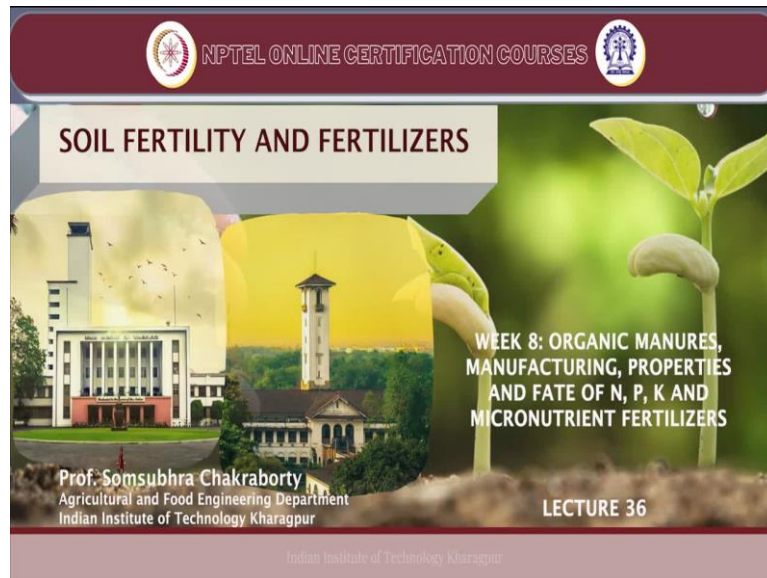


Soil Fertility and Fertilizers
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Agricultural and Food Engineering Department
Indian Institute of Technology, Kharagpur

Lecture: 36

**Organic Manures, Manufacturing, Properties,
and Fate of N, P, K and Micronutrient Fertilizers**

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Welcome friends to this new week of NPTEL online certification course of Soil Fertility and Fertilizers. We are going to start week 8 lectures. And the topic of this week is basically Organic Manures as well as Manufacturing Properties and Fate of N, P, K and other Micronutrient Fertilizers. So, not only we will be focusing on discussing about different manures, we will be also discussing the manufacturing of different nutrient different different macronutrient and micronutrient fertilizers. So, in this first lecture, that is lecture number 36, we are going to discuss these following concepts.

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CONCEPTS COVERED

- Components of sustainable agriculture
- Difference between manures and fertilizers
- Characteristics of bulky organic manures
- Classification of manures
- Compost

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We are going to first discuss about the components of sustainable agriculture. Then we are going to discuss about difference between manures and fertilizers. And then we are going to discuss about characteristics of bulk organic manures. And then we are going to discuss about classification of manures and compost.

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KEYWORDS

- Fertilizers
- Organic manures
- Compost
- NADEP
- Coimbatore method

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Manures	Fertilizers
Contains O.M. and hence improves soil physical properties	Do not contain O.M. and can not improve soil physical properties
Contains all plant nutrients but small in concentration	Contains one or more plant nutrients but in higher concentration
Required in large quantity, bulky and costly	Required in less quantity, concentrated and comparatively cheaper
Nutrients are slowly available upon decomposition	Nutrients are readily available
Long lasting effect on soil and crop	Very less residual effect
No salt effect; No adverse effect	Salt effect is high; Adverse effects are observed .

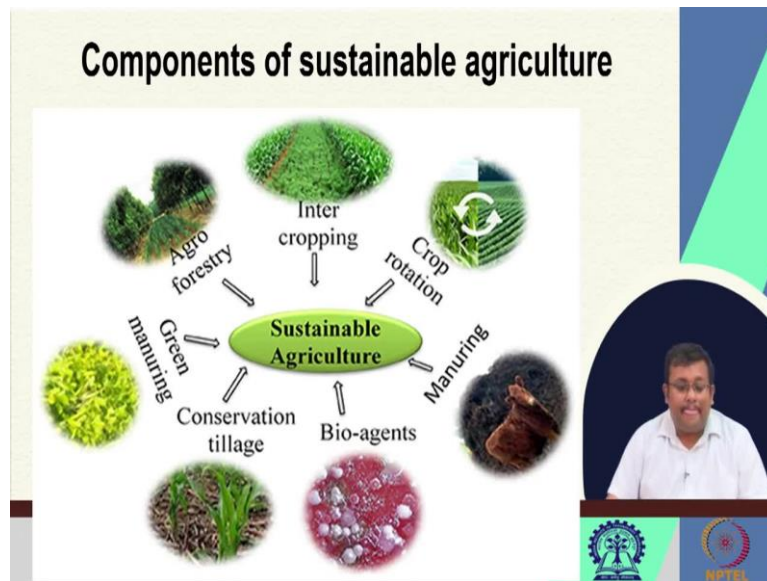


Now, if we see, if we want to see more differences between manures and fertilizers, we can see that manures contain organic matter and thereby it improves the soil physical properties whereas, fertilizer do not contain organic matter and cannot improve soil physical properties. Manures on the other hand can contain all plant nutrients, but small in concentration.

