CROP PRODUCTION

Level -II

Learning Guide-28

Unit of Competence:-Assist Preparation of Organic Fertilizers

Module Title:-Assisting Preparation of Organic Fertilizers

LG Code: - AGR CRP2 M08 LO-01-LG-28

TTLM Code: - AGR CRP2 TTLM 0919v1

LO 01: Prepare raw materials and compost

Instruction Sheet	Learning Guide 28

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

- Identifying ,collecting and checking raw materials and additives
- Confirming composting technology and methods
- Pre-processing raw materials
- Mixing pre-processed raw materials
- Handling feedstock mixtures for composting
- .Assigning batch numbers or codes and creating batch documentation

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Identify, collect and check locally available materials
- Confirm composting technology and methods
- Handle Feedstock mixtures for composting
- Create and assign Batch numbers or codes and batch documentation

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number below 3 to 6
3. Read the information written in the “Information Sheets 1”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the “Self-check 1,2,3,4,5” in page :8,15,21,24,27and 30
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 1).
6. If you earned a satisfactory evaluation proceed to “Information Sheet 2”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.
7. Submit your accomplished Self-check. This will form part of your training portfolio.
8.

Information Sheet-1	Identifying ,Collecting And Checking Raw Materials And Additives

1.1. Definition:

Compost is an organic fertilizer that can be made on the farm at very low cost. The most important input is the farmer's labor. Compost is decomposed organic matter, such as crop residues and/or animal manure. Most of these ingredients can be easily found around the farm. Compost is a nutrient rich soil-like material created by the biological decomposition of organic materials such as vegetative debris and livestock manures. Compost can improve soil fertility, extend fertilizers, save water, suppress plant diseases, and boost soil tilth. Composting manures can improve manure handling and help to reduce their environmental impacts.

Composting is the practice of creating humus – like organic material outside the soil by mixing, pilling, or otherwise storing organic materials under conditions conducive to aerobic decomposition and nutrient conservation.

1.2. Specifying row materials for composting

- When selecting materials for composting, we have several primary goals:
  - Provide the desired ratio of carbon (C) and nitrogen (N)
  - Provide a balanced diet of all the other essential nutrients
  - Provide the greatest possible biological diversity to inoculate the pile
  - Provide a mix of particle sizes that favors aeration in the pile
  - Provide materials that favor adequate but not excessive moisture retention and be careful not to use toxic materials.
- Examples of materials available for composting include Animal mortalities, Bio solids such as : sewage sludge, Crop residuals, Dairy waste, Fats and oils, and Food organics such as: food processing waste, food waste ,kitchen waste, forestry residuals, manures, organic sludge's, other organic waste or by-product of processing, paper mill wastes, paper-based materials, sawdust and wood shavings, sewage facility grit and screenings, Wood and timber (non-treated).

1.2.1. Additives

- May include, but not limited to:
- Biological inoculants that aid the processing of particular
- Raw materials or manufacture of compost products with
- Particular attributes
- Ferrous sulphate or other chemical additives
- Lime
- Nutrients
- Urea.

1.2.2. Crop Residues

In general, any type of organic material of plants and animals can be used. It is essential to mix old and tough materials, which are difficult to decompose (crop residues, small twigs), with young and sappy materials, which are easily decomposable (fruit, vegetable skins, young leaves).Crop residues are used as mulches to cover the surface of the soil and help maintain favorable soil moisture content and temperature as well as prevent the accumulation of salts or the multiplication of weeds on the soil surface. These materials can well be combined with swine or poultry manure that has a high nitrogen content to make better compost for crops.

1.2.3. Green Manure

Leguminous green manure crops are an important source of natural nitrogen. They fix nitrogen from the air and at flowering stage are usually incorporated into the soil, about ten days before planting the main crop. In extensively cropped areas, green manure crops are of great value to farmers since they reduce fertilizer costs. These green manure crops that have low C: N ratio (lower than 20 at vegetative stage) can be considered primary sources of nitrogen.

1.2.4. Animal Manure (Cattle, Goat, Swine, Chicken)

Cattle manure has a reasonably high content of nitrogen, potassium, and fibrous materials. It is good animal manure because it does not have heavy metals and antibiotics in it. Repeated applications of this manure to the soil can be recommended, but phosphorus should be supplied from other sources to make up for its shortage in this manure. Nutrient content of goat manure is slightly higher than that of cattle manure.

1.2.5. Micro-organisms

The composting process happens due to the activity of microorganisms and other larger organisms like worms and insects. The first condition for composting is the presence of the composting organisms. Adding these organisms to the heap can be done by mixing ready-made compost with the organic materials. If there is no compost the soil can be added. Collect this soil preferably from a shady and humid place, e.g. from below trees. Soil that contains moisture contains micro-organisms. Soil that has been dried out by the sun usually does not contain many living organisms anymore.

1.2.6. Air

The micro-organisms in the heap require oxygen to survive and to do their work converting the organic material. The carbon dioxide which is produced by the micro-organisms as a result of their activity needs to be blown out by a flow of air. If there is not enough air in the heap, the useful micro-organisms will not survive. Other micro-organisms that do not need oxygen will thrive and decomposition of the organic material will slow down.

1.2.7. Moisture

The micro-organisms need moisture to live and to spread through the heap. The activity of the organisms will slow down if the heap is too dry. But if the heap becomes too wet, then there will not be enough air and the composting organisms will die. This will cause the heap to ferment rather than compost. Judging the right amount of water requires a little experience.

1.2.8. Moisture test

The moisture level of a compost heap can be tested easily. Put a bundle of straw in the heap. If after 5 minutes it feels clammy, then the moisture level is good; if still dry after 5 minutes, the moisture level is

too low.

- Moisture tester
- Cut lace/Machete
- Shovels/Spades
- Watering can
- Mattock ,Brush & grass cleaner

1.2.10. Personal protective equipment (PPE).

❖ Personal protective equipment's

- Eye Protection
- Hand Protection
- Foot Protection
- Hearing Protection
- Protective Clothing Figure:1

Advantages of Composting

- Composting improves the physical characteristics of agricultural wastes.
- It lowers the volume of waste by four-fifths its original volume.
- It sterilizes, because of high temperatures during composting, weed seeds, germs, and pests in agricultural wastes, reducing the cost of production and disease and pest control.

- It minimizes poor aeration problems. When directly applied without composting, agricultural wastes may exude toxic substances such as H2S, organic acids, and phenolic compounds and gas of methane and N2O.

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided.

Name: _____ Date: _____

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

1. What is composting?(2)
2. List row materials for composting?(3)
3. Discuss advantages of crop residues?(1)
4. Compare cattle, goat, swine and chicken manure?(2)
5. Write advantages for composting agricultural wastes for fertilizer use?(2)

Note: **Satisfactory rating - 5 and above points Unsatisfactory - below 5 points**

Name: _____ Date: _____

Short Answer Questions

Operation sheet-1	Organize for work

Organize for work

1. You are requested to select and prepare appropriate materials for composting

NB: - Raw materials that might be used as possible inputs to produce organic fertilizers are animal manure, agricultural residues, sewage sludge, composts, slaughter house wastes and municipality solid waste. It would be advisable to segregate potentially dangerous materials such as heavy metals such as cadmium, lead, zinc and chromium, and other physical contaminants, that might possibly be present in municipal wastes.

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 30 hour.

- **The following practical questions can serve as a guideline when you start making organic fertilizers:**

1 .what do people need to learn about making these fertilizers?
2. Where should the heap is set up?
3. How big can/may the heap be?

Information Sheet-2	Confirming composting technology and methods

2.1. Composting process and techniques

Composting is the natural process of 'rotting' or decomposition of organic matter by microorganisms under controlled conditions. Raw organic materials such as crop residues, animal wastes, food garbage, some municipal wastes and suitable industrial wastes, enhance their suitability for application to the soil as a fertilizing resource, after having undergone composting. Compost is a rich source of organic matter. Soil organic matter plays an important role in sustaining soil fertility, and hence in sustainable agricultural production. In addition to being a source of plant nutrient, it improves the physico-chemical and biological properties of the soil. As a result of these improvements, the soil:

(i) becomes more resistant to stresses such as drought, diseases and toxicity;

(ii) (ii) helps the crop in improved uptake of plant nutrients; and

(iii) (iii) Possesses an active nutrient cycling capacity because of vigorous microbial activity.

These advantages manifest themselves in reduced cropping risks, higher yields and lower outlays on inorganic fertilizers for farmers. be maintained to maximize the microbial activity in the compost production system.

- **Influencing Factors:**
- C: N ratio in raw materials.
- Moisture content
- Aeration
- Reaction
- Shredding
- Turning
- Microbial activity
- Nutrient supply

2.2. Types of Composting

Composting may be divided into two categories by the nature of the decomposition process. In **anaerobic composting**, decomposition occurs where oxygen (O) is absent or in limited supply. Under this method, anaerobic micro-organisms dominate and develop intermediate compounds including methane, organic acids, hydrogen sulphide and other substances. In the absence of O, these compounds accumulate and are not metabolized further. Many of these compounds have strong odours and some present phytotoxicity. As anaerobic composting is a low-temperature process, it leaves weed seeds and pathogens intact. Moreover, the process usually takes longer than aerobic composting. These drawbacks often offset the merits of this process, viz. little work involved and fewer nutrients lost during the process.

Aerobic composting takes place in the presence of ample O. In this process, aerobic microorganisms break down organic matter and produce carbon dioxide (CO2), ammonia, water, heat and humus, the relatively stable organic end product. Although aerobic composting may produce intermediate compounds such as organic acids, aerobic micro-organisms decompose them further. The resultant compost, with its relatively unstable form of organic matter, has little risk of phytotoxicity. The heat generated accelerates the breakdown of proteins, fats and complex carbohydrates such as cellulose and hemi-cellulose. Hence, the processing time is shorter. Moreover, this process destroys many micro-organisms that are human or plant pathogens, as well as weed seeds, provided it undergoes sufficiently high temperature. Although more nutrients are lost from the materials by aerobic composting, it is considered more efficient and useful than anaerobic composting for agricultural production. Most of this publication focuses on aerobic composting. 2 On-farm composting methods Composting objectives may also be achieved through the enzymatic degradation of organic materials as they pass through the digestive system of earthworms. This process is termed vermicomposting.

- **Methods of Composting**

There are a few methods available for production of compost namely:

(1) Heap method
(2) Pit method
(3) Cage method
(4) Barrel method

2.3. Compost Production Process

Composting systems are often described in terms of a complete process from the reception of raw material through to the handling of the end-product. However, when only the composting process itself is considered, most systems are nearly always variations of a common theme.

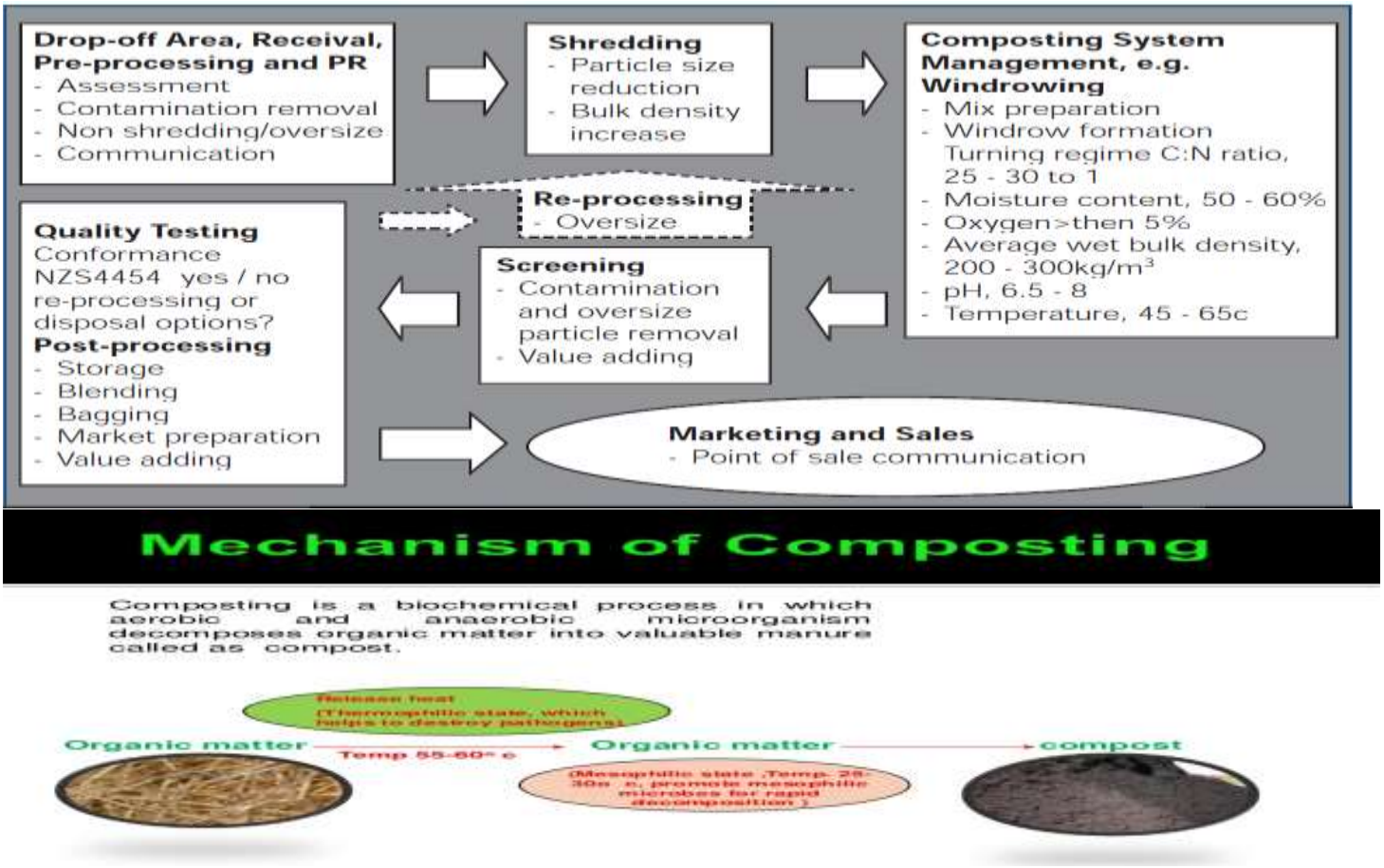


Figure-2.Composting and processing technologies and methods

2.4. Composting methods

Many composting methods have been developed over time. In the Netherlands, there has been a long history of compost use. Cities were already composting refuse and selling it to farmers before the introduction of synthetic fertilizers around 1900. In 1929 the city of The Hague started operating a composting plant using a modified version of the so-called Indore process in which large windrows

were used7. The Indore composting system was developed in India by Sir Albert Howard (1873-1947) during the 1920s. The method uses layered mixtures of high C/N feed stocks like plant leaves with low C/N feed stocks like animal manure in an approximately 3:1 ratio. Thick layers of crop residues are covered by thin layers of manure, and these are covered by very thin layers of topsoil and limestone.

