When your Contingency Plan is initiated during the event of a service disruption, you may require approvals or changes to a site's Environmental Compliance Approval.

G. Prepare and send Medical Officer of Health Letter #1

H. Contingency Plan Stand-by

• Regular review and update of contingency plan

I. Implement Contingency Plan as necessary

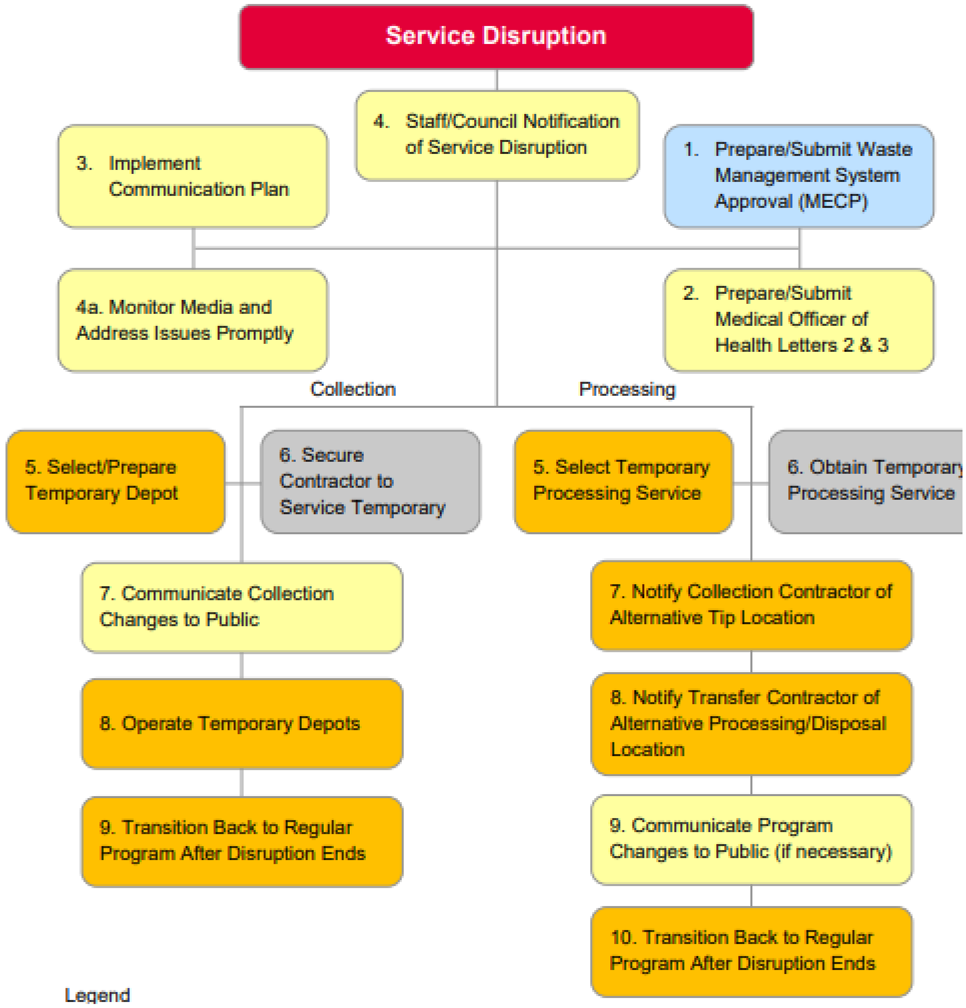


Figure 7.1 Short Term Disruption Contingency Plan

Self-Check – 7	Written test

Name…………………………………………… ID……………………… Date……

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Give short answers (4 points)

1. Why contingency plan is important?
2. What are the steps to prepare contingency plan?

- ***Note:*** **Satisfactory rating - 4 points Unsatisfactory - below 4 points**

You can ask your teacher for the copy of the correct answers.

Operation sheet 1- Prepare compost production and marketing plan

Objective: to acquire organic fertilizer preparation and marketing skill

Materials required

- Note pad
- File
- Computer
- External drive

Procedure:

- Identify suitable raw materials, tools and equipments
- List production requirements(C:N ratio, moisture, air ,etc)
- Point out activities or steps to produce compost
- Decide budget required for each activities
- Allocate time to perform the activities
- Assign responsible person for each activities
- Set quality parameters
- Identify customers
- Select marketing strategies
- Prepare production and marketing plan
- Submit for concerned body

Operation sheet 2- Develop contingency plan

Objective: to address potential oversupply or undersupply of raw material or product.