So, since it is majorly organic matter, it can contain different nutrients both macro and micronutrients, but, they are present in very small concentration. However, since fertilizers are synthetic in nature, they can contain one or more nutrients, but in higher concentration. In case of manure we required these manure in large quantity, these are mostly bulky in nature and of course, costly.

In contrast, fertilizers are required in less quantity then manures and they are concentrated and the comparatively cheaper than manure. In case of manure nutrients are slowly available upon decomposition. Whereas in case of fertilizers nutrients are readily available. In case of manure we can see long lasting effects soil and crop whereas in case of fertilizer, there is very less residual effect. In case of manure there is no salt effect or no adverse effect however, in case of fertilizers salt effect is high and adverse effects are also observed if we apply them in higher quantity. So, these are the some of the major differences between manures and fertilizers.

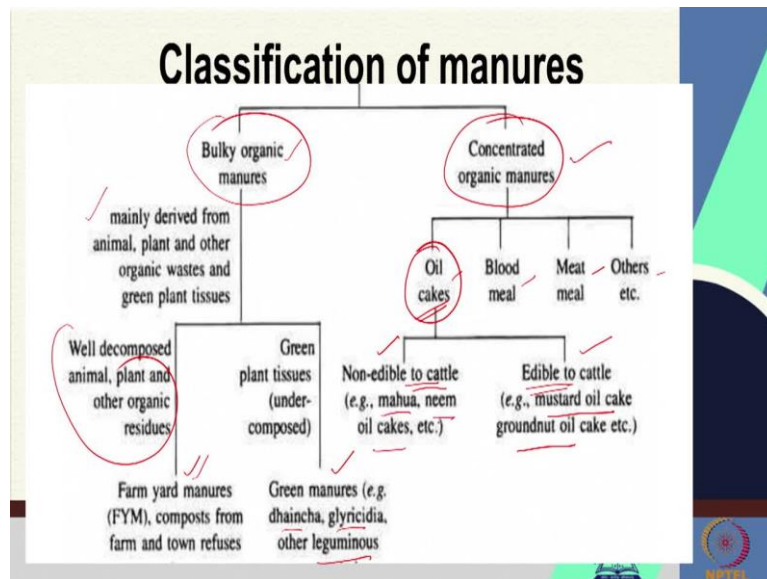
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Now, if we see the components of sustainable agriculture as we have discussed sustainable agriculture can be an interplay of many components, what are these components, first of all intercropping is one of the major components then crop rotation, then manuring, then different bio-agents which we are going to discuss like bio fertilizers, then conservation tillage, green manuring, agroforestry. So, all these are components of sustainable agriculture and we are going to focus on manures and fertilizers in this week.

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Now, let us now discuss in details about organic manures. Now, if we classify the manure they are of mainly 2 types we can see that the major classification of manures bulky organic manure and concentrated organic manure. Now, bulky and concentrated organic manure mainly differ in the amount of manure requirements, so bulky organic manures are required in bulk quantity however, concentrated organic manures record in comparatively less quantity.

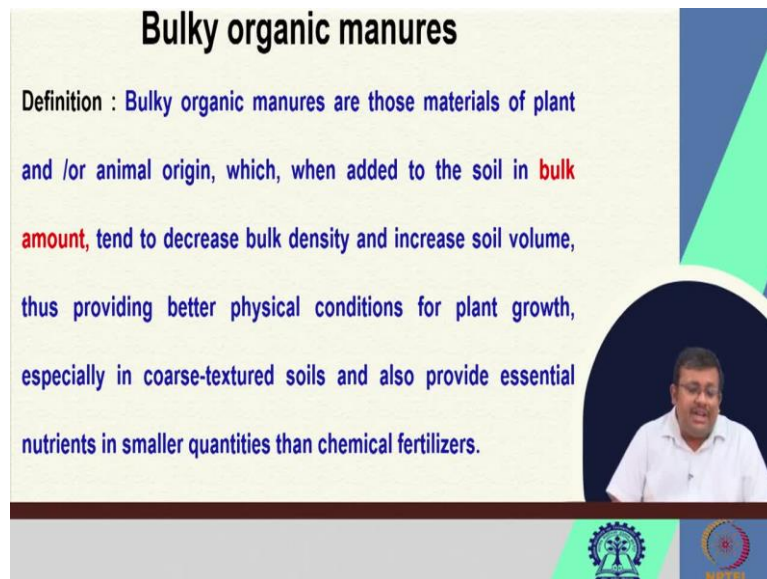
Now, these bulky organic manures are mainly derived from animal plant and other organic waste and green plant tissues. Whereas, this concentrated organic manure are can be classified into oil clicks, blood meal, meat meal and other considered organic manure. So, this bulky organic manure are mainly derived from animal plant and other organic wastes and green plant tissues and they can be classified into 2 major class one is called farm yard manure and other is green manure.