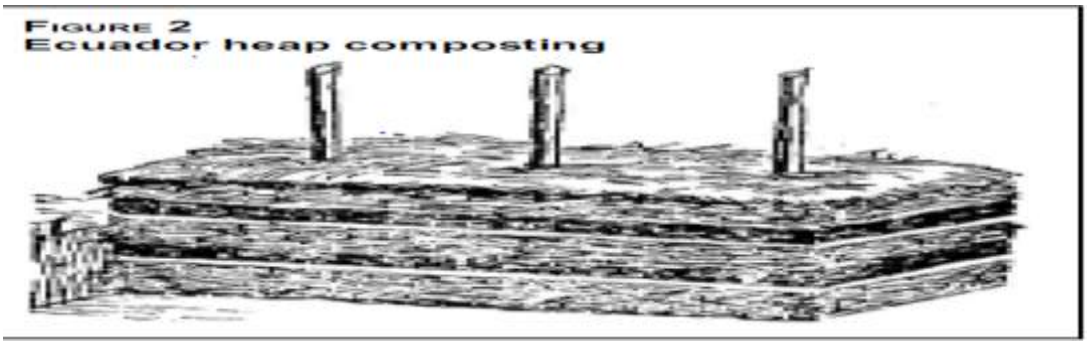
The waste is put into pits or trenches, or piled on open ground to a height of 1.5-1.8 m, and manually turned at 6-8 week intervals. The total composting time of the Indore method is 4-6 months7-8. In 1932 the Dutch government supported the establishment of a non-profit organization, which was entrusted with the composting of municipal refuse in Wijster: the VAM (Vuilafvoer Maatschappij) or Refuse Disposal Company. The manual process of the Indore method was adapted, and mechanical processes were introduced in some of the composting steps. In the 1930s and 1940s mechanical processes were further developed, mainly involving initial shredding and mixing of materials to facilitate composting. Giovanni Beccari developed and patented a new composting method in the 1920s in Florence, Italy.

The Beccari method starts with anaerobic fermentation, and has a final stage in which decomposition takes place under partially aerobic conditions. Another system was developed in the early 1930s in Copenhagen. Partial decomposition of the feedstocks was obtained by pre-treatment of refuse in a rotating silo or drum. The materials were mixed and grounded before they were composted using the Indore method7. In the 1940s Eric Eweson developed a rotary drum composting system in the US. Influenced by Sir Albert Howard, he designed a system in which the compost material is anaerobically fermented in a large rotary drum, for 3-6 days, followed by windrow composting.This system has been very successful, and is still being applied8.

- **May include, but not limited to**:
- In-vessel, such as: aerated turned trough, agitated bed, rotating drum, turned windrow composting, Open, such as: aerated static pile, static pile and Vermiculture.

- Pit method

- Heap method



Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided .

1. What is composting? (3)
2. List Processing technologies and methods (2)

Note: **Satisfactory rating – 2.5 and above points, Unsatisfactory - below 2.5 points**

Name: _____ Date: _____

Short Answer Questions

Operation sheet-2	Identifying handling and locating key processes and technologies.

Identifying handling and locating key processes and technologies.

- **You are requested to select and perform one of the following composting methodologies**

A. Heap

B. Pit

C. Cage

D. Trench composting

E. Barrel

PROCEDURES

A. HEAP METHOD

Building the heap

The basis of the heap should consist of twigs and cane shoots. The following successive layers are piled on top of this:

- a layer of about 10 cm tough organic material which is difficult to decompose;
- a layer of about 10 cm fresh organic material which decomposes easily;
- a layer of 2 cm animal manure, compost or slurry from a biogas tank.
- a thin layer of soil; the soil should be collected come from the top layer (top 10 cm) of clean (moist) soil (e.g. from under trees).

B. PIT METHOD

The layering is as follows:

1) 1 10 cm of material, which is difficult to decompose (twigs, stalks)
2) 10 cm of material which is easy to decompose (green and fresh)
3) 2 cm of animal manure (if available)
4) A thin layer of soil from the surface of arable land to obtain the micro-organisms needed for the composting process
5) Repeat these layers until the heap reaches 1 to 1.5m high
6) Cover with grass or leaves (such as banana leaves) to prevent water loss.

C. CAGE AND BARREL METHODS

- Prepare a cage with stakes or placed a compost barrel or compost bin in a suitable place.
- Advantage of these methods is raw materials can be added at any time.
- Cage or barrel can be filled with different raw materials alternatively according to their decomposition rate.
- In addition, inoculants can be added to increase the decomposition of raw materials.
- Since drying is fast in the cage method water should be added regularly to maintain the reasonable moisture content inside the cage.
- In addition, top of the cage can be covered with coconut frond or with suitable covering materials to maintain the optimum moisture content inside the cage.

Produced compost could be collected from the bottom of the cage or barrel.

D. Trench composting

1.10cm of material which is difficult to decompose (stalks or crop residues)

2. 10cm of material which is easy to decompose (fruit and vegetable scraps)

3. Add 2cm of animal manure (if available)

4. A thin layer of soil from the surface of arable land to obtain the micro-organisms needed for the composting process

5. Repeat these layers until the pile is about 50cm above the ground

6. Cover with soil, grass or leaves (such as banana leaves) to prevent water and nutrient loss and leave to settle for about one month before planting.

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within --- hour.

Task 1. Prepare compost by using pit method

Task 2. Prepare compost by using heap method

Information Sheet-3	Pre-processing raw materials

3.1. Identification of compost and other products

Making high quality compost requires some practice, experience and experimentation. There is not agreement on one best way to make compost and many different methods will work. Start with a “resource” approach rather than a “waste” approach. Work to increase the diversity of stock materials. Ask the hard questions about how to make a quality product that will demand a higher price and return a fair return for time invested.

A healthy compost pile should have much more carbon than nitrogen. A simple rule of thumb is to use one-third green and two-thirds brown materials. This allows oxygen to penetrate and nourish the organisms that reside there. Too much nitrogen makes for a heavy, smelly, slowly decomposing mass. Good composting hygiene means covering fresh nitrogen-rich material, which can release odours if exposed to open air, with carbon-rich material, which often exudes a fresh, wonderful smell. If in doubt, add more carbon!

3.2. Characteristics of products

Characteristics of the organic fertilizer produced from solid waste

The composted product was analyzed for OM, N, P, K, Zn, Cu and Cd, The result is shown in Table 1. The organic fertilizer produced contained an average of 2.0% N, 2.60% P, 1.75% K and 196 ppm Zn while the leachate contained 100 ppm NO3-N, 770 ppm NH4-N, 60 ppm K and P was trace while the pH was 7.4. The microbial population was determined by counting the number of colony-forming units per ml of sample using the serial dilution technique; it showed that the leachate had 4-x104 cfu/ml for bacteria and 1.0 x 102 cfu/ml for fungi but there were no rhizobia. It was noted that bacteria were more abundant than fungi.

Table 1. Analysis of the organic fertilizer produced

Chemical properties	Reading/analysis
OM (%)	32.00

N (%)	1.72
P (%)	2.60
K (%)	1.75
Zn (ppm)	196.00
Cu (ppm)	45.50
Cd (ppm)	0.00

⌘ Pre-processing is the activity that should be done for making favorable condition of material for composting.it may include, but not limited to:

- Immediate incorporation with absorbent raw materials
- Materials size reduction
- Moisture adjustment through such things as addition of water
- Particle size screening
- Physical contaminant removal.

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided.

1. What is the purpose of pre-processing? (3)
2. List the activities of pre-processing of composting? (3)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

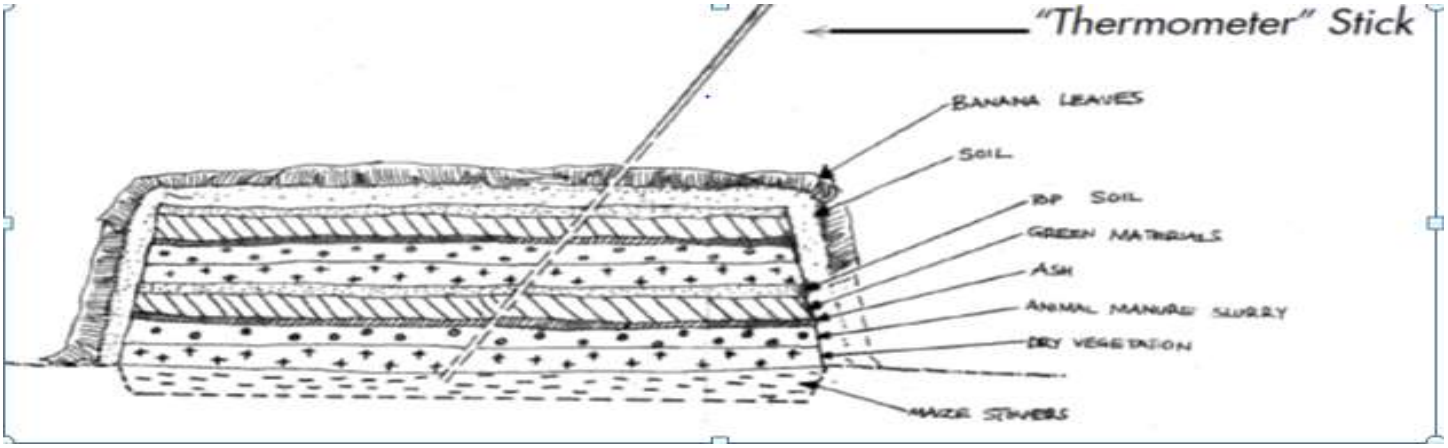
Name: _____ Date: _____

Short Answer Questions

Information Sheet-4	Mixing pre-processed raw materials

- Definition:

Composting (mixing of pre-processed raw materials) is the natural process of ‘rotting’ or decomposition of organic matter by microorganisms under controlled conditions. Raw organic materials such as crop residues, animal wastes, food garbage, some municipal wastes and suitable industrial wastes, enhance their suitability for application to the soil as a fertilizing resource, after having undergone composting.figure:3.



The end product of the process is compost or humus which, is of value in agriculture. In addition, compost could be considered as a value added product of organic materials, which has a high commercial value when compared to many other forms of organic materials. Organic fertilizers are derived from plant or animal materials.

In general, any type of organic material of plants and animals can be used. It is essential to mix old and tough materials, which are difficult to decompose (crop residues, small twigs), with young and sappy materials, which are easily decomposable (fruit, vegetable skins, young leaves).

- **Raw materials commonly used in their production include**:

- Animal manure
- Post-harvest plant material
- Organic waste

 Bio solids / sludge (human waste)

- **Micro-organisms**

The composting process happens due to the activity of microorganisms and other larger organisms like worms and insects. The first condition for composting is the presence of the composting organisms. Adding these organisms to the heap can be done by mixing ready-made compost with the organic materials. If there is no compost the soil can be added. Collect this soil preferably from a shady and humid place, e.g. from below trees. Soil that contains moisture contains micro-organisms. Soil that has been dried out by the sun usually does not contain many living organisms anymore.

- Air

The micro-organisms in the heap require oxygen to survive and to do their work converting the organic material. The carbon dioxide which is produced by the micro-organisms as a result of their activity needs to be blown out by a flow of air. If there is not enough air in the heap, the useful micro-organisms will not survive. Other micro-organisms that do not need oxygen will thrive and decomposition of the organic material will slow down.

- **Types Of Composting**

Composting may be divided into two categories by the nature of the decomposition process. In anaerobic composting, decomposition occurs where oxygen (O) is absent or in limited supply and aerobic composting takes place in the presence of ample O.

Self-Check -4	Written Test

Directions: Answer all the question

1. Define/explain the following:
   - Type of compost (5)?
2. List raw materials of composting (5)?

Note: **Satisfactory rating - 5 and above points, Unsatisfactory - below 5 points**

Name: _____ Date: _____

Short Answer Questions

Information Sheet-5	Handling feedstock mixtures for composting

5.1. Compost feedstocks

Different feedstock will add different amounts of carbon (energy) and nutrients to the compost. When composting on-farm, the availability of manure will influence the characteristics of the resulting compost. Some basic knowledge of manure types can be helpful in designing the right starting mixture for the composting process. The composition of manure is highly variable, according to animal type, animal diet, type of housing, and the amount and type of litter, and (spilling) water used. Storage conditions and the length of storage are important factors in the amount of gaseous losses. Treatment measures such as rotating the manure heap, aeration and the use of additives will also influence the loss of organic matter and nutrients.

Analysis of solid and liquid manures from cattle and solid manure from pigs on German organic farms has shown that minimum and maximum values from these farms were often wider apart than corresponding ranges of conventional farmyard Manures and that mean nutrient values tended to be in the lower to mid-range of conventional manures. Manure from deep-litter stables was found to be particularly rich in potassium, as this type of manure also contains the urine. Manure from ruminants (cattle, goats, sheep) differs essentially from manure from non-ruminants (pigs and poultry).Ruminants have a four-compartment stomach, and are able to digest structured and cellulose-rich plant materials, with the aid of fermentation by anaerobic bacteria that reside inside the rumen.

The nutrient ratio in the manure is comparable with the nutrient ratio of many crops. The ratio between protein and energy-yielding nutrition in the ruminant diet can significantly influence the nutrient contents of the manure. A low protein diet will result in lower total N contents of the manure, and in higher amounts of organic N2. Research on dairy farms on mineral soils in the Netherlands has shown that during the period 1997-2010, N-total, Total Ammoniacal Nitrogen (TAN) and K contents of dairy cattle manure significantly decreased, probably as a result of decreasing fertilizer inputs on the land. On the other hand, P and Mg contents in manure remained stable.

5.2. Compost starting mixes

In the previous paragraph we discussed how the input materials influence the characteristics of the produced compost. The choice of input materials also influences the composting process, and the resulting compost quality. To obtain a high compost quality, it is first of all important that the organic input materials are of high quality. They should be free from pollutants and other undesirable materials like plastics, metal or glass.

High-quality compost can only be produced with source separated organic materials. To guarantee a good composting process, the starting mixture has to have an adequate C/N ratio between 25 and 35. The mixture should also have an appropriate structure to allow optimal oxygenation of the material without too much loss of temperature. The higher the windrow is, the coarser the mixture has to be.

Figure-4-Wood chips (left) cannot be efficiently decomposed by compost microorganisms, whereas defibered wood (right) can. The use of defibered wood results in a better structure within the windrows and allows for a better aeration.

Self-Check -5	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided.

1. What is feed stock (5)?

Note: Satisfactory rating - 5 points Unsatisfactory - below 5 points

Name: _____ Date: _____

Short Answer Questions

Information Sheet-6	**Assigning batch numbers or codes and creating batch documentation**

6.1. Matching of batching sheets or other product formulas

When time and space is not critical, a farmer has significantly greater flexibility in how they use their compost. A batch of compost set up in the spring, even if not fully cured, can be applied to fields in the fall. However, batches set up in the summer and fall may not be mature enough for spring application, hence experienced farmers often wait a full year before using a batch to ensure the compost is fully cured and mature, especially when used on high-valued crops or in transplant medium.

Documentation is the key to GMP compliance and ensures traceability of all development, manufacturing, and testing activities. Documentation provides the route for auditors to assess the overall quality of operations within a company and the final product. Location of a plant is determined on the basis of proximity to raw material, nearness to potential market outlets and the availability of developed infrastructure. Consideration is also given to fair distribution of industrial projects. It is therefore proposed that the organic fertilizer plant be located near town.

Manure should be suitably contained before treatment. The location for storage and treatment of animal manure should be as far away as possible from produce growing areas. Barriers or some type of physical containment should be used in manure storage areas to prevent contamination of produce or production areas by pathogens. These can be spread from the stored manure by rain wash, subterranean water-flow or wind.