Materials required

- Note pad
- File
- Computer
- External drive

Steps to Prepare Contingency Plan

A. Assign responsibility for developing / managing the Contingency Plan.

B. Define the critical waste management services.

C. Identify the likely disruptions.

D. Identify alternatives for delivery of critical services

E. Develop a Contingency Plan for both short and long term service disruptions.

F. Consult with the MECP during the development of the Contingency Plan

G. Prepare and send Medical Officer of Health Letter #1

H. Contingency Plan Stand-by

I. Implement Contingency Plan as necessary

LAP TEST	Performance Test

Name_________________________________ ID……………Date………

Time started: _________________________ Time finished: _________________

Instructions: Given necessary templates, and materials you are required to perform the following tasks within one month. The project is expected from each student to do it.

Task-1 prepare compost production and marketing plan

Task- 2 .Develop contingency plan

LG #35	LO #2. Schedule production to meet requirements

Instruction sheet -2

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Calculating batch types and volumes of compost-based products
- Obtaining laboratory and field test data of compost
- Monitoring and adjusting production schedule.
- Making requiring product available

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Calculate batch types and volumes of compost-based products
- Obtain laboratory and field test data of compost
- Monitor and adjust production schedule.
- Make requiring product available

Learning Instructions:

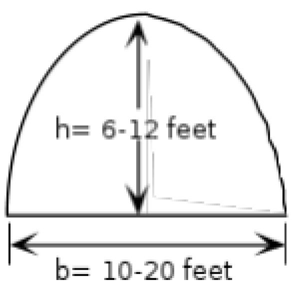
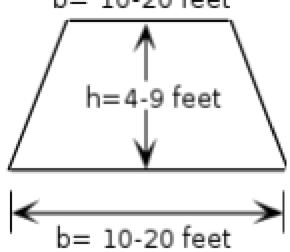
1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the "Self-checks" which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).

Information Sheet 1- Calculating batch types and volumes of compost-based products

1.1 Introduction

Calculating space for active compost .The shape and size of windrows vary depending on the type of turning equipment used. The aisle space needed between windrows is also impacted by equipment selection. To accurately calculate the footprint of the site which will be occupied by the active processing area, operators will need to estimate the peak volume of organic materials and how much can be placed into each windrow, Where more sophisticated indoor or in-vessel approaches are used, the area requirements will be different to accommodate the equipment and building. Often, though, the curing and finished compost is stored outside and the area and pads need to accommodate these volumes.

Calculating Windrow Volume

Method and equipment used	Approximate shape	Avg. aisle width	Cross-sectional area
Windrows/piles turned with a bucket loader		11'	A = 2/3 x b x h
Self-propelled and tractor-drawn windrow turners		5'	A = h x (b - h) *

** This formula is an approximation and is valid only when the width is greater than or equal to twice the height.*

Product quality enhancement

Transformation into Pellets

Several factors motivate the production of pellets from co-compost. First, it can help logistically, because pelletization reduces the bulkiness of the co-compost through densification of the biomass. The increased bulk density and lowered volume can reduce the space needed for storage or transportation (increasing cost-effectiveness), and ease the handling of the product during application.

Note: Pelleting and pelletizing are two terms often used interchangeably, although their processing methods differ. Pelleting commonly refers to forcing material through a die or mesh to create a unique size. Pelletizing, on the other hand, can include the use of a binding agent and densification using a rotary drum or a pan pelletizer. In our context, we refer to pelletizing.

The newly produced pellets may be weak for a few seconds or a few minutes. The receiving plate and its subsequent transfer into a different processing unit (for example bagging) must consider this fact. Poor handling will result in the formation of fine materials and constitute an increase in processing cost.

Storage and Labeling of enriched Co-compost

Bagging is required for short-term storage (from a few weeks to a few months, or more) and distribution of the final products. Generally, bagged composts will last well for few years provided that they are stored in dry conditions. However, especially nitrogen-enriched compost can lose nitrogen to the air (ammonia volatilization). Over two years of storage using nylon bags in an experiment in Ghana, a non-enriched co-compost lost 13% of its nitrogen content, while an ammonium sulfate-enriched co-compost lost 24-46%, and a urea-enriched co-compost 47-59% .Especially for the enriched composts, the observed changes make the nitrogen content, as specified on the bag label, outdated.

Table 1.1 bagging and storage of compost

Bagging requirement	Type of bag required	Storage condition
Compost	Polypropylene, nylon or recyclable bags.	Store products in a shelter or room to ensure that they remain dry and not exposed to heat above 35 °C or direct sun (UV) light.
Enriched (co-) compost/ pellets	A bag that has a plastic lining to exclude moisture and humidity.	