Now, this farm yard manure is basically well decomposed animal plant and other organic residues however, green manure basically that decompose plant tissues. So, there are several plants like dhaincha, glyricidia and other leguminous crop which you can use as grain manure to increase not only the organic matter but also, they can also improve the soil physical conditions. Now, when we discuss about the concentrated organic manure, this concentrated organic manure, the one of the major concentrate organic manure are oil cakes.

Now, oil cakes are again divided into non-edible oil cake or edible oil cakes. Now, non-edible oil cakes can you can cannot feed to cattle however, edible oil cakes you can use as a feed to the cattle what are the examples of edible oil cakes, mustard, oil cake groundnut oil cake et

cetera are examples of edible oil cake however non-edible oil cakes are mahua, neem oil cake et cetera, we are going to discuss these in details.

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Bulky organic manures

Definition : Bulky organic manures are those materials of plant and /or animal origin, which, when added to the soil in **bulk amount**, tend to decrease bulk density and increase soil volume, thus providing better physical conditions for plant growth, especially in coarse-textured soils and also provide essential nutrients in smaller quantities than chemical fertilizers.



The slide features a video inset of a man in a white shirt speaking. At the bottom, there are logos for a university and a research organization.

Now, let us first let us now discuss the word bulky or getting manure. Now, the definition of the bulk organic manure says that these are the manures of plant and animal origin which when added to the soil in bulk amount tend to decrease the bulk density and increase the soil volume thus providing better physical condition for plant growth especially in coarse textured soils and also provide essential nutrients in smaller quantities than chemical fertilizers. So, as the definition says these manures are required in bulk quantity in tons per hectare basis. And when we apply this manure in bulk quantity, they can supply the nutrients at the same time they can improve the soil physical and as well as chemical properties.

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Characteristics of bulky organic manures:

1. Organic materials are relatively poorer in the concentration of plant nutrients.
2. These materials possess wider C: N ratio and C:S ratios and supply energy needed for microorganisms.
3. The mineral nutrients in the organic materials become available to plants after mineralization.
4. A judicious combination of organic manures is essential to maintain fertility status. Examples: FYM, Composts, Green manures, Biogas slurry, Sewage or sludge, Molasses, and Vermicompost






Now, let us discuss some of the important characteristics of bulk organic manure. Now, organic manures are relatively poorer in the concentration of the plant nutrients and these materials possess wider CN ratio and carbon sulfur ratios and supply energy needed for microorganisms. The mineral nutrients in the organic materials become available to plants after mineralization, we know that that these are mainly organic matter and through mineralization process, the organic form of nutrients convert into inorganic forms. And finally, a judicious combination of organic manures is essential to maintain the fertility status. For example, FYM, compost, green manure biogas slurry, sewage or sludge, molasses and vermicompost can be mixed together to produce to maintain the soil fertility status.

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I.FARM YARD MANURE (Cattle manure)

Definition: The physical composition of cattle manure is called **Farm Yard Manure**, which consists of dung and urine of cattle and the litter, a bedding material like hay, straw used for cattle.

Cattle manure is slow acting, bulky and a low analysis fertilizer, obtained from dung and urine of farm animals mixed with litter and other miscellaneous farm wastes.



<https://agritech.tnau.ac.in/>

So, let us discuss more about farm yard and manure. Now, if we see the definition of the farm yard Manure it says that the physical composition of cattle manure is called farm yard manure which consists of dung and urine of cattle and the litter which is a bedding materials like hay, straw used for cattle so these can be used as a bedding material.

Now, remember that this cattle manure is slow acting, bulky and low analysis fertilizer. Low analysis means it contains low quantity of nutrients and this cattle manure is obtained from dung and urine of farm animals mixed with litter and other miscellaneous farm wastes. As you can see, below these photographs are showing the preparation of farm yard manure.

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I. FARM YARD MANURE (Cattle manure)

On an average well decomposed farmyard manure contains 0.5 per cent N, 0.2 per cent P₂O₅ and 0.5 per cent K₂O. The present method of preparing farmyard manure by the farmers is defective. Urine, which is wasted, contains one per cent nitrogen and 1.35 per cent potassium. Nitrogen present in urine is mostly in the form of urea which is subjected to volatilization losses. Even during storage, nutrients are lost due to leaching and volatilization.

And on an average well decomposed farm yard manure contains 0.5 percent nitrogen 0.2 percent P₂O₅ and 0.5 percent K₂O. The present method of preparing this farmyard manure by the farmers is generally defective. So, urine which is wasted content 1 percent of nitrogen and 1.35 percent potassium, nitrogen present in urine is mostly in the form of urea, which is subjected to volatilization losses you already know what is volatilization loss? Now, even during the storage nutrients are lost due to leaching and volatilization.