The batch number should be immediately recorded in a logbook or by electronic data processing system. The record should include date of allocation, product identity, and size of atch.Documentation of completion of each significant step in the batch production records (batch production and control records) should include:

1. Dates and, when appropriate, times
2. Identity of major equipment used (e.g., reactors, driers, mills, etc.)

3. Specific identification of each batch, including weights, measures, and batch numbers of raw materials, intermediates, or any reprocessed materials used during manufacturing
4. Actual results recorded for critical process parameters

- Generally, after all activities of composting is completed batch numbers or codes and creating batch documentation is the most important which can be done by the following way:

1. Manual or electronic recording systems that enable
2. Tracking of product such as:
3. delivery of final product via the assignment of batch numbers
4. individual batch preparation and formation
5. Production process.

Self-Check -6	Written Test

Directions: Answer all the questions listed below.

1. What is the importance of assigning code /number during documentation? (5)
2. List the ways of coding /numbering? (5)

Note: Satisfactory rating - 5 points Unsatisfactory - below 5 points

Name: _____ Date: _____

Short Answer Questions

CROP PRODUCTION

Level -II

Learning Guide-29

Unit of Competence:-Assist Preparation of Organic Fertilizers

Module Title:-Assisting Preparation of Organic Fertilizers

LG Code: - AGR CRP2 M08 LO-02-LG-29

TTLM Code: - AGR CRP2 TTLM 0919v1

LO 02: **Monitor composting process**

Instruction Sheet	Learning Guide 29

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

- Monitoring compost batch by observation and use of field testing equipment
- Maintaining processing and operations records
- Reporting faults or variations observed at any stage of process

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Monitor Composting batch by observation and field testing equipment
- Maintain , process and operations records
- Observe faults or variations at any stage of process , report to supervisor and take remedial action

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number below 3 to 6.
3. Read the information written in the “Information Sheets 1”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the “Self-check 1,2,3” in page :36,42 and 45
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6. If you earned a satisfactory evaluation proceed to “Information Sheet 2”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.
7. Submit your accomplished Self-check. This will form part of your training portfolio.

Information Sheet-1	Monitoring composting batch by observation and use of field testing equipment

1.1. Monitoring the process

Composting is the natural process of 'rotting' or decomposition of organic matter by microorganisms under controlled conditions. Raw organic materials such as crop residues, animal wastes, food garbage, some municipal wastes and suitable industrial wastes, enhance their suitability for application to the soil as a fertilizing resource, after having undergone composting. Compost is a rich source of organic matter. Soil organic matter plays an important role in Sustaining soil fertility, and hence in sustainable agricultural production. In addition to being a source of plant nutrient, it improves the physico-chemical and biological properties of the Soil.

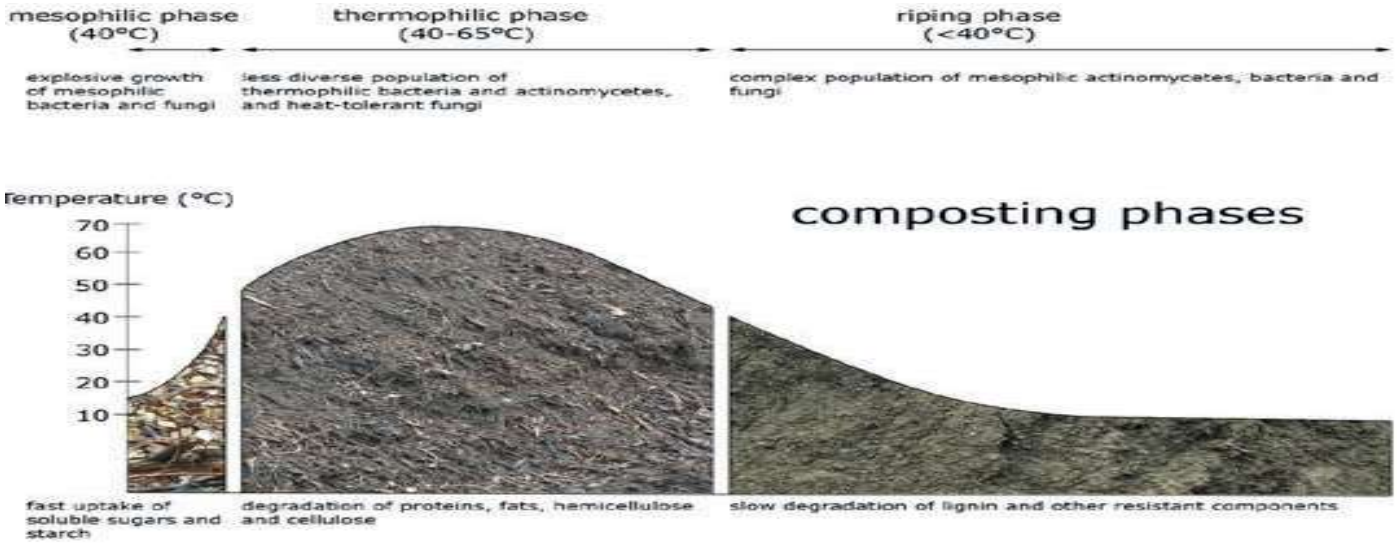
As a result of these improvements, the soil: (i) becomes more resistant to stresses such as drought, diseases and toxicity; (ii) helps the crop in improved uptake of plant nutrients; and (iii) possesses an active nutrient cycling capacity because of vigorous microbial activity. These advantages manifest themselves in reduced cropping risks, higher yields and lower outlays on inorganic fertilizers for farmers. The identification and evaluation of pertinent operational parameters and their bearing on the compost process are essential elements in the development of an effective monitoring program.

The attainment of these elements and understanding of their underlying principles can be greatly facilitated by a thorough knowledge of the sequence of events that takes place during the compost process when all conditions are satisfactory. Certain features of the course of the compost process can fill this role and serve as parameters in the monitoring of system performance. Three prominent features are: 1) temperature rise and fall, 2) changes in physical characteristics (odour, appearance, and texture).

1.1.1. Temperature rise and fall

A typical temperature change as a function of time is presented in Figure -5 below. As is indicated by the curve in the figure, the temperature of the material to be composted begins to rise shortly after the establishment of composting conditions, i.e., after the material has been windrowed or has been placed in a reactor unit. The initial change in temperature parallels the incubation stage of the microbial populations. If conditions are appropriate, this stage is succeeded by a more or less exponential rise in temperature to 60° to 70°C. The exponential character of the temperature rise is a consequence of the breakdown of the easily decomposable components of the waste (e.g., sugars, starches, and simple proteins). It is during this period that the microbial populations increase exponentially in population size. The temperature remains at this level (plateaus) over a period of time that is determined by the system used and the nature of the waste. Thereafter, the temperature begins to drop gradually until it reaches the ambient level.

In these cases, the temperature level probably would be lower, i.e., in the 50° to 60°C range. If any other condition is less than satisfactory, the results would also be a prolonging of the duration and a reduction of the level of the high-temperature plateau. Bacterial activity becomes less intense and the resulting temperature drops after the readily decomposable components have been degraded, and only the more refractory components remain. Consequently, it may be assumed in routine compost practice that by the time the temperature has descended to ambient or a few degrees above, the more biologically unstable components have been stabilized and, therefore, the material is sufficiently composted for storage or for utilization. Past experience indicates that the compost mass can be safely used or stored after the temperature has finally dropped to about 40°C.



1.1.2. Changes in physical characteristics

1.1.2.1. Appearance

Provided that the process is progressing satisfactorily, the composting mass gradually darkens and the finished product usually has a dark grey or brownish colour.

1.1.2.2. Odour

An assortment of odours replaces the original odour of the substrate within a few days after the start of the process. If the process is advancing satisfactorily, the succeeding odours probably could be collectively described as “faint cooking”. However, if conditions are unsatisfactory (e.g., an aerobiosis), the predominant odour would be that of putrefaction. If the C: N of the substrate is lower than about 20:1 and the pH is above 7.5, the odour of ammonia could become predominant. An earthy aroma is characteristic of the curing and maturing stages.

1.1.2.3. Particle size

Because of abrasion by the other particles and of maceration, the particle size of the substrate material becomes smaller. Additionally, decomposition renders fibers brittle and causes amorphous material to become somewhat granular.

Self-Check -1	**Written Test**

Directions: Answer all the questions listed below.

1. what is the importance of compost?(3)
2. list the Three prominent features factors of monitoring composting process?(3)

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Name: _____ Date: _____

Short Answer Questions

Information Sheet-2	Maintaining processing and operations records

2.1. Identify and carry out site maintenance requirements.

Composting may be defined as a biochemical process by which diverse and mixed group of microorganisms breaks down organic materials to humus. Some favorable characteristics of site include:

- Located adjacent to Public Works Facility –
  - Facilitates site monitoring of pubic use and easy access by Public Works Staff as needed to complete tasks.
- Compost pad is fenced and site is generally buffered from residential receptors or
- impacting other sensitive areas –
  - Reduces negative residential impacted by sight, noise, odors and dust.
- Outgoing Material Demand –
  - Finished mulch and compost material moves offsite quickly because of the demand by residents and local landscapers.
  - This minimizes the need for large material storing areas.
  - Material is readily available for the rented gardens.
- Paved Compost Pad
  - The paved compost pad provides an efficient and solid working surface to manage compost piles, which minimizes impact

(E.g. ponding) from rain events, reduces dust, improves vehicle mobility and eliminates soil and gravel being mixed into windrows.

5.2. Identifying Traffic access routes and site traffic/pedestrian safety rules.

Traffic Flow and Safety

- ✓ Residential and commercial vehicles that enter the drop off or
- ✓ Receiving area at the compost facility enter and park to unload or dump yard waste onto a centralized pile.
- ✓ In periods of low traffic volume, the current configuration appears to operate satisfactorily

- ✓ The configuration could be safer and more efficient.
- ✓ the finished compost and mulch is located inside the gate of the drop-off/receiving area,

5.3. Maintaining Vehicle access routes on site

- Vehicles, during the time of transportation of animal by-products other than manure or poultry litter must not enter any place where farm animals are kept.
- Vehicles and receptacles used for transporting compost products/material shall be maintained
- Containers, receptacles and vehicles used for transporting untreated material must be cleaned, washed and disinfected after each use, with the following exceptions:
  - In the case of vehicles transporting only untreated catering waste, only the wheels of the vehicle need to be cleaned and disinfected
  - Vehicles transporting external cleaning and disinfection procedures before leaving the Plant.
  - This is particularly important in the case of vehicles transporting manure where the vehicle is returning to a place where farm animals are kept.
- Wheel-wash facilities must be designed, operated and maintained in a manner which works properly.
- In the case of manually operated cleaning and disinfection facilities for containers/receptacles /vehicles, the cleaning procedures must be recorded and signed off by the transporter.

Therefore, optimum conditions should be maintained to maximize the microbial activity in the compost production system. Influencing Factors

- ♠ C: N ratio in raw materials.
- ♠ Moisture content
- ♠ Aeration
- ♠ Reaction
- ♠ Shredding
- ♠ Turning
- ♠ Microbial activity
- ♠ Nutrient supply

- **C: N ratio in raw materials**:

- Low C: N ratio in raw materials is beneficial for decomposition.

- Low C: N ratio increases microbial activity.
- Green leaves are low in C:N ratio
- Do not use materials with high C:N ratio alone.
- Arrange high C: N ratio and low C: N ratio raw materials alternatively.

➢ **Moisture Content** :

- Moisture is necessary for microbes
- If moisture is low microbial activity is also low
- Too much of moisture is not suitable.
- Optimum moisture should be maintained throughout the process.
- A suitable cover should be used to maintain the optimum moisture content.

➢ **Aeration:**

- During the composting process O_2 should be well supplied and CO_2 should be easily released.
- If not anaerobic condition may take place.
- Under the anaerobic condition bad odor may appear.
- To obtain good aeration arrange different types of raw materials in layers
- Turning may increase the aeration.
- Keep the reasonable width in heap method (maximum 6-7 feet).

➢ **Reaction:**

- Reaction is important for microbial activity.
- In the alkaline condition activity of microorganisms may reduce.
- Therefore, liming materials such as ash, lime and dolomite are not recommended.
- In addition, under the alkaline condition N in raw materials may loss as NH_3.
- Ash could be added after completion of the composting process.

➢ **Shredding**:

- Shredding or chopping of raw materials in to small pieces will increase the microbial activity.
- Increase aeration
- Optimum size of pieces is almost 5 cm.
- Increase surface area for microbial activity.
- Shredding is laborious.
- Recommended raw materials such as banana trunk, hard raw materials etc..
- In general shredding is not recommended due to high cost.

- **Turning**:
- Increase aeration
- Increase decomposition
- Un-decomposed raw materials may mix properly.
- Facilitate to keep the optimum moisture by adding water or drying.
- It is laborious.
- Maximum 3 times turning is recommended
- **Microbial activity**:
- Add inoculants after every 2-3 layers of raw materials.
- Inoculants may increase the microbial activity and increase the decomposition.
- In addition to compost decomposed garbage or any other organic materials are suitable as inoculants.
- **Nutrient supply**:
- Addition of N fertilizers reduces the C: N ratio and increase the decomposition of raw materials.
- Increase the microbial activity.
- Increase decomposition.
- Rock phosphate is suitable to enrich compost with P

1.2. Monitoring Environmental and occupational health and safety (OHS)

2.2.1. Environmental impact

I. Advantage

- **Benefits of Compost on Soil:**

- Improves Physical Properties: Increases water retention; improves soil aeration and structural stability; resistance to water and wind erosion; root penetration; soil temperature stabilization.
- Enhances Chemical Properties: Increases macro-and micronutrient content; availability of beneficial minerals; pH stability; converts nutrients to a more stable form, reducing fertilizer requirements.

- Improves Biological Properties: Increases the activity of beneficial micro-organisms; promotes root development; can increase agricultural crop yields; suppresses certain plant diseases; acts as bio-filter, bonding heavy metals.

II. Dis advantage

- **Leachate:**- Samples of liquid runoff, or Leachate, from the dump sites were tested and were found to have levels of contaminants that were far above the maximum allowed in drinking water. Most of this Leachate seeps untreated into groundwater, a source of drinking water, and runs into the River systems. The risks to human health are enormous.

Self-Check -2	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided.

1. Identify Conditions that affect production requirements? (5)
2. write down the advantage dis advantage of composting ?(5)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Name: _____ Date: _____

Short Answer Questions

Information Sheet-3	Reporting faults or variations observed at any stage of process

3.1. Occupational health and safety (OHS)

- **Respiratory Illness**

Acute respiratory illnesses include organic dust toxic syndrome, a febrile, influenza-like illness that occurs 4 to 12 hours after exposure and is self-limiting. This problem develops in about a third of grain and livestock farmers at some time.

- **Hearing Loss**

Farmers are regularly subjected to loud noises when working with machinery such as tractors, feed grinders, and chain saws.57'58 Noise made by large animals such as pigs can be loud enough to damage hearing.59 Hearing loss has been documented as early as the teenaged years in farm youth.60 As with other industries where high levels of noise are a problem, the noise-induced hearing loss initially occurs in the region of the cochlea responsible for higher frequencies. If noise exposure continues, the hearing loss extends to lower and higher frequencies, making normal human speech difficult to understand

- **In preparation of compost worker face so many hazards like**:-

-Contamination by different kinds of disease causing organisms.

-compost preparations areas are the home of different kind’s organisms that affect humans like snakes

-Different kinds of chemicals may be released due to different chemical process under taken in compost preparation.