Labeling: The label to be used should meet the requirements of the country in which the product is to be marketed.

Figure 1.1.Labelling of compost

It might be 'safer' to state a nutrient range on the bags rather than a certain percentage, as the waste composition (and final compost quality) can vary and volatile nutrients might be lost during storage. Stating a range can also reduce the frequency of laboratory analyses required to verify the nutrient content of the final product. Sell/use the bagged co-composts ideally within 12 months after bagging, and N-enriched compost within 6 months. Older N-enriched compost bags do not have to be discarded, but can still be sold/used with a note of caution (and, for example, discount) to serve purposes such as landscaping and forestry, where nitrogen demand is low.

Recording of observations and data

Good data management allows for

(a) Benchmarking processes (quantities, efficiencies, quality) for improvement (for example, to become more cost-effective); and

(b) Tracing reasons for possible failures or shortcomings.

Therefore, accurate recording of all observations and measurements (or in short ‘data’) at the co-composting facility is important to establish and maintain operating records which can be verified or referred to when needed. Both soft (electronic) and hard (printed) copies of records as well as pictures should be kept at a site designated for data storage.

Activities or measurements on which records should be kept include

- Feedstock management,
- General observations and incidents (like heavy rainfall) that potentially (or de facto) affect the co-composting processes,
- Pelletization processes and machinery,
- Co-compost quality assessment (including physical/chemical analyses) and
- Staff management dynamics.

As much as possible, data management should include:

- The raw materials entering the plant (amounts, sources, quality observations)
- The quantities and dates of production of the material ready for sale.

Monthly reports on all observations, product quality data and activities have to be prepared and stored safely and appropriately. Detailed but simple templates, based on standard operating procedures should be developed for respective activities to ensure uniformity or formalized for easy reporting requirements.

Table 1.2.Tools for record keeping

Tools	
Notebook, pens	For record keeping on site
File	For storing hard copy records
Computer	For data transfer, analysis and long-term storage
External drive	For safeguarding data

Source: IWMI

Figure 1.2 Labeled compost sack

Self-Check – 1	Written test

Name…………………………………………… ID……………………… Date……

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short answer questions (6)

1. What is pelletization?
2. Describe the common information should be written on the compost bags
3. Calculate the cross sectional area of a compost heap having a base 1m and height 1.5m

Test II: True or false (4)

1. The shape and size of windrows and aisle space needed vary depending on the type of turning equipment used.

2. Good data management allows for benchmarking processes (quantities, efficiencies, quality) tracing reasons for possible failures or shortcomings.

***Note:* Satisfactory rating - 10 points Unsatisfactory - below 10 points**

You can ask your teacher for the copy of the correct answers.

Answer Sheet

Score = ___________

Rating: ____________

Introduction

The compost needs to be frequently analyzed to provide important information about nutrient content and invisible pollutants like heavy metals. Figure 2.1 below provides an overview of the most important physical, chemical and biological quality criteria,

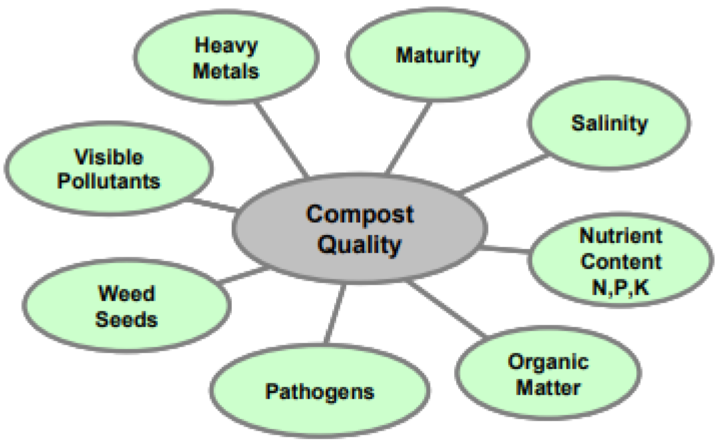


Figure 2.1: Selected quality criteria for compost.

Visible Pollutants can be easily detected by the end-user. Each piece of glass or plastic shows the user the origin of the material and causes a loss in confidence in the product. Especially glass or metal pieces pose harm to users and should be strictly avoided. Pre-sorting the incoming waste and avoiding crushers before the composting process results, in most cases, in clean and good quality compost.