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I.FARM YARD MANURE (Cattle manure)

However, it is practically impossible to avoid losses altogether, but can be reduced by following improved method of preparation of farmyard manure.

- Trenches of size 6 m to 7.5 m length, 1.5 m to 2.0 m width and 1.0 m deep are dug.
- All available litter and refuse is mixed with soil and spread in the shed so as to absorb urine.

The slide features a circular inset of a male presenter in a white shirt and glasses. At the bottom, there are logos for a university and NPTEL.

Then also, it is practically impossible to avoid losses altogether but it can be reduced by following improved method of preparation of farm yard manure. So, how do you prepare the farm yard manure? First of all, you dug trenches of size 6 meter to 7.5-meter length 1.5-meter 2-meter width and 1-meter depth and all available litter and refuse is mixed with soil and sprayed in the shade so as to observe the urine.

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I.FARM YARD MANURE (Cattle manure)

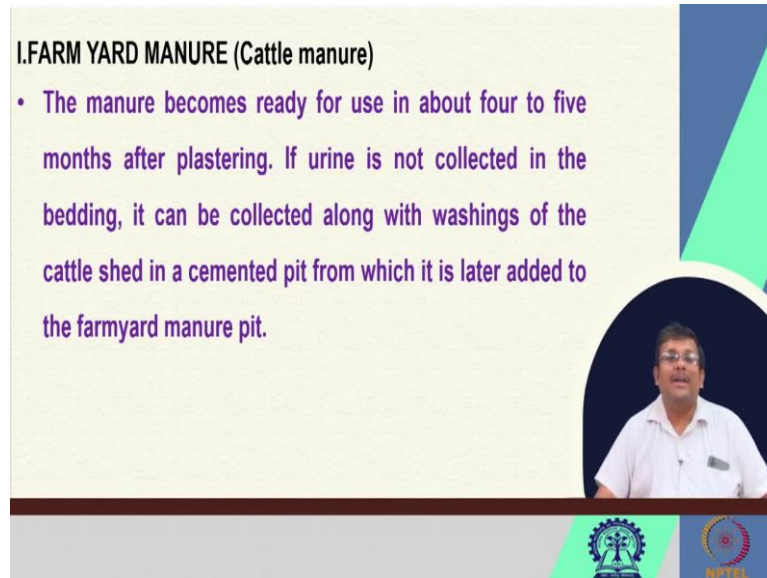
- The next morning, urine soaked refuse along with dung is collected and placed in the trench.
- A section of the trench from one end should be taken up for filling with daily collection. When the section is filled up to a height of 45 cm to 60 cm above the ground level, the top of the heap is made into a dome and plastered with cow dung earth slurry. The process is continued and when the first trench is completely filled, second trench is prepared.

The slide features a circular inset of the same male presenter. At the bottom, there are logos for a university and NPTEL.

The next morning you urine-soaked refuse along with dung is collected and placed in the trench. A section of the trench from one inch should be taken up for filling with daily collection. When the section is filled up to a height of 45 centimeter to 60 centimeter above the ground level. The top of the heap is made into dome and plastered with cow dung or

slurry. The process is generally continued and when the first trench is completely filled, second trench is prepared, so this is how this farm yard manure is being prepared.

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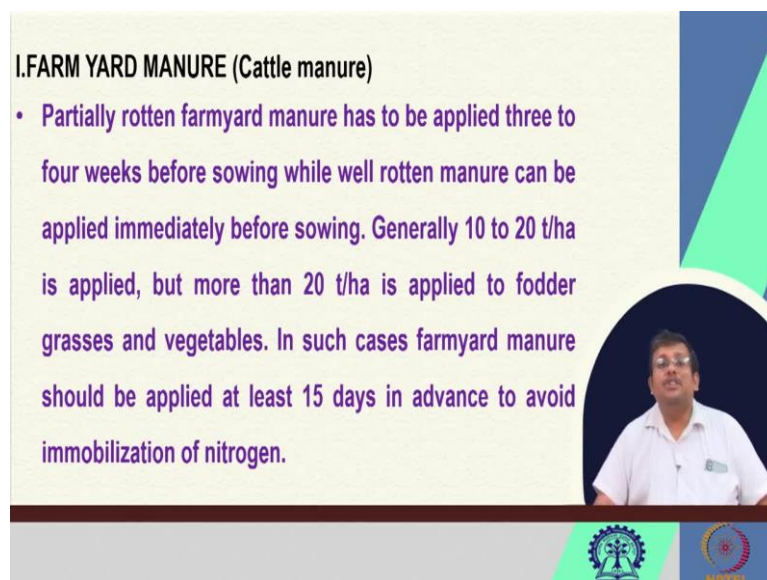
I.FARM YARD MANURE (Cattle manure)

- The manure becomes ready for use in about four to five months after plastering. If urine is not collected in the bedding, it can be collected along with washings of the cattle shed in a cemented pit from which it is later added to the farmyard manure pit.