- **WORKPLACE INSPECTIONS**

- **General requirement**

Every employer must ensure that regular inspections are made of all workplaces, including buildings, structures, grounds, excavations, tools, equipment, machinery and work methods and practices, at intervals that will prevent the development of unsafe working conditions.

- **Remedy without delay**

Unsafe or harmful conditions found in the course of an inspection must be remedied without delay.

- **Reporting unsafe conditions**

Whenever a person observes what appears to be an unsafe or harmful condition or act the person must report it as soon as possible to a supervisor or to the employer, and the person receiving the report must investigate the reported unsafe condition or act and must ensure that any necessary corrective action is taken without delay.

- **Emergency conditions**

If emergency action is required to correct a condition which constitutes an immediate threat to workers only those qualified and properly instructed workers necessary to correct the unsafe condition may be exposed to the hazard, and every possible effort must be made to control the hazard while this is being done.

Self-Check -3	Written Test

Directions: Answer all the questions listed below.

1. State hazards encountered in compost preparation?(3)
2. Discuss work place inspection?(3)
3. Discuss places in which regular inspection required? (4)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Name: _____ Date: _____

Short Answer Questions

CROP PRODUCTION

Level -II

Learning Guide-30

Unit of Competence:-Assist Preparation of Organic Fertilizers

Module Title:-Assisting Preparation of Organic Fertilizers

LG Code: - AGR CRP2 M08 LO-03-LG-30

TTLM Code: - AGR CRP2 TTLM 0919v1

LO 03: Manage crop residue/by-product

Instruction Sheet	Learning Guide30

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

- .Planning, designing and co-ordinating activities
- Separating crop residue/by-product
- Collecting and storing crop residue/leftovers and by-product after threshing
- Converting and using crop by-products

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- plan, design and co-ordinate activities to be undertaken in crop residue/by-product management and utilization
- separate crop residue/by-product from the crop
- collect and store crop residue/leftovers and by-product after threshing

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number below 3 to 6.
3. Read the information written in the “Information Sheets 1”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the “Self-check 1,2,3” in page:55,67,72 and 75
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 1).
6. If you earned a satisfactory evaluation proceed to “Information Sheet 2”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.
7. Submit your accomplished Self-check. This will form part of your training portfolio.

Information Sheet-1	Planning, designing and co-ordinating activities

1.1. Production Planning and Scheduling

Production planning is the function of establishing an overall level of output, called the production plan. The process also includes any other activities needed to satisfy current planned levels of sales, while meeting the firm's general objectives regarding profit, productivity, lead times, and customer satisfaction, as expressed in the overall business plan. The managerial objective of production planning is to develop an integrated game plan where the operations portion is the production plan.

1.1.1. Determining agro-ecological requirements for establishment of compost production

Selection of a compost heap, pit and basket site is very important for a better compost-making process. A heap/pit/basket/barrel method of the site should be selected close to where you want to use compost. The site should be sheltered from the sun, rain, and protected from surface run-off example put under a tree, under a roof or an old store or house to avoid loss of nutrients. A compost pit/basket should be under the shade of a tree to help retain moisture and flood water should not enter the pit. Trainees should be taken for an outdoor practice in selecting compost sites and should discuss about the location among them before reporting back to the trainer.

- If the site is not found in a good place with shade and appropriate slope in the area, a compost pit can be dug with some safeguards. These are:
- first, to make a shade with plastic, grasses, old sacks, etc. similar to the shade used in a seedling nursery
- Second, make structures to divert possible flood water from entering into the pit.
- Both these safeguards should be put in place after the pit/basket has been completely filled with composting materials.
- It is especially useful for food production in home gardens with basket.

- Using barrels might make it easier and more hygienic to practice composting near the house/residence.

There is ever increasing pressure on the farmer to reduce impacts to the environment from what have long been considered traditional methods of farming. In part, this is the result of a more stringent regulatory environment. It also results from more intensive farming methods combined with a decrease in land base. The following environmental issues also should be considered:

- Surface Water Contamination - Runoff
- Ground Water Contamination - Infiltration
- Nitrate Build-up in Agricultural Soil
- Legal and Cost Effective Alternatives for Organic Waste Disposal (Utilization)

1.1.1.2. On-Farm Composting Facility

A site for an agricultural composting facility must provide the required area and conditions for all weather composting as well as limit the environmental risk associated with odor, noise, dust, leaching, and surface water runoff. Site planning involves finding an acceptable location, adapting the composting method to the site, providing sufficient land area, and implementing surface water runoff and pollution control measures as needed. The materials being composted and system management will also impact these environmental concerns. In addition to the site regulatory requirements that may apply, it is important to be aware that starting a composting facility may raise concerns among neighbors and local public officials.

Educating these groups about composting and its advantages will be a critical part of getting started smoothly. It is essential to include concerned individuals in the planning process from the beginning to develop a “good-neighbor” working relationship. The location of the composting site should allow easy access, a minimum of travel and materials handling, and a firm surface to support vehicles under varying weather conditions. Usually the most convenient composting site on the farm is near the barn or manure storage facility. However the convenience of a particular site must be weighed against factors such as area, proximity to neighbors, visibility, drainage, and runoff control. The best site on the farm may not be the most convenient; or a convenient site may require modifications such as grading or drainage.

Odor is the single greatest reason for composting facilities to be shut down. Sites near sensitive locations, such as schools, hospitals, and nursing homes, should be avoided. Odors from the composting process are minimized through good management only if the composting system is properly designed and laid out. In siting the facility, consider the direction of prevailing winds during warm periods (open windows and outdoor activities) and cold periods (thermal inversions). Turning windrows should be avoided during high impact weather conditions. Consideration must also be given to the noise and dust resulting from the composting operations and from transport vehicles traveling to and from the site. This can be addressed somewhat by selective scheduling of activities during the day.

1.1.1.3. Separation Distances

The separation distance, or buffer zone, between the farm composting operation and streams, water resources, and nearby human housing is intended to address water quality concerns and the nuisance factors of odor, dust and equipment noise.

Sensitive Area	Minimum Distance (feet, 0ne feet = 0.3m)
❖ Residence or Place of Business	200 - 500
❖ Private well or other potable water source	100 - 200
❖ Wetlands or surface water (streams, ponds, lakes)	100 - 200
❖ Water table (seasonal high)	2 - 5 (vertical)

1.1.1.4. Drainage Requirements

Good drainage at composting sites is critical. Poor site drainage leads to ponding of water, saturated composting materials, muddy site conditions, and excessive runoff and leachate from the site. In areas of high precipitation, composting operations should be conducted on an impervious surface, such as concrete or asphalt, or under cover to provide all-weather access to composting equipment and to avoid contamination of the finished compost with soil and rocks. An impervious surface also serves to protect infiltration of compost leachate and prevent contamination of the ground water.

The site should be graded to direct surface water runoff to one or more collection points (e.g., catch basins, manure lagoons, retention ponds). The collected runoff can be directed to pasture, cropland, or retained for future beneficial use. Run-on water or the surface water from surrounding land that drains

onto the site should be diverted away from the composting pad and storage areas. This can be accomplished by using diversion ditches, interceptor drains.

1.2 Determining materials required for compost making

- **All clean organic recyclable materials** can be used for compost making. But listing all for a trainee does not help, even it confuses her/him. It is best if the composting materials are grouped into four categories, and then the trainees can suggest materials they know that fit each category. These are:
- **Dry stalks (stover)** – maize, sorghum, grasses with thicker stems, or thin branches from trees, which could not decompose easily. These are put in the bottom of the compost pit to make sure there is a good circulation of air and moisture inside the pit.
- **Dry plant materials** – this refers to all kinds of dry biomass such as straw of field crops, all kinds of weeds, grasses, etc. It is preferred if these materials are the leftovers from animal feed and bedding. This is because there is no need to compete with clean straw and grass needed for animal feed. These leftovers also have the advantage of already being mixed with urine and fresh animal dung produced by the animals while they are in the barn. The urine and dung are very good for improving decomposition of the straw and the establishment of compost making micro-organisms.
- **Green plant materials** - all kinds of green plant material; such as leaves and soft branches, weeds, grasses, etc. Troublesome weeds such as Parthenium and spiny/thorny plants can also be included.
- **Qimemaqmem** - Starter material = "spices" – is a mixture of other naturally decomposable materials other than stalks, dry and green plant materials mentioned above. Farmers called it "qimemaqmem" because it is used at every step of compost making. Dry qimemaqmem is a dry starter, which includes any animal manure (dike in afan Oromo or figh-Amharic), bird and chicken droppings, ash, fertile soil, etc; and Wet qimemaqmem is a fresh or wet starter including fresh animal dung, urine (human and animal) and water. This mixture contains the micro-organisms (worms, beetles) as well as the fungi and bacteria that do the work of turning the plant and animal materials into compost.

Others: biosolids such as sewage sludge, fats and oils, food organics such as: food processing waste, food waste, • kitchen waste, forestry residuals, organic sludge's, other organic waste or by-product of processing, paper mill wastes, paper-based materials, sawdust and wood shavings,

- **Prepare testing stick** – it is used to test the condition inside the composting materials in a pit.

  It is also recommended that the trainer also arranges to have compost materials collected 1 or 2 days before the training is to take place.

1.2.1. Identify materials not part of compost

- Recommendations in listing materials not to be included as part of the compost preparation should be considered and these includes fuel (kerosene, diesel, petrol), engine oil, stones, pieces of iron, broken glass, plastic materials, any pieces of clothes (especially nylon or plastic cloth), hyena or dog droppings, any type of wax, any type of fat, hide/skin, etc.

1.3 Organize for processing

- The following major activities should be organized
- The Job sheet/Operation sheet should be provided, and reviewed to clearly identify all processing requirements.
- Cropping calendar and climatic conditions in relation to the type of organic fertilizer to be prepared should be analyzed and determined
- Machinery (particle size screening machinery such as trammel screens, vibrating screens, power screens or screening plants size reduction machinery such as tub-grinder, hammer mill, shredder or rotary shear, windrow turning machinery and other specialized machinery), equipment and raw materials should be selected and identified.
- Potential OHS hazards (biological hazards associated with waste, ergonomic hazards associated with manual handling, physical hazards such as: compressed air and water, dust, hammer mills and grinders, hot or cold weather conditions, noise, shredders, underfoot conditions, vehicles and mobile machinery sharps or other physical contaminants in materials. and risks should be identified and assessed.
- Suitable personal protective equipment (PPE) (such as dust masks, earmuffs, fire extinguishers, gloves, hard hats, protective clothing, reflector high visibility, vests, safety footwear, safety glasses etc) should be selected, fitted, used, and maintained.

1.4 Scheduling production activities

Production scheduling has three primary goals or objectives. The first involves due dates and avoiding late completion of jobs. The second goal involves throughput times; the firm wants to minimize the time a job spends in the system, from the starting of site selection to until the produce is completed. The third goal concerns the utilization of work centers. Firms usually want to fully utilize costly equipment and personnel. Composting is the microbiological transformation of organic materials under controlled aerobic conditions. There are two phases to the thermophilic composting process:

 Pasteurization which generates heat within the material to significantly reduce the number of viable pathogens and plant propagules

 Maturation which sees the decline in microbial activity and an increase in biological stability of the organic material. These phases are discussed further in section 7 below.

A combination of feedstock (organic wastes), siting and process factors determine the level of risk that composting facilities pose to the environment, human health and amenity. Best practice design and operation of facilities can minimize many of the potential impacts.

The standard provides information on the composting process as well as product standards. This guideline has been informed by elements of the 2012 edition of the standard that relate to environment protection.

Before making compost the producer should prepare the action plan to address what activities has to be done and when to implement each targeted activities to meet the proposed target. After listing all major activities that have to be implemented (with date or month) the responsible bodies should also be indicated clearly in the plan. To meet the production requirements scheduling major activities is important in order to clearly list and give responsibilities to the concerned bodies. In scheduling determining the type of crops targeted to be cultivated and the market should be given in an account.

Table 1. Schedule for compost preparation & utilization

SN	List of activities	Months/weeks/dates proposed for implementation											
1.	Determine type of crop to be cultivated												
2.	Decide the amount of compost to be applied on target area and available for selling												
3.	Determining methods of composting												
4.	Identify tools, equipments & materials and make ready for compost making												
5.	Identifying raw materials for composting												
6.	Select the site of compost preparation												
7.	Based on the method of composting chosen prepare the pit/barrel/basket composting methods												
8.	Prepare compost												
9.	Follow up and maintenance												
10.	Prepare the compost storage												
11.	Promote the product												
12.	Plant the crop and apply on target area/crop and supply to the market												
13.	Collect feedback from crop performance or yield and customers (customer survey)												

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided.

7.2. Establish production requirements (3)?

7.3. The following environmental issues also should be considered (3)?

7.4. Determining materials required for compost making (4)?

Note: **Satisfactory rating – 5 points** **Unsatisfactory - below 5 points**

Name: _____ Date: _____

Short Answer Questions

Information Sheet-2	Separating crop residue/by-product

2.1. Identifying the Major Sources of Organic Matter

1. Livestock and human wastes

- Cattle – shed wastes such as cattle and buffalo dung, and urine.
- Other livestock and human excreta.
- By-products of slaughter-houses and animal carcasses: blood and meat wastes, bones, horns, hooves, leather and hair wastes.

2. Crop residues, tree wastes and aquatic weeds

- Crop residues of cereals, pulses and oil seeds.
- Stalks of corn, cotton, tobacco, sugarcane trash, leaves of cotton, jute, tapioca, areca nut, tree leaves, water hyacinth, forest litter, etc.

3. Urban and rural wastes

- Urban and rural solid wastes.
- Urban liquid wastes – sewage and slag.

4. Agro – industries by – products

- Oil-cakes.
- Paddy husk and bran.
- Bagasse and pressmud.
- Sawdust.
- Fruit and vegetable wastes.
- Cotton, wool and silk wastes.
- Tea and tobacco wastes

5. Marine wastes

- Fish meal and aquatic/ sea weeds.

Table- 2. The major nutrient contents of main raw materials for ex – situ manuring.