Maturity is the most important aspect for horticulture and vegetable production. Compost should be stable, which means that it does not release substances (e.g., ammonia or acidic substances) which can hamper plant growth. The application of immature compost causes root damage and nutrient loss, and therefore a reduction in yield. Unfortunately, maturity is difficult to measure; it requires more than one test to assess maturity. The four indicators below allow a rough on-the-spot check of maturity:

- Appearance: dark brown, soil-like material, no insects or larvae visible
- Earthy smell
- If you dig into the compost (storage) heap, the temperature should not exceed ambient temperature
- 0.5± pH 7

Non-toxicity means the absence of substances which could harm plants and human beings. Apart from the above mentioned visible pollutants, many toxic substances are invisible. The absence of toxic substances (e.g., organic chemicals or heavy metals) is particularly crucial for the application of compost for food production, as many plants are able to take up these substances. Heavy metals play a particular role. Once heavy metals are detected in the compost, they hardly can be eliminated again. Mixed municipal solid waste can contain heavy metals, but the organic fraction is low in heavy metals. Hence a contamination can largely be avoided by separating the organic waste from other residues prior to composting.

Balanced nutrient content is defined by each customer differently according to individual needs. Hence, different products are available on the market. Pure compost contains a balanced mixture of nitrogen, phosphorous, potassium, calcium and other essential micronutrients. It cannot compete with artificial fertilizers in terms of nutrient content, but is especially beneficial due to the high content of organic matter and the presence of useful micronutrients. If higher nutrient contents are required, enrichment with other fertilizers is an option.

Figure 2.2: A Quality Control Laboratory facility

Figure 2.3 an Atomic absorption spectroscopy (AAS) Machine facility for determining heavy metals for compost quality control

Self-Check –2	Written test

Name…………………………………………… ID……………………….. Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Write true or false (4)

1. The compost needs to be frequently analyzed to provide important information about nutrient content and invisible pollutants like heavy metals

2. The application of immature compost causes root damage and nutrient loss, and therefore a reduction in yield

Test II. Short answer question (6)

1. Explain the quality criteria's for compost
2. List the matured compost indicators

***Note:* Satisfactory rating - 10 points Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Information sheet 3- Monitoring and adjusting production schedule

3.1. Introduction

In order to maintain an efficient operation and develop a safe, attractive product, you should regularly track the volume of incoming waste, the temperature and, possibly, the oxygen content of the piles, as well as evaluation of any odor generation. Perform an initial and regular follow-up analyses of the compost produced, including tests for contaminants and the compost's nutrient value. The data will help you evaluate the success of your operation and decide whether to alter your process. Also, it will provide information that will be requested from potential end users. While carrying out composting activities, quality control of the compost needs to be ensured by regular laboratory tests of incoming waste and final product compost.

Monitoring Aspects

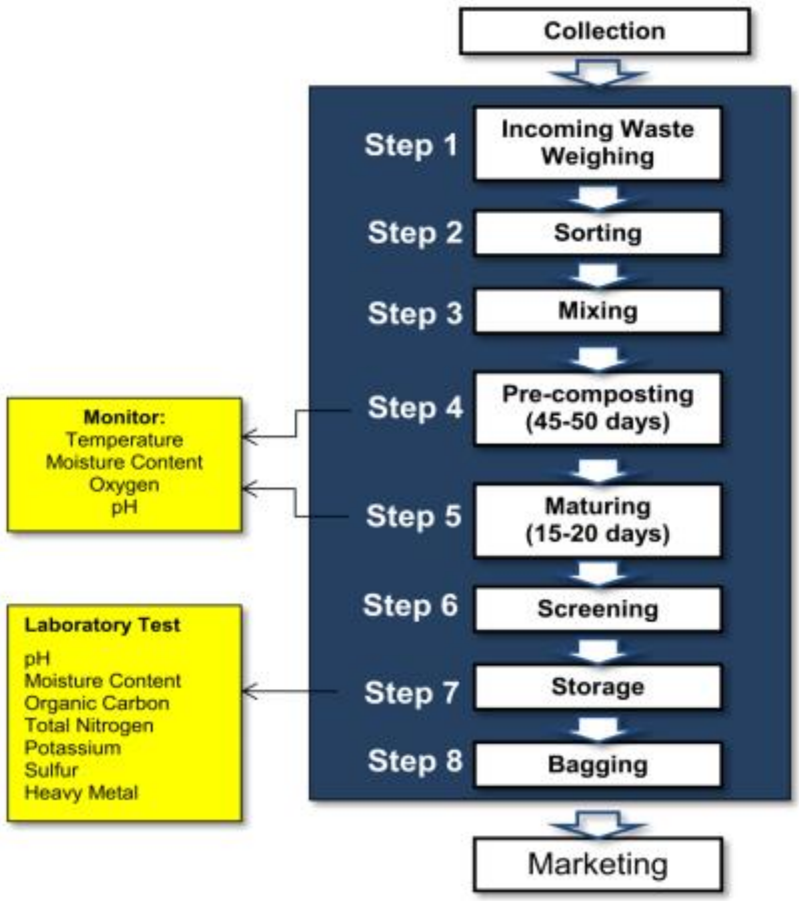


Figure 3.1.Monitoring of composting

Self-Check – 3	Written test

Name…………………………………………… ID……………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short answer questions (6 points)