The slide features a video inset of a man in a white shirt speaking. At the bottom, there are logos for a university and a research organization.

Now the manure becomes ready for use in about 4 to 5 months after plastering. Now, if urine is not collected in the bedding it can be collected along with washing of the cattle shed in a cemented pit from which it is later added to the farm yard manure pit. So, this is how you prepare the farmer manure.

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I.FARM YARD MANURE (Cattle manure)

- Partially rotten farmyard manure has to be applied three to four weeks before sowing while well rotten manure can be applied immediately before sowing. Generally 10 to 20 t/ha is applied, but more than 20 t/ha is applied to fodder grasses and vegetables. In such cases farmyard manure should be applied at least 15 days in advance to avoid immobilization of nitrogen.

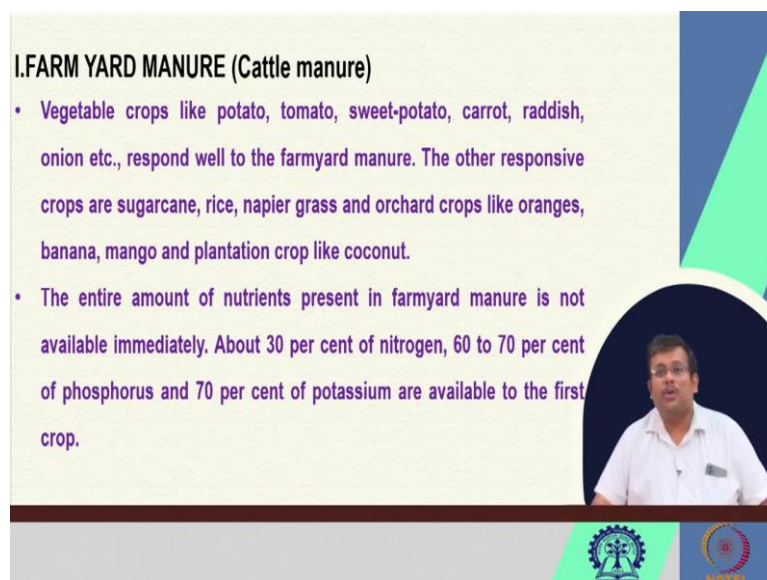
The slide features a video inset of a man in a white shirt speaking. At the bottom, there are logos for a university and a research organization.

Now, partially rotten farmyard manure has to be applied 3 to 4 weeks before sowing while well rotten farm yard manure can be applied immediately before sowing. So, when it is well

rotten the availability of the nutrients are quite fast. So, you can apply that well rotten manure immediately before the sowing. Generally, 10 to 20 ton per hectare of this manure is applied. So, you will see that most of the recommendation you will see that 10 ton per hectare basis they have recommended but more than 20 ton per hectare is applied to fodder grasses and vegetables.

Now, in such cases farmyard manure should be applied at least 15 days in advance to avoid immobilization of nitrogen. So, depending on your crop, whether it is a field crop, whether it is a fodder crop, whether it is a vegetable, you have to apply this farm yard manure at different rates.

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I.FARM YARD MANURE (Cattle manure)

- Vegetable crops like potato, tomato, sweet-potato, carrot, raddish, onion etc., respond well to the farmyard manure. The other responsive crops are sugarcane, rice, napier grass and orchard crops like oranges, banana, mango and plantation crop like coconut.
- The entire amount of nutrients present in farmyard manure is not available immediately. About 30 per cent of nitrogen, 60 to 70 per cent of phosphorus and 70 per cent of potassium are available to the first crop.

The slide features a video inset of a man in a white shirt speaking. At the bottom, there are logos for a university and NPTEL.

Now, vegetable crops like potato, tomato, sweet potato, carrot, radish, onion, et cetera. They can respond well to the farming manure. They are generally known to respond well to farm yard manure. The other responsive crops are sugarcane rice, napier grass and orchard crops like oranges, banana, mango and plantation crop like coconut.

So, the entire amount of nutrients present in farmyard manure is not available immediately remember that about 30 percent of the nitrogen 60 to 70 percent of the phosphorus and 70 percent of the potassium are available to the first crop. So, this is very important consideration when you apply this farmer yard manure.

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II. Compost : Compost is a product of the decomposition of plant and animal wastes with various additives. The compost had the largest variation of all organic materials ranging from neglected garbage dumps to carefully composted and treated substances with high fertility.

Composting :
Composting is a process of converting organic matter into manure in a short time by accelerating the fermentation process under controlled conditions.