Name of materials	Natural dried			Fresh		
	N%	P%	K%	N%	P%	K%
Dejecta & Urine	4.689	0.802	3.011	0.605	0.175	0.411
Human D & U	9.973	1.421	2.794	0.643	0.106	0.187
D	6.357	1.239	1.482	1.159	0.261	0.304
U	24.591	1.609	5.819	0.526	0.038	0.136
Pig D & U	3.773	1.095	2.495	0.238	0.074	0.171
D	2.090	0.817	1.082	0.547	0.245	0.294
U	12.126	1.522	10.679	0.166	0.022	0.157
Horse D & U	2.552	0.419	2.815	0.378	0.077	0.573
D	1.347	0.434	1.247	0.437	0.134	0.381
Cattle D & U	2.462	0.563	2.888	0.351	0.082	0.421
D	1.560	0.382	0.898	0.383	0.095	0.231
U	10.300	0.640	18.871	0.501	0.017	0.906
Sheep D	2.317	0.457	1.284	1.014	0.216	0.532
Chicken D	2.137	0.879	1.525	1.032	0.413	0.717
Rabbit D	2.115	0.675	1.710	0.874	0.297	0.653
Duck D	1.642	0.787	1.259	0.714	0.364	0.547
Goose D	1.599	0.609	1.651	0.536	0.215	0.517
Silkworm D	2.331	0.302	1.894	1.184	0.154	0.974
Stall Manure	0.925	0.316	1.278	0.429	0.137	0.487
Pigsty M	0.958	0.443	0.950	0.376	0.155	0.298
Stable M	1.070	0.321	1.163	0.454	0.137	0.505
Bullpen M	1.299	0.325	1.820	0.500	0.131	0.720
Sheep code M	1.262	0.270	1.333	0.782	0.154	0.740
Straw	1.051	0.141	1.482	0.347	0.046	0.539
Rice S	0.826	0.119	1.708	0. 302	0.044	0.663
Wheat S	0.617	0.071	1.017	0.314	0.040	0.653
Maize S	0.869	0.133	1.112	0.298	0.043	0.384
Soybean S	1.633	0.170	1.056	0.577	0.063	0.368

Rape S	0.816	0.140	1.857	0.266	0.039	0.607
Potato S	2.403	0.247	3.581	0.310	0.032	0.461
Sweet Potato S	2.131	0.256	2.750	0.350	0.045	0.484
Groundnut S	1.658	0.149	0.990	0.572	0.056	0.357
Broad Bean S	2.215	0.204	1.466	0.482	0.051	0.303
Tobacco S	1.295	0.151	1.656	0.368	0.038	0.453
Agri – by – product						
Rice Husk	0.310	0.034	0.307			
Maize Cobs	0.606	0.071	0.542			
Bagasse	1.001	0.128	1.005	0.205	0.043	0.511
Bean Cake	6.684	0.440	1.186	4.838	0.521	1.338
Oil P Cake	5.250	0.799	1.042	5.195	0.853	1.116
Wine P Residue	2.867	0.330	0.350	0.714	0.090	0.104
Cassava Residue	0.475	0.054	0.247	0.106	0.011	0.051
Sea Manure	2.513	0.579	1.528	1.178	0.332	0.399
Urban Residue	0.319	0.175	1.344	0.275	0.117	1.072
Rural Residue	0.882	0.348	1.135	0.317	0.173	0.788
Mixed Manure						
Soil Manure	o.239	0.247	1.620	0.183	0.102	1.530
Fertile Soil	0.555	0.142	1.433	0.207	0.099	0.836
Humic Acids	0.956	0.231	1.104	0.438	0.105	0.609

2.2. Methods to Make Compost

Principles in Composting

Composting may be defined as a biochemical process by which diverse and mixed group of microorganisms breaks down organic materials to humus. Therefore, optimum conditions should be maintained to maximize the microbial activity in the compost production system.

Influencing Factors

- C: N ratio in raw materials.
- Moisture content
- Aeration
- Reaction
- Shredding

- ♠ Turning
- ♠ Microbial activity
- ♠ Nutrient supply

There are a few methods available for production of compost namely:

(1) Heap method
(2) Pit method
(3) Cage method
(4) Barrel method

2.2.1. Indore Method

The Indore Method is much used for composting in layers.

Building the heap

The basis of the heap should consist of twigs and cane shoots.

The following successive layers are piled on top of this:

➢ A layer of about 10 cm tough organic material which is difficult to decompose;

➢ A layer of about 10 cm fresh organic material which decomposes easily;

➢ A layer of 2 cm animal manure, compost or slurry from a biogas tank.

➢ A thin layer of soil; the soil should be collected come from the top layer (top 10 cm) of clean (moist) soil (e.g. from under trees). This ensures that the right micro-organisms are brought into the heap. This sequence of layers is repeated until the heap has reached a final height of 1.5 to 2 meters. In this way the heap is composed of many layers. Building the heap should be done quickly, preferably within a week.

Turning over

During decomposition the heap has to be turned over regularly, in order that it remains well aerated and all the material is converted into compost. The first turning over of the heap should be done after 2 to 3 weeks. The heap is broken down and built up again next to the old heap. The layers are mixed and the heap is, as it were, turned upside down and inside out. Again, a foundation of coarse plant material is made first. Then the drier and outer, less decomposed part of the old heap is placed in the central part of the new heap. The drier material will have to be watered before the heap can be built up further.

This core is covered with the rest of the. Material The original layered structure is lost. The second turning over takes place after 3 weeks and it may even be necessary to turn the heap over again for a third time. Repeat the moisture test and the temperature test a few days after each turning over operation.

- **Time for decomposition**

Decomposition is complete if the plant material has changed into an unrecognizable crumbly, dark mass. Twigs and thick stems do not decompose completely and can still be seen. Under favorable conditions, the decomposition process in the Indore Method takes 3 months, but under adverse conditions it may take longer than 6 months. Some substances, such as human urine and wood ash promote.

- **Growth of the micro-organisms.**

A small amount of these in the heap is sufficient to accelerate their growth. If the process has to be speeded up spread some urine or wood ash over the thin layers of soil, but only in small quantities; too much ash kills the micro-organisms. Urine, diluted with water 1:4 is sprinkled over the heap, using a watering can. The Indore Method usually gives good results.

- **The advantages of this method are**:

➢ the process can be kept under control and runs smoothly, because the heap is turned regularly;

➢ Compost is produced in a short time.

Disadvantages of this method are:

➢ it requires much water;

➢ it is very labour intensive.

2.2.2. Pit composting

This method involves making compost in pits which have been dug in the ground. The best depth for a pit varies according to local soil conditions and the depth of the water table. A typical pit would measure 1.5 to 2 m wide, 50 cm deep and any length. The pit can be lined with a thin layer of clay to reduce water loss. Often, several trenches are dug next to each other, to allow turning from one pit into the next.

Material should be placed in the pit in layers as described below. For a larger pit measuring 2m wide, 2m long and 1 m high, 1 to 1.5 liters of water should be poured on before applying the layer of soil, which seals the pit.

- The layering is as follows:

1. 10 cm of material, which is difficult to decompose (twigs, stalks)
2. 10 cm of material which is easy to decompose (green and fresh)
3. 2 cm of animal manure (if available)
4. A thin layer of soil from the surface of arable land to obtain the microorganisms needed for the composting process
5. Repeat these layers until the heap reaches 1 to 1.5 m high
6. Cover with grass or leaves (such as banana leaves) to prevent water loss

After 2 to 3 weeks, all the contents of the pit should be turned over intothe second pit and 2 to 3 weeks later this should be turned into the third pit. As the decomposing material from pit 1 is turned into pit 2, new material, which is ready for composting, can be put into pit 1, thus creating a process of continual compost making.

- **Advantages:**

Pit composting is quick, easy and cheap as it does not require investment in materials. It needs less water so it is useful for dry areas.

Disadvantage:

It is more difficult to follow of the decomposition process than with an above ground heap.

2.2.3. Trench composting

Trench composting is similar to pit composting except that plants are grown directly onto the pit as opposed to taking the compost out of the pit and spreading it on land. A trench should first be dug. The size depends on how much material you have available and how many plants you are planting in the trench. The width can range from 50cm to several meters, the depth lm or less and it can be any length.

- **It should then be filled as follows**:

1. 10 cm of material which is difficult to decompose (stalks or crop residues)
2. 10 cm of material which is easy to decompose (fruit and vegetable scraps)
3. Add 2 cm of animal manure (if available)
4. A thin layer of soil from the surface of arable land to obtain the microorganisms needed for the composting process
5. Repeat these layers until the pile is about 50 cm above the ground
6. Cover with soil, grass or leaves (such as banana leaves) to prevent water and nutrient loss and leave to settle for about one month before planting Less digging is required if the trenches are dug as shown in the picture. In these smaller, individual trenches layers of soil should be added in between the organic material. It should be left to settle for about a month before planting. These trenches make more efficient use of organic material because more crops can be grown in the same area as a wider trench.

Advantages:

Trench composting is especially useful against termite attack as most species live above ground level.

2.2.4. Barrel method

If materials for composting are in short supply, you can still make good use of them by using the basket method of composting. It is especially useful for food production in home gardens. The method is as follows

1. Dig circular holes 60 cm in diameter and 60 cm deep
2. Line the bottom with material which is difficult to decompose (twigs, stalks)
3. Add 8 cm of animal manure

4. Add 15 cm of green vegetation (young leaves that have a high water content)
5. Add 0.5 cm of ash
6. Repeat steps 3 to 5 until the hole is full
7. Cover with grass or leaves to prevent water and nutrient loss
8. Using thin sticks and weaving them together, mark the circular outline of the pit with a round 'basket', 10cm in height. Seeds or seedlings can then be planted around the basket structure. The plants will make use of the nutrients in the compost. If you build more compost baskets in your garden, place them in different areas every time so that the whole garden becomes more fertile.

- **Advantages:**

Basket composting makes good use of nutrients for a small kitchen garden. This method is also good for using up small quantities of waste.

- **Site of the compost heap**

Choosing a good place for a compost heap is important. Bear in mind the following points:

- **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.

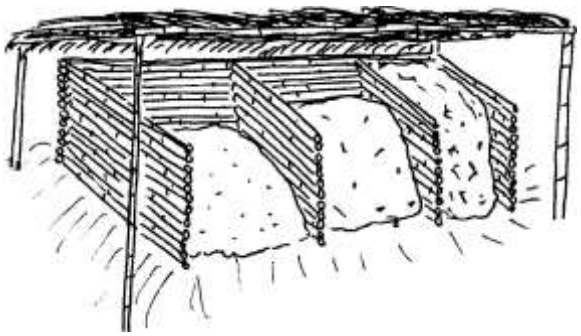


Figure -6: Simple roof above three compost heaps (Mira Louis)

- **Transport**

The heap should be situated as close as possible to the source of organic material (for instance, the field or harvesting place). It should also be near the place where the compost is to be used. This saves time and labor in transport or organic material and compost. Space around the heap. There should be enough space around the heap to enable the compost to be turned over or examined. A space about 2 to 3 times that of the heap itself is the most practical. (Read the learning module for further discussion).

2.3. Identification of characteristics of raw materials

- When selecting materials for composting, we have several primary goals:
  - Provide the desired ratio of carbon (C) and nitrogen (N)
  - Provide a balanced diet of all the other essential nutrients
  - Provide the greatest possible biological diversity to inoculate the pile
  - Provide a mix of particle sizes that favors aeration in the pile
  - Provide materials that favor adequate but not excessive moisture retention

All compostable materials are either carbon or nitrogen-based. The secret to a healthy compost pile is simple: maintain a working balance between these two elements Carbon - carbon-rich matter (like branches, stems, dried leaves, peels, bits of wood, bark dust or sawdust, shredded brown paper bags, coffee filters, conifer needles, egg shells, hay, peat moss, wood ash) gives compost its light, fluffy body. Nitrogen - nitrogen or protein-rich matter (manures, food scraps, leafy materials like lawn clippings and green leaves) provides raw materials for making enzymes.

- Suggestions for information to be recorded:

  - Origin of the organic materials used
  - Date composting process started
  - Treatment applied
  - turning of windrows (minimum five times)

 Temperatures during composting (daily temperature readings of 55°C (131°F) or higher should be attained).

 Period at 55°C (131°F) or higher for windrow composting.

 Source and physical make-up of composted material

 Amount used

 Place of application

 Date of application

 Method of application

 Person responsible for application

 Microbiological testing (Acceptable: *E. coli* <1,000 /gram and *Salmonella* < 3 MPN/4 grams) [MPN= Most Probable Number]

2.5. Ensuring adequate available storage capacity

- Storage and Warehousing

1. Stocks of organic raw materials, work in progress and finished products must be clearly labeled and kept separate from non-organic products, so as to avoid any possible contamination or accidental mixing of materials.

2. Storage areas, bins and containers for organic raw materials and products must be:

 Clean and free from non-organic material. Ideally, they should be left clean and empty for a period of time before use to break the reproductive cycle of any pest or disease present.

 Dedicated to organic produce or products only;

 in an area separated from non-organic raw materials by sufficient space or physical barriers to prevent cross contamination

 labeled clearly enough to prevent mistakes being made between organic and non-organic produce.

 Constructed of suitable materials for food use when in contact with the raw materials;

 Protected from access and contamination by birds, insects and vermin;

 Subject to a regular cleaning programme to ensure that they are maintained in a generally clean state and they are free from visible residues or any material that may contaminate or impair the organic integrity of the products held therein;

 regularly inspected for cleanliness, good housekeeping and to ensure proper stock control and rotation.

2.6. Labeling of raw material stockpiles clearly

- Record Keeping

Records must be maintained sufficient to identify the organic and non-organic ingredients and raw materials purchased and used, both the overall quantities and those used for each specific recipe or listed item.

- Labeling

The following information must be displayed clearly in the licensed operation:

1. The annual certificate of registration/license/symbol certificate
2. A statement describing the nature and scope of the certification (Note: This should identify whether the whole operation is certified or whether certification is limited to specific dishes/part of dishes and in what specific areas).
3. A statement describing the organic purchasing policy of the operation.
4. A complete and up to date list of the organic ingredients and products used.
5. A complete and up to date list of the non-organic ingredients used.

Self-Check -2	Written Test

Directions: Answer all the questions listed below..

1. What are the advantages of Heap method of composting?((2)
2. Write at least four tips for successful composting(3)
3. Write the influencing factors of composting (5 points)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Name: _____ Date: _____

Short Answer Questions

Information Sheet-3	Collecting and storing crop residue/leftovers and by-product after threshing

3.1. Initial handling requirements, stockpiling location and arrangement on site

Location of a plant is determined on the basis of proximity to raw material, nearness to potential market outlets and the availability of developed infrastructure. Consideration is also given to fair distribution of industrial projects. It is therefore proposed that the organic fertilizer plant be located near town. Manure should be suitably contained before treatment. The location for storage and treatment of animal manure should be as far away as possible from produce growing areas. Barriers or some type of physical containment should be used in manure storage areas to prevent contamination of produce or production areas by pathogens. These can be spread from the stored manure by rain wash, subterranean water-flow or wind. Contamination of groundwater supplies can be minimized by storing animal manure on a cement floor or in special holes lined with clay.

Rainfall on manure piles can result in a run-off containing pathogenic bacteria that can contaminate the fields, equipment, etc. Therefore, manure piles should be covered with plastic or other materials and/or stored underneath a raised shed. Equipment (tractors) coming into contact with untreated manure can be a source of contamination for the produce and/or the production area. Equipment should be cleaned with high-pressure water or steam before it is allowed into the production area. In a similar way, personnel handling manure should not enter the growing fields without paying attention to personal hygiene.

Treated manure should be kept covered and away from waste and garbage to prevent recontamination by birds or rodents. It should be stored well away from the growing fields and separated from product packaging material, so it will not contaminate the fresh produce, water sources or packaged products. Properly-treated organic fertilizer should be applied prior to planting or during the early stages of plant growth. It should be applied near the roots and covered with soil. Organic fertilizers should NOT be used when the fruit or vegetable is nearing maturity or harvest.

3.2. Identifying, collecting and checking locally available raw materials and additives for processing

- Locally available raw materials are:

• Young plant leaves, Animal and human wastes, Manures, cow dung, vegetable remainings, astraws of different crops, and pruned plant parts.

• Remaining's of food ,wood straws ,FYM and waste products of slaughter house

Additives may include

• Biological inoculants that aid the processing of particular raw materials or manufacture of compost products with particular attributes

• Ferrous sulphate or other chemical additives like lime, nutrients and urea

3.3. . Confirming Composting *technology and methods* to be used

Composting approaches

Passive composting involves simply stacking the materials in piles to decompose over a long time period with little agitation and management. The process has been used for composting of animal wastes. Needless to mention that simple placement of manure in a pile does not satisfy the requirements for continuous aerobic composting. Without considerable bedding material, the moisture content of manure exceeds the level, which enables an open porous structure to exist in the pile. Little, if any, air passes through it. Under these circumstances, the anaerobic micro-organisms dominate the degradation. All of the undesirable effects associated with anaerobic degradation occur including low temperatures, slow decomposition, and the release of hydrogen supplied and other malodorous compounds.