1. What is the importance of monitoring
2. Describe composting activities that need monitoring and explain the parameters which require monitoring

Note: **Satisfactory rating - 6 points Unsatisfactory - below 6 points**

You can ask your teacher for the copy of the correct answers.

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Information sheet 4- Making required product available

4.1. Introduction

Compost is a diverse product and it would be wrong to consider all compost as the same. Variation in raw materials, plant management, processing, and presentation result in many product variations, including:

- grade: Very fine to very coarse;
- maturity: Raw or mature;
- form: Natural, powdered or pelletised;
- moisture content;
- nutrient levels: Negligible to enriched depending on input material, production method and processing;
- quality: Ranging from low quality with incidence of shards of glass/plastic or contaminants (e.g. heavy metals) to certified high quality products; and
- packaging: None for bulk collection or small bags for domestic use.

Understanding your market better: It is necessary for you to acquire a detailed understanding of your market. Some information can be obtained from secondary sources, but you really need to spend time talking directly to customers; these hold the answers to the key questions you should be asking.

Geographical

- Where are your customers located?
- Do they have means of transport (i.e. can they collect compost themselves)?
- How can they access your compost?

Uses

- What do customers want or need from compost?
- How will they use it? Why do they want compost?

Quantity

- How much compost will they use and how often?
- Is the market limited by the number of customers, cost or supply of compost? (i.e. do people buy as much as they can afford or as much as is available?) If compost is limited by supply, how much would the customer like to buy?

Quality

- What quality do customers require? Why? (e.g. aesthetics or safety for food crops)
- What types of input materials are acceptable? (e.g. agricultural waste, urban waste, sewerage sludge, human waste)

Quantifying market demand

We are now beginning to understand the range of market segments. We now need to quantify how much compost is required by each segment, and consider the business' ability to provide it. Demand is measured in terms of financial value based on volume per year.

Marketing can help define, adapt and refine your product for the needs of the market. Market analysis may reveal that there is a ready-made market for the type of product your business most naturally produces. On the other hand, it may reveal significant markets, untapped by competitors requiring a different type of compost (e.g. fine grade in small bags rather than coarse in bulk). Remember that since markets are dynamic, it is vital to regularly assess them and make changes to products if necessary.

It is important to ensure that there is a place for your compost in the market, or that a 'niche' can be carved out, for example, by promotion or education. To understand your product's position, consider the following questions:

- What exactly is the product you are making?
- How can your product be used?
- Is it particularly suited to certain uses?
- What is special about the product?

- Does it have a unique selling point or a competitive edge?
- How does your product compare with that of competitors?
- Can you offer greater value either by lowering the price or offering more? '

Branding' is the name, term or symbol that identifies your product. Some market specialists believe that what you call your product is the single most important product decision you make.

It can be difficult for customers to assess compost quality, so branding is imperative. Brands are an easy way for people to identify your product. Once satisfied with the product, they will look for the same brand again. As your reputation grows and improves, your brand can be a useful way of ensuring customers return to you for their compost. Compost can be branded with the name of your company or compost or a logo. You should always use a brand name on your packaging, leaflets and promotional material.

Figure 4.1.branding of compost

Self-Check – 4	Written test

Name…………………………………………… ID……………………….. Date……

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short answer questions (6 points)

1. Reason out why all compost are not the same
2. What are the questions you should consider to understand your product's position

Note: **Satisfactory rating - 6 points Unsatisfactory - below 6 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ___________
Rating: ____________

Name: _________________________ Date: _______________

Reference Materials

Book:

Adamtey, N. 2010. Nitrogen enrichment of compost and co-compost for maize (Zea mays L.) cultivation and its effects on the soil environment. PhD dissertation. University of Ghana.

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Michigan Compost Operator Training Guidebook

Operational Manual on Composting for Integrated Resource Recovery Center (IRRC) 2012

WEB ADDRESSES

- http://www.wikipedia.org
- http://www.compostnetwork.info/index.php, European Compost Network (ECN)

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