The slide features a circular inset of a man in a white shirt and glasses, and logos for a university and NPTEL at the bottom.

Now, when you covered the farm yard manure the next important bulky organic manure is compost. Now, compost is a product of the decomposition of plant and animal wastes with various additives. Now, the compost had the largest variation of all organic materials ranging from neglected garbage dumps to carefully composted and treated substances with high fertility.

Now, what is composting? Composting is the process of compost making. So, composting is essentially the process of converting organic matter into manure in a short time by accelerating the fermentation process under control condition. So, composting is mediated by different microorganisms, it is a microorganism mediated process.

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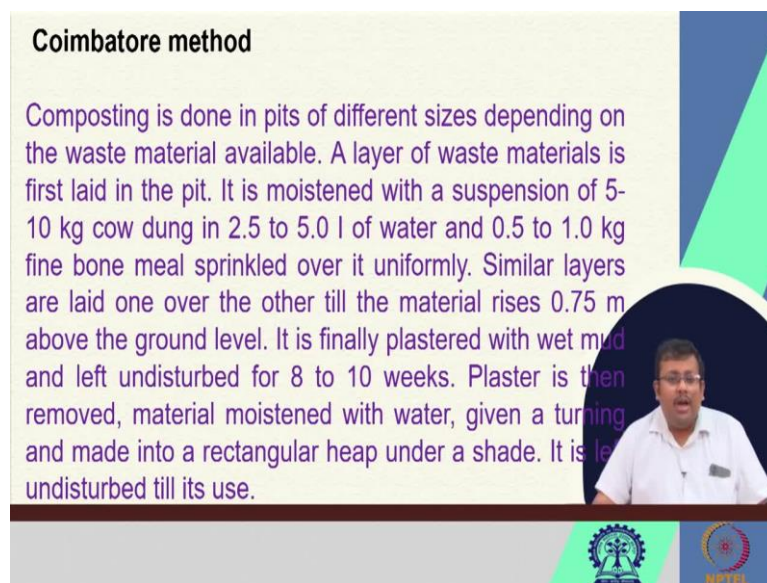
Methods of composting: The process of composting were first initiated in England during the period of first world war (1914 - 1918). Since then; the various systems of composting are:

1. ADCO process (Agricultural Development Company)
2. Activated compost process
3. Indore process
4. Bangalore process
5. Coimbatore process
6. NADEP
7. Rain -water compost
8. Rural compost
9. Urban compost
10. Vermicompost

The slide features a circular inset of a man in a white shirt and glasses, and logos for a university and NPTEL at the bottom.

Now, let us discuss about methods of composting. Now, the process of composting were first initiated in England during the period of First World War. Since then, the various systems of composting have been developed. And some of them are mentioned here like agriculture development company or ADCO process, activated compost process, Indore process, Bangalore process, Coimbatore process, NADEP method, rainwater compost, rural compost, urban compost, vermicompost. Now, we are going to focus the 3 major methods of compost production Indore process, Bangalore process and 4 method actually Indore process, Bangalore process, Coimbatore process and NADEP process of compost making.

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Coimbatore method

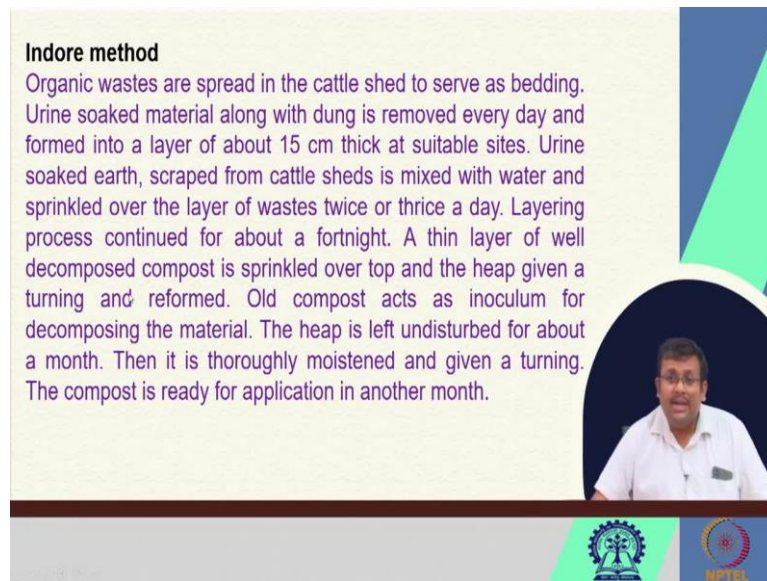
Composting is done in pits of different sizes depending on the waste material available. A layer of waste materials is first laid in the pit. It is moistened with a suspension of 5-10 kg cow dung in 2.5 to 5.0 l of water and 0.5 to 1.0 kg fine bone meal sprinkled over it uniformly. Similar layers are laid one over the other till the material rises 0.75 m above the ground level. It is finally plastered with wet mud and left undisturbed for 8 to 10 weeks. Plaster is then removed, material moistened with water, given a turning and made into a rectangular heap under a shade. It is left undisturbed till its use.