When a livestock management system relies on bedding to add to livestock comfort and cleanliness, the bedding becomes mixed with the manure and creates a drier, more porous mixture. This provides some structure and, depending on the amount of bedding, enables the mixture to be stacked in true piles. The bedding also tends to raise the C: N ratio of the manure.

A mixture of manure and bedding requires a considerable proportion of bedding to provide the porosity necessary for composting. At least equal volumes of bedding and manure are required. If the amount of bedding is too low to provide a porous mix, then additional dry amendments must be provided by either increasing the bedding used in the barn or adding

amendments when piles are formed. Manure from horse stables or bedded manure packs can often compost in piles alone, whereas non-bedded manure from dairy, swine, and many poultry barns needs drying or additional amendments.

The pile must also be small enough to allow passive air movement, generally less than 6 feet high and 12 feet wide. This passive method of composting is essentially windrow composting but with a much less frequent turning schedule. It is a common method used for composting leaves. It demands minimal labor and equipment. Passive composting is slow because of its low aeration rate, and the potential for odour problems is greater.

Generally, composting is carried out in a corner of a field and in a circular or rectangular pit. Rice straw, animal dung (usually pig), aquatic weeds or green manure crops are used and often silt pumped from river beds is mixed with the crop residues. The pits are filled layer by layer, each layer being 15 cm thick. Usually, the first layer is of a green manure crop or water hyacinth, the second layer is a straw mixture and the third layer is of animal dung. These layers are alternated until the pit is full, when a top layer of mud is added; a water layer of about 4 cm depth is maintained on the surface to create anaerobic conditions which help to reduce losses of nitrogen.

Approximate quantities of the different residues in tons per pit are: river silt 7.5, rice straw 0.15, animal dung 1.0, aquatic plants or green manure 0.75 and superphosphate 0.02. Three turnings are given in all, the first one month after filling the pit and, at this time, the superphosphate is added and thoroughly mixed in. Water is added as necessary. The second turning is done after another month and the third two weeks later. The material is allowed to decompose for three months and produces about eight tons of compost per pitted cost, these devices could be designed to also harvest BSFL. On many farms, the basic composting ingredients are manure generated on the farm and bedding. Straw and sawdust are common bedding materials.

Non-traditional bedding materials are also used, including newspaper and chopped cardboard. The amount of manure composted on a livestock farm is often determined by cleaning schedules, land availability, and weather conditions. Each type of manure has its own physical, chemical, and biological characteristics. Cattle and horse manures, when mixed with bedding, possess good qualities for composting. Swine manure, which is very wet and usually not mixed with bedding material, must be mixed with straw or similar raw

materials. Poultry manure also must be blended with carbonaceous materials - those low in nitrogen preferred, such as sawdust or straw

3.4. Handling Feedstock mixtures for composting method, industry best practice and technology procedures

The particle size of the feedstock will affect porosity, air flow and the amount of microbial activity. Smaller particle size has more surface area. Per unit volume and therefore microbes more surfaces to colonize. However, if particles are too small, porosity will decreas, compaction will occur, air flow with in the compost pile will be restricted. Wood chips(less than 2 inches is preferred) can be added as a bulk material to increase pile porosity.

3.5. Assigning, Creating and documenting batch numbers or codes through compost production cycle.

Batch documentation may include:

- Manual or electronic recording systems that enable tracking of product such as
- Delivery of final product via the assignment of batch number
- Individual batch preparation and formation

Self-Check -3	**Written Test**

Directions: Answer all the questions listed below.

1. How to handle feedstock for production (3)?
2. Discus about collecting raw materials and additive (2)?

Note: **Satisfactory rating – 2.5 points** **Unsatisfactory - below 2.5 points**

Name: _____ Date: _____

Short Answer Questions

Information Sheet-4	Converting and using crop by-products

4.1. Compost starting mixes

The choice of input materials also influences the composting process, and the resulting compost quality. To obtain a high compost quality, it is first of all important that the organic input materials are of high quality. They should be free from pollutants and other undesirable materials like plastics, metal or glass. High-quality compost can only be produced with source separated organic materials. To guarantee a good Composting process, the starting mixture has to have an adequate C/N ratio between 25 and 35. The mixture should also have an appropriate structure to allow optimal oxygenation of the material without too much loss of Lignin-rich material can be stored for a long time without loss of nutrients.

A useful rule-of-thumb to prepare a starting mix is:

• 1/3 rough wood (e.g. shredded wood, saving rest material from compost, snipped bark).

• 1/3 medium-fine, fibrous material (e.g. shredded branches, wood fibers, straw, foliage, switch grass, reed).

• 1/3 fine materials (kitchen waste, grass clippings, manure, vegetable waste).

To improve the composting process, clays such as zeolites (5-10 kg/m3 starting mixture) or clay-rich soil (3-5 % of the starting mixture) can be added. These materials buffer the composting process, diminish odor emissions and improve the formation of stable crumbs during the curing phase of the compost. The technical preparation of the input materials also plays an important role in the decomposition of the material.

This is especially important for wood. If wood is chopped into chips, microbial colonisation is inefficient and the capacity of the wood as a structure-adding material to improve the aeration of the windrow is low. If the wood is correctly shredded and well de-fibered, microorganisms have good access to the material and the aeration of the windrow is highly improved. Finally, it is essential that the starting mixture contains sufficient moisture to allow the microorganisms to become active.figure;7.




Self-Check -4	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided.

1. How input materials influence the composting process? (5)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Name: _____ Date: _____

Short Answer Questions

Crop production

Level: II

Learning Guide-31

Unit of Competence:-Assist Preparation of Organic Fertilizers

Module Title:-Assisting Preparation of Organic Fertilizers

LG Code: - AGR CRP2 M08 LO-04-LG-31

TTLM Code: - AGR CRP2 TTLM 0919v1

LO 04: Establish green manure crops and tree hedges

Instruction Sheet	Learning Guide- 31

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

- Identifying and established suitable leguminous crops
- Identifying and planting leguminous trees

This guide will also assist you to attain the learning outcome stated in the cover page.

Specifically, upon completion of this Learning Guide, you will be able to –

- Identify and establish suitable leguminous crops
- Identify and plant leguminous trees

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number below 3 to 6.
3. Read the information written in the “Information Sheets 1”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the “Self-check 1and 2” in page :81 and 83
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 1).
6. If you earned a satisfactory evaluation proceed to “Information Sheet 2”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.
7. Submit your accomplished Self-check. This will form part of your training portfolio.

Information Sheet-1	Identifying and established suitable leguminous crops

1.1. What are green manures

Green manures, often known as cover crops, are plants which are grown to improve the structure and nutrient content of the soil. They are a cheap alternative to artificial fertilisers and can be used to complement animal manures. Growing a green manure is not the same as simply growing a legume crop, such as beans, in a rotation. Green manures are usually dug into the soil when the plants are still young, before they produce any crop and often before they flower. They are grown for their green leafy material which is high in nutrients and protects the soil.

If food is in very short supply it may be better to grow a legume from which a bean crop can be harvested and then dig the plant remains into the soil. These plant remains will not break down into the soil so quickly and will not be as good for the soil as younger plants but they will still add some nutrients to the soil for the next crop.

1.2. Importance of using green manures

Green manuring offers an inexpensive way of improving crop yields and it takes little extra effort. Green manures are especially important on farms where there is not enough animal manure available, and when it is not possible to bring in natural fertilisers from elsewhere. Although the use of green manures may seem to create extra work, they do provide a number of benefits:

Green manures recycle nutrients and add organic matter to the soil. They help prevent nutrients being washed out of the soil. The nutrients are taken up by the green manure and held inside the plant. When the nutrients are needed for the next crop the plants are dug into the soil or used as mulch on top of the soil. This helps to increase crop yields. Legumes and other nitrogen fixing plants which take nitrogen from the air to the soil are particularly beneficial. It also improves soil structure, prevent soil erosion, and control weeds.

1.3. Method of green manure preparation

- How are green manures used?

Farmers often see the benefits of green manures but many do not use them because they do not know which species to use and how to include them in their own farming system. It is therefore important to plan in advance where and when they are to be grown.

1. Green manures in rotation

Growing green manures as part of a crop rotation is an important part of an organic farming

system. They help to build soil fertility and are particularly useful when grown before crops which need a lot of nutrients.

- Green manures can be used in rotation:

• Whenever there is no crop in the ground, rather than leaving the land bare and allowing weeds to grow and nutrients to leach out of the soil.

• As break crops, when there is only a short time between main crops.

Timing of sowing is important. The green manure must be ready to dig in before the crop next is sown. There should not be a long gap between digging- in the green manure and planting the next crop. This is to prevent nutrients from the green manure leaching out of the soil, before being taken up by the next crop.

2. **Green manures and under sowing**

Under sowing involves growing a green manure at the same time as a crop, among the crop plants. Sometimes they are sown with the crop or slightly later when the crops are already growing. This reduces competition between the green manure and the crop. For example, under sowing is sometimes used with maize crops where a green manure is sown under the young maize plants. The green manure seeds are broadcast sown when the second weeding of the maize is carried out. In this way when the maize is harvested the green manure is already established and ready to grow quickly.

3. **Green manures for mulching**

Green manure plants can be cut and left on the soil surface as a mulch. Mulching releases nutrients slowly but has some advantages:

• Mulching helps to prevent weed growth

• Mulching protects the soil from erosion

• Mulching keeps the soil moist by reducing evaporation

4. Green manures in agro forestry

Agro forestry is the practice of growing trees and/or shrubs together, with crops and/or animals. The trees/shrubs act as long term green manures and the leaves can be used for digging in or as a mulch. The regular pruning of agroforestry trees such as Leucaena (Leucaena leucocephala), Mother of cocoa (Gliricidia sepium) and Calliandra (Calliandra calothyrsus calothyrsus) during the crop growing period provides large amounts of green material for digging into the soil and reduces competition with the main crop. The material can also be used as mulch. It is spread on the top soil, usually between crop rows or before a crop has been planted. As well as improving the soil in the ways described above, trees and shrubs also provide food, fodder, fuel wood, erosion control and other benefits.

1.3. Time and application

- Digging in green manures

Before a crop is sown the green manure is dug back into the soil. Here it decomposes and the nutrients held inside green manure plants are released.

• The plants take a short time, usually about two weeks, to rot down into the soil before the next crop is sown.

• Green manures should not be ploughed in as this buries the plants and the nutrients too deep. They should be turned in just under the soil surface.

• Digging is easier if the plants have been chopped into small pieces before digging. This also helps prevent the problem of regrowth if this should occur.

• If digging-in is difficult the plants can be dug in roughly, left for a few days and dug over again.

- Digging in a green manure

Younger green manure plants are easier to dig into the soil than older ones and land will be ready to use more quickly after they have been dug in. So, over a long period, two short term green manures may be better than one longer term green manure. However this may involve more of time and effort. For most green manure plants, the best time to dig in is just before flowering begins, but this is different for some species. If plants become too old and tough, they will be more difficult to dig in. Soil organisms will find it difficult to break down and decompose old, tough plants. If this happens green manures can be cut and composted instead.

- The choice of green manure

When choosing which green manure plant to use, you should consider the following points:

• A green manure must suit the local climate, and the soil that it is to be sown in. This will help to keep the green manure healthy and to keep pests and diseases to a minimum.

• Fast growing and leafy green manures are often preferred as they provide more nutrients when dug in.

• Green manures should not be closely related to the following crop as they could attract pests and diseases which may affect the following crop.

• It is important to know whether seed is easily available and affordable.

• The length of time that land is free and how long the green manure will take to grow.

• Plants which can be grown as a green manure include legumes and non-legumes.

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided.

1. Define and discuss green manure (5pts)
2. What are the criteria for selecting plants for green manure? List some examples (10pts)
3. What is the importance of green manure (10pts?)

Note: **Satisfactory rating – 12.5 and above points Unsatisfactory - below 12.5 points**

Name: _____ Date: _____

Short Answer Questions

Information Sheet-2	Identifying and planting leguminous trees

2.1. Identifying and planting leguminous trees as hedge and periodically pruned

This is the system by which multipurpose trees in agroforestry that involves trees in combination with other agricultural enterprises, including livestock. Different species of trees can be planted with many types of crops in a variety of patterns. Trees in agroforestry system promote soil and water conservation, enhance soil fertility and act a wind breaks for nearby crops.

- What are the best multipurpose trees in agroforestry?
  - It is important to select the most suitable trees, since it not easy to replace them once they have been planted.

- Factors for selecting trees

- Environmental adaptation
- Needs of farmers
- Ease of maintenance
- Availability of genetic material

Farmers should prune hedge grows regularly to prevent them from competing with nearby crops for sunlight and water. Plant them in North to South not to east to west.

To obtain green manure farmers can prune the top of the hedge grows every 6 - 8 weeks.

- Desirable characteristics of species

- Easily established and Good sprouting
- Fast growing and Nitrogen fixing
- Heavy and palatable foliage(provide more green manure and acceptable fodder)
- Deep root system(to absorb water and nutrients from deeper layers)
- Easy to propagate
- Adaptable to close spacing(hedges require dense planting)

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. List the factors for selecting trees (3)?
2. List desirable characteristics of species (3)?

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Name: _____ Date: _____

Short Answer Questions

Crop production

Level: II

Learning Guide-32

Unit of Competence:-Assist Preparation of Organic Fertilizers

Module Title:-Assisting Preparation of Organic Fertilizers

LG Code: - AGR CRP2 M08 LO-05-LG-32

TTLM Code: - AGR CRP2 TTLM 0919v1

LO 05: Collect Green Manure and Incorporate

Instruction Sheet	Learning Guide 32

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

- Determining green manure requirement of the farm
- Identifying, collecting and checking raw materials
- Utilizing locally available materials
- Analyzing /assessing weather and soil conditions,
- Ploughing green manure crops and incorporating with the soil
- Pruning tree hedges at appropriate stage and applying as green manure

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Determine green manure requirement based on the nutrition program of the farm
- prune and apply tree hedges at appropriate stage as green manure

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number below 3 to6.
3. Read the information written in the “Information Sheets 1”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the “Self-check 12,3,4,5 and 6” in page -. 87,90,93,95,98 and 101
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 1).
6. If you earned a satisfactory evaluation proceed to “Information Sheet 2”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.
7. Submit your accomplished Self-check. This will form part of your training portfolio.

Information Sheet-1	Determining green manure requirement of the farm

1.1. Establishing green manure crops and tree hedges

- Identifying and establishing leguminous crops and Green manure in economic consideration
- Identifying and planting leguminous trees as hedge and periodically pruned

1.2. Collecting green manure and incorporate

- Determining green manure requirement based on the nutrition program of the farm
- Identifying, collecting and checking raw materials to ensure compliance
- Utilize locally available materials
- Analyzing /assessing and identifying conditions that favors rapid Decomposition of green manure
- Incorporating the green manure and crop with the soil at appropriate stage
- Pruning tree hedges and applying as green manure at appropriate stage

1.2.1. Preparing and regulating eco-san toilet

- Selecting site considering drainage
- Identifying and collecting materials based on the enterprise guidelines
- Determining size of the chambers and including alternative chamber for shifting
- Giving directions to the users about the toilet, its usage and potential health risks
- Inspecting urine container and faeces chambers for the level of filling and Presence of damage and repaired.
- Monitoring and assessing faeces batch by observation and Finished faeces for its readiness to use
- Maintaining and processing operation records for process through The faeces production cycle.
- Reporting faults or variations observed at any stage of process to supervisor and taking remedial action
- The soil where they become available for use by other organisms Including crop plants.

