MODULE 11: UNIT #1
Composting of Animal Wastes

THE COMPOSTING PROCESS

Composting is the biological decomposition of organic residues or wastes under controlled conditions to yield a product useful in agriculture. In general, any type of organic material of plants and animals can be used in the compost heap. In the compost heap some materials decompose more quickly than others, and it is important that a combination of various types of material are used. Organic material can be divided roughly into two (2) groups:

1. Organic material which decomposes easily; usually young and living material. Examples: green plant parts, animal manure and domestic waste.

2. Organic material which breaks down with difficulty; tough, often dead material. Examples: twigs, dead leaves, maize cobs and straw.

Composting involves the acceleration of microbial decomposition through conditions favorable for microbial reproduction and metabolic activity. Controlling factors are temperature (50 - 70 ^{o}C), oxygen supply, moisture (50 - 70%), and of course the nature of the substrate.

Composting is, as stated before a biological process in which organic wastes are converted into humus by the activity of a complex of interacting soil organisms (e.g. microorganisms such as bacteria, fungi, and protozoa as well as invertebrates such as nematodes, earthworms, mites, and various other organisms).

Nutrients are conversed through the composting process. Some become absorbed on the cellulose fibres of the waste, while others are incorporated within the humic pellets formed by the organisms. After compost is applied to the field, these nutrients are released slowly and made available to plants over long periods.

Decomposition in the compost heap proceeds in consecutive stages, depending on the temperature in the heap as follows:

- a heating phase

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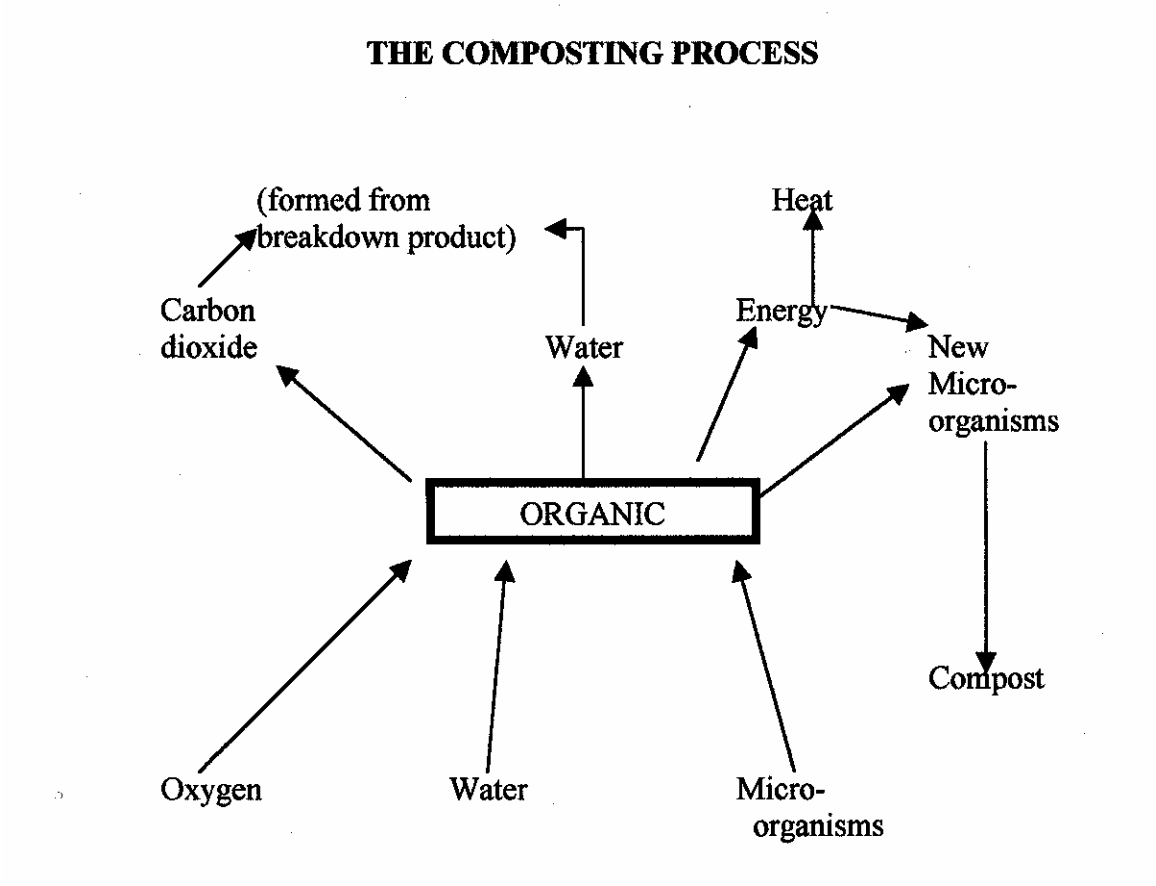
- a cooling down phase
- a maturation