The slide features a video inset of a man in a white shirt speaking. At the bottom, there are logos for IIT Bombay and NPTEL.

So, let us start discussing about the Coimbatore method. Now, in the Coimbatore method, what we do composting is done in pits of different sizes depending on the waste material available. So, a layer of waste material is first laid in the pit and it is moistened with a suspension of 5 to 10 kg cow dung in 2.5 to 5 liter of water and 0.5 to 1 kg of fine bone meal sprinkled over it uniformly. So first of all, you first lay a waste material in the pit and then you moisten it with this slurry of cow dung and water and bone meal.

Now, similar layers are laid over one another till the material rises 0.75 meters above the ground level. It is finally plastered with wet mud and left undisturbed for 8 to 10 weeks. That means 2 to 2 and a half months. Plaster is then removed material moistened with water and then we turn the material and made into a rectangular heap under the shed and it is unlined undisturbed till its use. So, this is called Coimbatore method this is one of the important methods of compost making.

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Indore method
Organic wastes are spread in the cattle shed to serve as bedding. Urine soaked material along with dung is removed every day and formed into a layer of about 15 cm thick at suitable sites. Urine soaked earth, scraped from cattle sheds is mixed with water and sprinkled over the layer of wastes twice or thrice a day. Layering process continued for about a fortnight. A thin layer of well decomposed compost is sprinkled over top and the heap given a turning and reformed. Old compost acts as inoculum for decomposing the material. The heap is left undisturbed for about a month. Then it is thoroughly moistened and given a turning. The compost is ready for application in another month.

The slide features a video inset of a man in a white shirt speaking. At the bottom, there are logos for a university and NPTEL.

The next process is the Indore method. So, in this method organic wastes are sprayed in the cattle shed to serve as bedding. Now, urine-soaked material along with dung is removed everyday and form into a layer of about 15-centimeter-thick at suitable sites. Urine soaked earth scraped from the cattle shed is mixed with water and sprinkle over a layer of waste twice or thrice a day. Now, this layering process really it continues for about a fortnight or 15 days.

So, a thin layer of well decomposed compost is sprinkled over the top of the heap given and given a turning and reform. So, this old compost when you sprinkle the old compost these basically acts as inoculum for decomposing the material. So, that the heap of compost is left undisturbed for about a month and then it is roughly or thoroughly moistened, and given a turning the compost is generally in this method, Indore method is ready for application in another month. So, this is another method that is called Indore method.

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Bangalore method
Dry waste material of 25 cm thick is spread in a pit and a thick suspension of cow dung in water is sprinkled over for moistening. A thin layer of dry waste is laid over the moistened layer. The pit is filled alternately with dry layers of material and cow dung suspension till it rises 0.5 m above ground level. It is left exposed without covering for 15 days. It is given a turning, plastered with wet mud and left undisturbed for about 5 months or till required.

Third method is Bangalore method. In the Bangalore method, what happens dry waste material of 25 centimeter thick is sprayed in a pit and a thick suspension of cow dung in water is sprinkle over for moistening. A thin layer of dry waste is laid over the moistened layer and the pit is filled alternatively we dry layers of materials and Cow dung suspension, till it rises 0.5 meter above the ground level. Now, it is left exposed without covering for 15 days or a fortnight. Now, it is given a turning, plastered with wet mud and left undisturbed for about 5 months or till required so this is called Bangalore method of composting.

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NADEP method

The NADEP method of composting was introduced by N.D. Pandharipande from Maharashtra. This composting takes place in constructed brick tanks and around 2.5 tons of compost can be prepared in short period (4 months) using this method.

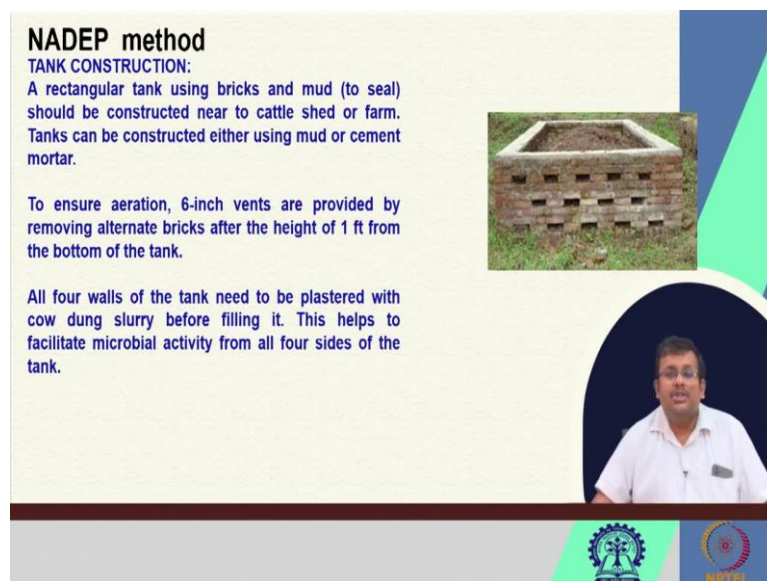
RAW MATERIALS:
Agriculture waste (Weeds, crop residues, forest litter) - 1350 - 1400 kgs
Cattle dung/biogas slurry - 98-100 kgs
Fine sieved soil - 1675 kgs
Water - 1350 - 1400 ltrs