Self-Check -1	Written Test

Directions: Answer all the questions listed below.

1. Define green manure(6)

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Name: _____ Date: _____

Short Answer Questions

Information Sheet-2	**Identifying, collecting and checking raw materials**

2.1. Identifying green manure in economic consideration

Green manure plant material which can be used as manure can be identified and collected. The choice and management of green manure crops depends largely upon the farmer's objectives. For example, the structure of fertile soils may be improved with cereal and other non-legume crops, but legumes or mixtures including legumes would be chosen to improve the nitrogen status of poorer soils. Following are some of the points to be considered when selecting green manures for particular situations and purposes:

- major objective (nitrogen source, bulk organic matter, weed competition, Bio-fumigation);
- adaptation to seasonal climatic conditions (heat or cold tolerance);
- adaptation to local soils (heavy or light, pH, salinity);
- availability of water (rainfall or irrigation);
- availability and cost of seed and microbial inoculants if required;
- Length of time from sowing to flowering (short enough to fit the 'window' between cash crops).Collection can be from the green leaves and twigs of trees, shrubs and herbs that are growing outside of the farm land.Trees that are important for this purpose are like neem and sesbania

❖ Establishment and management

Like any crop, green manures require good management for successful establishment and growth. Good seedbed preparation, correct sowing rate and depth are all important. Other keys to success include:

♠ Weed management:

Although densely planted green manures can effectively smother weeds, early weed management is important to ensure good crop establishment and prevent the early establishment of weeds. Correct timing of sowing; sowing into a weed-free seedbed and well-timed mechanical weeding will all help get the crop off to a good start.

♠ Nutrition & irrigation:

In vegetable cropping, green manures require irrigation for optimal production of organic matter. The need for nutrient and water inputs depends on the crop chosen as well as local climate and soil conditions. Some fertilizer application is likely to be needed to optimize

establishment and growth of the crops. Nitrogen is generally not required for leguminous green manure crops but a small amount will aid establishment of the plants during the pre-nodulation stage. Non-legumes such as millet require adequate levels of nitrogen for good production a range of nitrogenous fertilizers approved for use by certified organic growers are available commercially. These are generally based on pelletized, composted poultry or cow manure.

- ♠ Inoculation:

Leguminous crops such as cowpea, bean, clover and vetch should be inoculated with the appropriate strain of Rhizobium bacteria before sowing. This helps the crop establish good levels of root nodulation and nitrogen fixation.

- ♠ Slashing:

Green manure crops are slashed, or better mulched, shortly before cultivation, to improve the mixing of organic matter into the soil and speed the release of nutrients. Earlier slashing is also used to improve the vigor of certain green manure crops.

- ♠ Some disadvantages of green manures

No cash income:

While green manures do require management inputs, they do not provide a cash return to the grower. Their benefits need to be weighed against the income that a cash crop would generate.

- ♠ Good timing needed:

If green manures are incorporated into the soil too late, when the plants are tougher, drier and relatively low in nitrogen, soil nitrogen levels may drop as the soil microbes use the available nitrogen to decompose the crop. This nitrogen depletion may affect the following crop.

- ♠ Short window of opportunity:

Some green manures may not fit into the crop rotation easily because they take too long to develop and also too long for their residues to decompose sufficiently to allow seeding of the next cash crop.

Self-Check -2	Written Test

Directions: Answer all the questions listed below.

1. List the condition to be considered when selecting green manures for particular situations and purposes (10)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5points**

Name: _____ Date: _____

Short Answer Questions

Information Sheet-3	Utilizing locally available materials

3.1. Preparing raw materials and compost the feedstock mixture

- Identifying, collecting and checking locally available Raw materials and additives for processing
- Confirming Composting technology and methods to be used
- pre-processing raw materials into suitable forms for composting
- Mixing pre-processed raw materials into suitable feedstock Mixtures for composting
- Handling Feedstock mixtures for composting method, Industry best practice and technology procedures.
- Assigning, Creating and documenting batch numbers or codes
- through compost production cycle

3. 2**. Monitoring composting Process**

- Monitoring ,field testing and maintaining effective composting process and efficient compost production schedule in Ethiopian standards
- Maintaining and controlling compost production cycle *processing and operations records*
- Reporting faults or variations observed to supervisor and remedial action is taken

3.3. **Managing crop residue/by-product**

- Planning, designing and coo-rdinating crop residue/by-product management and utilization
- Separating crop residue/by-product from the crop with crop species
- Collecting and storing Crop residue/ leftovers and by-product after threshing

♠ Converting and using crop by-products for animal feeds.

3.4. Determining materials required for compost making

- All clean organic recyclable materials can be used for compost making. But listing all for a trainee does not help, even it confuses her/him. It is best if the composting materials are grouped into four categories, and then the trainees can suggest materials they know that fit each category. These are:
- Dry stalks (stover) – maize, sorghum, grasses with thicker stems, or thin branches from trees, which could not decompose easily. These are put in the bottom of the compost pit to make sure there is a good circulation of air and moisture inside the pit.
- Dry plant materials – this refers to all kinds of dry biomass such as straw of field crops, all kinds of weeds, grasses, etc. It is preferred if these materials are the leftovers from animal feed and bedding. This is because there is no need to compete with clean straw and grass needed for animal feed. These leftovers also have the advantage of already being mixed with urine and fresh animal dung produced by the animals while they are in the barn. The urine and dung are very good for improving decomposition of the straw and the establishment of compost making micro-organisms.
- Green plant materials - all kinds of green plant material; such as leaves and soft branches, weeds, grasses, etc. Troublesome weeds such as Parthenium and spiny/thorny plants can also be included.
- Qimemaqmem - Starter material "spices" – is a mixture of other naturally decomposable materials other than stalks, dry and green plant materials mentioned above. Farmers called it "qimemaqmem" because it is used at every step of compost making. Dry qimemaqmem is a dry starter, which includes any animal manure (dike in afan Oromo or figh-Amharic), bird and chicken droppings, ash, fertile soil, etc; and Wet qimemaqmem is a fresh or wet starter including fresh animal dung, urine (human and animal) and water. This mixture contains the micro-organisms (worms, beetles) as well as the fungi and bacteria that do the work of turning the plant and animal materials into compost.
- Prepare testing stick – it is used to test the condition inside the composting materials in a pit. It is also recommended that the trainer also arranges to have compost materials collected 1 or 2 days before the training is to take place.

3.5. Identify materials not part of compost

- Recommendations in listing materials not to be included as part of the compost preparation should be considered and these includes fuel (kerosene, diesel, petrol), engine oil, stones, pieces of iron, broken glass, plastic materials, any pieces of clothes (especially nylon or plastic cloth), hyena or dog droppings, any type of wax, any type of fat, hide/skin, etc.

Self-Check -3	**Written Test**

Directions: Answer all the questions listed below.

1. List the group of composting materials (10)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Name: _____ Date: _____

Short Answer Questions

Information Sheet-4	Analyzing /assessing weather and soil conditions, and identifying and incorporating green manure

4.1. Collecting green manure and incorporate

- Determining green manure requirement based on the nutrition program of the farm
- Identifying, collecting and checking raw materials to ensure compliance
- Utilize locally available materials
- Analyzing /assessing and identifying conditions that favors rapid decomposition of green manure
- Incorporating the green manure and crop with the soil at appropriate stage
- Pruning tree hedges and applying as green manure at appropriate stage

4.2. Analyzing /assessing and identifying conditions that favors rapid decomposition of green manure:

1. Optimum temperature for microorganism activity
2. Optimum moisture that is suitable for both the plant and function of micro organism
2. Appropriate stage of the plant
3. N.B. if there is weed with in the green manure plant, remember there stage
4. If the weed is with matured seed, weeding must carried out before entering to the incorporation of the manure
5. If the weed is at vegetative and flowering stage mix it.

Self-Check -4	Written Test

Directions: Answer all the questions listed below.

1. Identifying conditions that favors rapid decomposition of green manure (10)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Name: _____ Date: _____

Short Answer Questions

Information Sheet-5	Ploughing green manure crops and incorporating with the soil

5.1. Incorporating the green manure and crop with the soil at appropriate stage

***Incorporation**:*

As the majority of biological activity in soils is typically concentrated in the top 15cm of the soil, the incorporation of organic matter should be limited to this depth. The objective should be to mix the plant material thoroughly with the soil and bury it lightly below the soil surface. The plant/soil mixture should remain moist and aerobic for optimal microbial decomposition of the organic matter

- ♠ **'Free' nitrogen**:

Soil nitrogen levels are increased by leguminous green manures through their association with nitrogen-fixing *Rhizobium* bacteria. These bacteria 'infect' plant roots and fix atmospheric nitrogen into a form that plants can use. When leguminous plants decompose, the nitrogen is released for use by other crops. By using this 'free' service, organic growers can improve their soils while reducing their reliance on off-farm nutrient inputs.

- ♠ **Weed control**:

Weeds are suppressed by the competition that dense, green manure crops exert for water, light and nutrients. Short-term green manures therefore provide organic growers with a productive, chemical-free and reduced-cultivation option for weed management during non-crop phases of their vegetable crop rotation.

- ♠ **Pest and disease management**:

Pest and disease cycles can be disrupted by the use of non-vegetable green manure crops in the crop rotation program. Some green manure plants, including cowpea, have extra-floral nectaries that attract beneficial insects like parasitic wasps to the cropping area. Others, like mustards, release natural chemicals into the soil and provide some bio-fumigant action against soil-borne diseases and nematodes. Thoughtful use of such green manures can benefit the overall cropping system whilst contributing to soil improvement.

5.2. Some benefits of green manures

- **Organic matter source:**

This critical component of soils is added through root growth, mechanical incorporation or mulching of the green manure crop. Soil organisms then decompose this organic matter into

humus and other organic compounds. The organic component of soils, particularly humus, is a major determinant of soil properties including structure and biological activity. The latter includes the vital role that predatory nematodes and mites, parasitic fungi and other beneficial microbes play in suppressing crop pests and diseases. Maintaining or improving the organic matter level and biological activity of soil is one of the fundamental objectives of organic agriculture, and green manure cropping helps growers achieve this.

- **Nutrient recycling**:

Residual nutrients which might otherwise be leached from the soil are absorbed by the green manure crop as it grows, and then released when that crop decomposes. The nutrients largely become available to the following cash crop. This helps growers make more efficient use of applied nutrients and reduces the risk of nutrients being leached out of the crop root zone and into ground water or water ways. In this way, green manuring helps organic growers address the issue of water pollution along with the conservation and recycling of nutrients.

Self-Check -5	Written Test

Directions: Answer all the questions listed below.

1. List the objective of mix the plant material thoroughly with the soil and bury it lightly (5)?
2. How green manure can be used for Nutrient recycling(5)

Note*:* Satisfactory rating - 5 points **Unsatisfactory - below 5 points**

Name: _____ Date: _____

Information Sheet-6	Pruning tree hedges at appropriate stage and applying as green manure

6.1. Pruning tree hedges and applying as green manure at appropriate stage

Green manures, often known as cover crops, are plants which are grown to improve the structure and nutrient content of the soil. They are a cheap alternative to artificial fertilisers and can be used to complement animal manures. Growing a green manure is not the same as simply growing a legume crop, such as beans, in a rotation. Green manures are usually dug into the soil when the plants are still young, before they produce any crop and often before they flower. They are grown for their green leafy material which is high in nutrients and protects the soil.

If food is in very short supply it may be better to grow a legume from which a bean crop can be harvested and then dig the plant remains into the soil. These plant remains will not break down into the soil so quickly and will not be as good for the soil as younger plants but they will still add some nutrients to the soil for the next crop.

6.2. Green manures in agro forestry

Agro forestry is the practice of growing trees and/or shrubs together, with crops and/or animals. The trees/shrubs act as long term green manures and the leaves can be used for digging in or as a mulch. The regular pruning of agroforestry trees such as Leucaena (Leucaena leucocephala*),* Mother of cocoa (Gliricidia sep*ium)* and Calliandra (*Calliandra calothyrsus calothyrsus*) during the crop growing period provides large amounts of green material for digging into the soil and reduces competition with the main crop. The material can also be used as mulch. It is spread on the top soil, usually between crop rows or before a crop has been planted. As well as improving the soil in the ways described above, trees and shrubs also provide food, fodder, fuel wood, erosion control and other benefits.

♠ Tree hedges will be pruned when the following characteristics is fulfilled by the tree

- There is high green leaves
- Either at flowering or before it
- But before setting the seeds
- Selective pruning is important to avoid unwanted plant species
- Free from any types of pests
- When there is high biomass
- Give more emphasis for species that have best N fixation potential

Self-Check -6	Written Test

Directions: Answer all the questions listed below.

1. List the characteristics should be fulfilled by the to be pruned (5)
2. What is agro-forestry?(5)

Note: **Satisfactory rating -5 and above points & Unsatisfactory – below 5 points**

Name: _____ Date: _____

Crop production

Level: II

Learning Guide-33

Unit of Competence:-Assist Preparation of Organic Fertilizers

Module Title:-Assisting Preparation of Organic Fertilizers

LG Code: - AGR CRP2 M08 LO-06-LG-33

TTLM Code: - AGR CRP2 TTLM 0919v1

LO 06: Conduct quality control inspection

Instruction Sheet	Learning Guide 33

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

- . Inspecting and assessing finished compost
- . Observing and reporting faults or variations
- .Processing none-compliant plants
- .Confirming compliance of compost with product requirements
- .Completing batch documentations
- . Informing sales and operational staff members
- . Reporting work outcomes, seeking feedback on performance and noting any Required improvements

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Inspect and assess finished compost
- Observe faults or variations and report to supervisor
- Ccomplete batch documentation for compliant compost product.

⌘ Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number below 3 to 6.
3. Read the information written in the “Information Sheets 1”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the “Self-check 1,2,3,4,5,6” in page -.106,108,110,113,115 ,117 and119
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 1).
6. If you earned a satisfactory evaluation proceed to “Information Sheet 2”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.
7. Submit your accomplished Self-check. This will form part of your training portfolio.

Information Sheet-1	Inspecting and assessing finished compost

1.1. Inspecting and assessing finished compost, faeces and urine for compliance

The quality of commercial compost varies because they are usually made from whatever local waste materials are available at the time. The contents will differ from batch to batch. Unless the producer monitors each batch carefully, brand that tested at the top of the class this month might flun out the net time. A simple look can be all you need to do to find a good quality product. How to check out the texture, color, moisture, and bouquet. The texture should be loose, and granular with little or no recognizable wood or bark.

The color should always be dark brown or almost black. Avoid products that are light in color. They probably contain too little organic matter and too much soil.it is easiest to tell the true color if you let the compost sample dry out. Urine and faeces should not be exposed for excessive heat or sun radiation, if it is they will produce too much gas that will burn out plant roots later on the field. Hence, there should not be any further change in color as compared to the fresh wastes. Compost should be moist, not dry or soggy.one of compost biggest benefits is that it can hold up to 2-1/2 times its weight in water.