It is not easy to draw a line between these stages. The process takes place very gradually and, with the help of continuously changing microorganisms, the organic material is converted into compost.



Heating Phase

During this phase, the compost heap starts to heat up considerably. This effect is known as fermentation and is the result of the breaking down of the complex and tough fibrous material of the organic matter. The fermentation process is strongest in the centre of the heap.

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To get the fermentation going quickly and effectively, a number of factors are important:

- the compost heap should be made up of all sorts of organic materials
- the right microorganisms have to be present
- there should be adequate oxygen and water.

Maximum fermentation takes place at a temperature of 60 - 70 ^{o}C in the compost heap. If the temperature is too high the necessary microorganisms may die and decomposition comes to a halt (decomposition turns into combustion, and essential are lost). Too great heat generation can be prevented by reducing the supply of air.

Cooling down phase

The fermentation phase gradually changes into a cooling down phase. Decomposition occurs without much generation of heat and the temperature changes slowly. During this phase, new microorganisms convert the organic compounds into humus. The heap remains clammy and hot inside and the temperature drops from 50°C to 30°C. the length of the cooling down phase depends on the type of heap, the material, the attention given to it, the climate, etc.. This period generally takes a few months, but in unfavorable conditions may require up to a year.

Maturation Phase

In this phase, the temperature drops to soil temperature, depending on the climate,
15 - 25°C. Apart from the microorganisms needed to make the compost, the large soil fauna are active at this stage too. In the tropical to semi arid regions, termites in particular play an important role, although these can also be very troublesome.

An important nutrient in the process is nitrogen and, in general if sufficient nitrogen is available most other nutrients will also be available in adequate quantities. It is important that the ratio of carbon to nitrogen (C/N ratio) is about 35 in the initial mixture. If it is much higher, the process will take a long time before sufficient carbon is oxidized off; if it is lower than nitrogen,

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which is an important fertilizer component of the final compost, will be volatilised off as ammonia.

In tropical situations fresh green materials, such as weeds, are frequently used for forage while dung is sometimes burnt as fuel. As a result, the available wastes tend to be those with rather high C/N ratios. It is important, therefore, to conserve liquid manure as this supplies nitrogen, moreover it also contains potash and trace elements. In many cases facilities are not provided for the collection of liquid manure; in these situations the soil under the animals can be collected from time to time and used for composting.

Nitrogen may also be added in the form of organic manures such as bone meal, hoof and horn meal, oil cakes, and dried blood. Inorganic nitrogenous fertilizers such as urea and ammonium nitrate may also be used. However, ammonium sulfate is not recommended as it appears to have an adverse effect on worms.

In order to maximize the nutrient content of the product compost, it is important to reduce serious leaching from the heap by protecting it against heavy rainfall and water-logging.

METHODS OF COMPOSTING

(From: Taiganides, 1977)

Essentially, there are two methods of composting animal wastes. These are:

Natural:

-consists of alternate layers of bulky trash, manures, grass, cuttings, garbage, leaves, etc.. The process depends on natural ventilation, and is therefore a slow process, requiring a minimum of six months to be completed. It is not suitable for large-scale composting.