- Compost quality is measured by several criteria, including the following:
- Moisture Content

The moisture content of the compost product is controlled by storing the product so as to avoid significant moisture addition by rainfall. The product must be dry enough to allow hauling with conventional loading, hauling, and spreading equipment / methods. The 45 percent moisture content criterion for efficient screening also provides a dry enough product to meet these needs. Care must also be taken not to over-dry the product as well. When compost is too dry, it will generate dust when handled, and dry compost can be difficult to re-wet.

- Nutrient Content

The nutrient content of compost is also a quality component. The major plant nutrients supplied by compost are nitrogen, phosphorus, and potassium. Most minor plant nutrients are also contained in compost and these also contribute to its quality. The level of nutrients in compost is controlled by the chemical composition of the material. While not a fertilizer, compost is often used as a fertilizer supplement.

- Particle Size Distribution

This quality parameter is primarily a function of the screen size used. Different end-users of compost will have different requirements for particle size distribution of the compost. The most demanding user in this regard will be horticulturists that will use the material in potting mixtures. The specifications for particle size distribution requirements can be ascertained from users. Those who will use the compost to amend field soils (e.g., landscapers, orchardists, field crop growers) will have less stringent requirements, but still should be provided samples of the product to test prior to deciding on an appropriate particle size specification.

- Stability

The term "stability" as used here means a product that will not undergo rapid decomposition or produce nuisance odors when applied by users. If the compost has undergone the adequate composting and curing procedures, there should be no problem in achieving a stable product. Assuring a minimum curing period of 30 days is important to producing a stable compost product.

- Product Consistency over Time

This quality parameter is one of the most important to users. In order to incorporate compost into their operating practices, users must be certain that each batch of materials has the same properties, within relatively narrow limits. Inconsistency in product quality will result in reduced consumer confidence and will jeopardize future marketing efforts.

- Pathogen Reduction Criteria

Agricultural waste compost is not required by regulation to comply with the pathogen reduction criteria that are stipulated for municipal sludge (bio solids) compost. However it is good practice and may be required if a site permit is required for non-farm organic waste material. The compost product should fulfill the following criteria:

- The compost product should be brought to a minimum temperature of 131oF (55^{o}C) in order to fulfill the requirements of a bio solids stabilization process to further reduce pathogens
- In addition to stabilization, these elevated temperatures are effective at killing weed seeds, which is a very important product quality concern.

The compost product should be exposed to a minimum composting period of 42 calendar days and a minimum curing period of 30 calendar days prior to distribution.

Self-Check -1	Written Test

Directions: Answer all the questions listed below.

1. Compost quality is measured by several criteria. List them and explain each of them?(10)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Name: _____ Date: _____

Short Answer Questions

Information Sheet-2	Observing and reporting faults or variations

2.1. Reporting faults or variations observed to supervisor

Avoid any products that have a strong unpleasant smell (Ammonia or sever gas) B/C the odor indicates an immature compost that might damage the plant later on when applied to the land by producing different gases. In preparation of compost worker face so many hazards like:-

-Contamination by different kinds of disease causing organisms.

-compost preparations areas are the home of different kind's organisms that affect humans like snakes

-Different kinds of chemicals may be released due to different chemical process under taken in compost preparation.

- WORKPLACE INSPECTIONS
  - General requirement

Every employer must ensure that regular inspections are made of all workplaces, including buildings, structures, grounds, excavations, tools, equipment, machinery and work methods and practices, at intervals that will prevent the development of unsafe working conditions.

Remedy without delay Unsafe or harmful conditions found in the course of an inspection must be remedied without delay.

  - Reporting unsafe conditions

Whenever a person observes what appears to be an unsafe or harmful condition or act the person must report it as soon as possible to a supervisor or to the employer, and the person receiving the report must investigate the reported unsafe condition or act and must ensure that any necessary corrective action is taken without delay.

  - Emergency circumstances

If emergency action is required to correct a condition which constitutes an immediate threat to workers only those qualified and properly instructed workers necessary to correct the unsafe condition may be exposed to the hazard, and every possible effort must be made to control the hazard while this is being done.

Self-Check -2	Written Test

Directions: Answer all the questions listed below.

1. List the hazards can be occurred in preparation of compost (10)?

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below -5 points**

Name: _____ Date: _____

Short Answer Questions

Information Sheet-3	**Processing none-compliant plants as directed to the processing technique and compost and faeces batch**

3.1. Processing non-compliant product further with necessary adjustments to achieve product quality

Not all composts are created equal. Compost quality depends on many different factors such as the characteristics of raw materials, environmental factors such as precipitation and ambient temperature, management practices, and most importantly, most importantly the intended use of compost. Compost has many biological, chemical and physical characteristics that allow it to be used in different ways.

- Typical ranges of test parameters in quality compost.

Test parameter	Range
P^H	6.8-7.3
C: N ratio	10:1-15:1
EC (soluble salts)	1:5V/V method0.35-0.64ds/m (mmhos/cm)
Nitrogen	1-2 %(by weight)
Phosphorus	0.6-0.9%(by weight)
Potassium	0.2-0.5%(by weight)
Moisture content	45-50%(by weight)
Organic matter	34-45%(by weight)
Particle size passes	3/8” screen
Bulk density	900-1000lb/yd3

Self-Check -3	Written Test

Directions: Answer all the questions listed below.

1. Compost quality depends on many different factors. List the discus over it(10)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Name: _____ Date: _____

Information Sheet-4	Confirming compliance of compost with product requirements

4.1. Identifying compost and other products for their intend use.

- BENEFITS OF COMPOSTING

Although making compost may involve more work and expense than applying uncomposted organic materials directly to the soil, the process offers at least seven advantages.

1. Safe storage

Composting provides a means of effectively and safely storing organic materials until it is convenient to apply them to soils.

2. Easier handling

As a result of CO_2 losses and settling, the volume of composted organic materials decreases by about 30% to 50% during the composting process. The smaller volume and greater uniformity of the resulting material may greatly ease the handling and eventual use of the organic matter as a soil amendment or potting medium.

3. Nitrogen competition avoidance

For residues with high initial C/N ratio, proper composting ensures that any nitrate depression period will occur in the compost pile, not in the soil thereby avoiding induced plant nitrogen deficiency.

4. Nitrogen stabilization

Composting can reduce environmentally damaging nitrate leaching from organic wastes with very low C/N ratios(such as livestock manure and sewage sludge) when applied to the soil, composted materials generally decompose and mineralize much more slowly than uncomposted organic materials. Co composting such low-C/N-ratio materials with high-C/N-ratio materials, such as sawdust, wood chips, senescent tree leaves, or municipal solid waste, provides sufficient carbon for microbes to immobilize the excess nitrogen and minimize any leaching hazard from the low-C/N materials. It also provides sufficient nitrogen to speed the decomposition of the high-C/N materials.

5. Partial sterilization. High temperatures during the thermophilic stage in well-managed compost piles kill most weed seeds and pathogenic organisms in a matter of a few days. Under less ideal conditions, temperatures in parts of the pile may not exceed 40 to 50^{o}C, so weeks and months may be required to achieve the same results.

6. Detoxification. Most toxic compounds that may be in organic wastes (pestisides, natural phytotoxic chemicals, etc) are destroyed by the time the compost is considered mature and ready to use. Compost is therefore often used as a method of biological treatment of polluted soils and wastes.

7. Disease suppression .Some composts can effectively suppress soil borne plant diseases by encouraging microbial antagonisms. Most success in disease suppression has occurred when well-cured compost is used as a main component of potting mixes for greenhouse grown plants. Some disease suppression has also been observed with field applications of compost.

8. **Plant-Available Nutrients and Micronutrients**

As compost breaks down in the soil, it provides the fertilizer nutrients of nitrogen, phosphorus, and potassium in forms that are readily available to plants. Unlike most inorganic fertilizers, compost functions as a slow-release store of nutrients, so that the nutrients are available as the plants require them instead of in one intense flush. Compost also provides a wide range of important micronutrients not found in commercial fertilizers.

9. **Organic Matter**.

Added to sandy soils, the organic matter in compost increases the soil's water holding ability so that both rain and irrigation water are held in the root zone for plant use. This can significantly lower the irrigation requirements in the orchard industry and other applications where water use is restricted or prohibitively expensive. Compost lightens heavy (high clay) soils, allowing better infiltration of both air and water into the root zone. This improves plant health and helps to prevent sealing of the soil surface caused by water pooling.

Organic matter functions like a sponge, enabling soil to retain nutrients and moisture in the root zone. Inorganic fertilizer nutrients as well as those released by the compost itself are kept from leaching down into ground water. Soil structure is improved, allowing effective drainage, extensive root growth, and soil aggregate stabilization, so that soil is less subject to erosion by either water or wind.

Self-Check -4	Written Test

Directions: Answer all the questions listed below.

1. List benefits of composting (5)?
2. Discuss nitrogen stabilization briefly (5)?

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Name: _____ Date: _____

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Information Sheet-5	Completing batch documentations

5.1. Completing batch documentation for compliant compost and faeces product

Documentation provides the route for auditors to assess the overall quality of operations within a company and the final product. When time and space is not critical, a farmer has significantly greater flexibility in how they use their compost. A batch of compost set up in the spring, even if not fully cured, can be applied to fields in the fall. However, batches set up in the summer and fall may not be mature enough for spring application, hence experienced farmers often wait a full year before using a batch to ensure the compost is fully cured and mature, especially when used on high-valued crops.

5.2. Confirming compliance of compost and faeces batch product requirements

- All composts will require the following information to appear on the label:
- Product name
- Granted analysis
- Name and address of the registrant or the responsible packager
- Lot number
- Directions for use
- Net weight
- Cautionary statements

Self-Check -5	Written Test

Directions: Answer all the questions listed below.

1. what is documentation (5)
2. list the benefits of documentation(5)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Name: _____ Date: _____

Information Sheet-6	Informing sales and operational staff members

6.1. Informing to sales and operational staff members suitable product for sale and/or preparation of value-added products.

Since organic production work is a local technology, the supervisor may invites different experts about organic production how can the trainees apply more, what are the things needed for organic production, how can we alleviate environmental problems by using organic production work.

5.2. Observing the handling and disposal of materials

♠. Observing the handling of materials and equipment in the store or

Your work site according to work place policy and procedure carefully.

♠. For example in our work activity the application of compost material we should take care.

♠.your work place policy and procedure lead you how to perform the activities (how to handle and dispose materials) properly

Self-Check -6	Written Test

Directions: Answer all the questions listed below.

1. List the benefits observing the handling and disposal of materials (10)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Name: _____ Date: _____

Information Sheet-7	Reporting work outcomes, seeking feedback on performance and noting any required improvements

7.1. Reporting work outcomes to supervisor and, noting required improvements for future action

Reporting means informing related information to a person who concerns. Reporting outcomes means announcing whether its goodness or badness about the work result for example if we want to report the problems we can use the following table format.

Table.2. Example of problems reporting format

No	Activities	Type of problem	Possible solution
1			
2			
3			
4			

Self-Check -7	Written Test

Directions: Answer all the questions listed below.

1. What is the outcome of composting (5)?

Note: **Satisfactory rating – 2.5 points** **Unsatisfactory - below 2.5 points**

Name: _____ Date: _____

Crop production

Level: II

Learning Guide-34

Unit of Competence:-Assist Preparation of Organic Fertilizers

Module Title:-Assisting Preparation of Organic Fertilizers

LG Code: - AGR CRP2 M08 LO-07-LG-34

TTLM Code: - AGR CRP2 TTLM 0919v1

LO 07: Clean up area

Instruction Sheet	Learning Guide 34

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

- Clearing and cleaning processing equipment
- Clearing raw materials and finished compost products, cleaning processing site

This guide will also assist you to attain the learning outcome stated in the cover page.

Specifically, upon completion of this Learning Guide, you will be able to –

- Clear and clean processing equipment as required to avoid contamination
- Clear raw materials finish compost products and cleaning processing site

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number below 3 to 6.
3. Read the information written in the “Information Sheets 1”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the “Self-check 1,2” in page -. 123,126
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 1).
6. If you earned a satisfactory evaluation proceed to “Information Sheet 2”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.
7. Submit your accomplished Self-check. This will form part of your training portfolio.

Information Sheet-1	Clearing and cleaning processing equipment

7.1. Clearing and cleaning Loading-shifting machinery and equipment to avoid contamination

An effective cleaning programme must be established and maintained. Product and other debris must not be allowed to accumulate in production areas or on the site as a whole.

1. Frequent and regular cleaning by scraping, brushing, aspirating and washing should be employed in storage areas, cleaning and drying equipment, conveyors and other accessible equipment, to avoid the buildup of problem areas and residues. Where a problem does arise steam cleaning is recommended.

2. All product contact surfaces must be clean before work begins and cleaned as frequently as necessary throughout work periods to prevent the buildup of undesirable microorganisms which could contaminate the product.

3. Wet cleaning routines and the use of disinfectants and sanitizers must be followed by a thorough rinsing with potable water to prevent residues remaining on surfaces where they might contaminate the food products.

4. Detergents, disinfectants and sanitizers must be properly labeled and stored safely when not in use to avoid the risk of contaminating the products.

5. The following materials may be used for cleaning purposes provided they are approved for use in food processing establishments and effective steps are taken to ensure that residues do not remain on contact surfaces:

• Detergents, disinfectants and sanitizing agents approved for use in food processing establishments

• Terminal sanitizers

• Washing in or with a controlled hypochlorite solution

(Note: All the above requires a rinse with potable water after use).

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Write the advantages of cleaning and disposing of materials, tools and equipment after work (6points)

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Name: _____ Date: _____

Short Answer Questions

Information Sheet-2	**Clearing raw materials and finished compost products, cleaning processing site**

2.1. Clearing and cleaning raw materials and finished compost products to designated areas, and processing site

Organic Products Management

PURPOSE: To ensure all precautions are taken to prevent contamination products that are determined as organics.

RESPONSIBILITY:

It is the responsibility of the management to ensure that the following procedures are adhered to and understood by all relevant personnel and the personnel follow State or local health department requirements.The Commercial Manager is responsible for ensuring the procurement procedure with regard to organic products is adhered to. The Technical Manager is responsible for ensuring any necessary risk assessments etc. are carried out.

2.2. Maintaining of tools, materials and equipment

- M maintenance and storage of materials, tools and equipment is very important for their reuse, minimizing cost to buy other new materials, tools and equipment.
- As we have seen in the above proper storing based on their category is very important.

2.3. Cleaning materials, tools and equipment after work

- -Cleaning materials, tools and equipment after work has so many advantages, such as:
- To prevent from rust
- To be durable and long life span to use
- To prevent our health and the environmental pollution etc.

2. 4. Reporting and following the direction of super visor

-Dear trainees you have to respect your super visor's instructions during and after your organic production work activities.

2.5. Benefits of cleaning working materials

- Dear trainees we have already seen the advantage cleaning materials, tools and equipment after work, so you can read the above.

2.6. Disposing unwanted materials, tools and equipment base on super visor direction

-Disposing means removing the materials, tools and equipment which are not functional during our work. So you have to properly dispose in the designated area.

Self-Check -2	Written Test

Directions: Answer all the questions listed below.

1. List down the benefits of cleaning working materials(5)

Note: **Satisfactory rating – 2.5 points** **Unsatisfactory - below 2.5 points**

Name: _____ Date: _____

Short Answer Questions

REFERENSE

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Marinari, S., G. Masciandaro, B. Ceccanti, and S. Grego. 2000. Influence of organic and mineral fertilisers on soil biological and physical properties. *Bioresource Technology* 72:9–17.