Most commonly known ones are: **(i) Indore Method; (ii) Heating Process Method;** and (iii) **Bangalore.**

Mechanical:

-divided into: **(i) windrow; (ii) continuous flow;** and **(iii) liquid.**

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windrow

The materials are shaped into windrows, that then shed rain water and preserve temperature and humidity. It requires little engineering, but much experience through trial and error for the particular mixture of materials. This method takes time and also space, for the process itself and for storage of the materials. For swine wastes this can be done by mixing 3m wide by 1m deep windrows every 4-7 days, taking 1-7 months to be completed.

continuous flow

Can be either open or enclosed continuous flow composters used. The main component of these systems is the biological reactor or the bioreactor (or sometimes called the digester). Here the environmental conditions are controlled mechanically to provide uniform airflow distribution and maintain optimum moisture.

liquid composting

(FROM: Taiganides, 1977)
Consists of submerged aeration with down draughting aerators equipped with propellers to agitate and aerate the liquid. They are thoroughly insulated to prevent heat losses, so the existing moisture content of the substrate can facilitate the growth of thermophilic bacteria (50-70°C) so as to reduce the pollution load and kill pathogenic organisms.

(From: Robertson, 1977)
Although not yet fully developed for agricultural use under UK conditions, there are a number of devices which may offer possibilities in treating livestock wastes. One is already marketed on the continent and in North America. It is known as the 'liquid composting' system and consists of an insulated aeration tank and specially designed sub-merged aerator. This unit operates at high temperatures (40-70°C). The heat required to maintain the required temperature is obtained from energy released by the treatment process. It is claimed that by employing high temperatures more efficient and rapid breakdown of organic matter can be achieved (Reinmann V. 1972). Aerobic treatment of swine wastes by aerator agitators ("Fuchs") Proceedings of Cornell University Conference on Agricultural Waste Management. New York; Grabbe, K. Thaer, R., Alcers, r. 1975. Investigations on the procedure and the turnover of organic matter by hot fermentation of liquid cattle manure. Managing livestock wastes. Proceedings of the 3rd International Symposium on Livestock Wastes,

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University of Illinois. 1975. St. Joseph, Michigan. American Society of Agricultural Engineers pp. 506-509).

Operation of the unit is on the batch principle with the aeration tank being filled and emptied at monthly intervals. One of the problems yet to be overcome with this type of system is that of controlling temperature in relation to the biochemical changes taking place in the tank. At high temperatures, it has been found that large volumes of ammonia are released into the atmosphere.

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TYPES OF COMPOSTING UNITS

These include:

1. A crude bin in which alternate layers of the desired material is placed.

2. Open pits or bin with a perforated floor. Air is sucked through the pile, or is forced into the pile.

3. Bioreactors where frequent mechanical agitation may also be used to provide the needed agitation.

4. Vertical silos with decks at various levels on which the materials are raked and then dropped from one level to the next, or

   Vertical silos with vertical augers mixing the silo contents.

5. Conveyor belts moving and dropping the mixtures.

6. Horizontally rotating steel drum used successfully for poultry and beef manure. This drum rotates at 1.5-5 rev/min. and is set at a slope of 5° from the horizontal. The material enters from one end of the drum and works its way to the other end in 3-5 days. Air is forced in to keep the mixture in suspension.

USES OF COMPOSTING/COMPOST:

-producing humus for incorporation into soil to improve its nutrient content, friability (ease of crumbling) and water-holding capacity;

-rendering harmful disease-causing organisms inactive by high temperature, exhaustion of nutrients, and natural antibiosis (an antagonistic association between two organisms (especially micro-organisms) in which one is adversely affected); and

-preventing and controlling erosion.

ADVANTAGES AND DISADVANTAGES OF COMPOSTING

Something for you to think about!!!!!!

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