The final composting method which we are going to discuss is called NADEP method. So, this NADEP method of composting was introduced by this fellow N.D. Pandharipande from

Maharashtra and these composting takes place in constructed brick tanks. So, this is the constructed brick tank and around 2.5 tons of compost can be prepared in short period of 4 months using this method.

What are the raw materials? These raw materials are agricultural waste like weeds, crop residues forest litter and we require around 1350 to 1400 kg of this agricultural waste. Apart from that we need 90 to 100 kg of cattle dung or bio gas slurry. Apart from that we required 1675 kg of finely sieved soil and around 1400 liters of water. So, these are the components of raw materials of NADEP method of composting.

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NADEP method
TANK CONSTRUCTION:
A rectangular tank using bricks and mud (to seal) should be constructed near to cattle shed or farm. Tanks can be constructed either using mud or cement mortar.

To ensure aeration, 6-inch vents are provided by removing alternate bricks after the height of 1 ft from the bottom of the tank.

All four walls of the tank need to be plastered with cow dung slurry before filling it. This helps to facilitate microbial activity from all four sides of the tank.

The slide includes a photograph of a brick tank with ventilation holes and a video inset of a presenter. Logos for IIT Bombay and NPTEL are visible at the bottom.

So, how to construct this brick tank. So, first day rectangular tank using bricks and mud should be constructed near to cattle shed or farm, so tanks can be constructed either using mud or cement mortar. So basically, generally we use the mud to seal the inner side of the of the tank and to ensure these aerations 6-inch vents are provided by removing the alternate brick after the height of 1 feet from the bottom of the tank. And all 4 walls of the tank need to be plastered with cow dung slurry before filling it. Now, this helps to facilitate the microbial activity from all 4 sides of the tank. So, this is how you prepare this tank for NADEP method.

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NADEP method

FILLING THE TANK:

First layer: 4 - 6 inches of stems and sticks are spread at the bottom to facilitate aeration. It is followed by a 4 - 6 inches layer of agricultural wastes (about 10-100 kg).

Second layer: A slurry, that is made using 4 - 5 kgs of cow dung and 100 - 125 liters of water is sprinkled over the dry wastes to facilitate microbial activity.

Third layer: 60 kg of sieved dry soil is spread evenly over the second layer for moisture retention. This layer also acts as a buffer during the biodegradation of the materials.



NADEP method

FILLING THE TANK:

The entire tank needs to be filled by the same process within 24 hours (not more than 48 hours) of time.

Now a layer of 3-inch sieved sand should be spread and sealed ultimately with a layer of cow dung and mud plaster.

After 15-30 days the volume of the materials gets reduced to 2 feet and is refilled with the layers of the dry wastes, slurry, and sand.

Now the entire mass is covered with a thatched roof to prevent the loss of moisture from the tank.



NADEP method

FILLING THE TANK:

Now the tank is left undisturbed for 3 months. Meanwhile, water is added for every 1 - 2 weeks to maintain the moisture percentage in the tank. If the tank develops any cracks, those can be filled with the slurry to maintain the quality of the compost.



Now, how to fill this tank. In the first layer, 4 to 6 inch of stems and sticks at sprayed at the bottom to facilitate the aeration it is followed by a 4 to 6 inch of agricultural waste, which weighs about 10 to 00 kg. In the second layer a slurry that is made up of 4 to 5 kg of cow dung and 100 to 125 liters of water is sprinkle over the dry wastes to facilitate the microbial activity. In the third layer 60 kg of sieved dry soil is spread evenly over the second layer for moisture retention and this layer also acts as a buffer during the biodegradation of the material.

In the next step the entire tank needs to be filled by the same process within 24 hours not more than 48 hours of time. Now, a layer of 3-inch sieved sand should be sprayed and sealed ultimately with a layer of cow dung and mud plaster. After 15 to 30 days, the volume of the material gets reduced to 2 feet and is refilled with the layer of the driveway slurry and sand. Now, the entire mass is covered with the thatched roof to prevent the loss of moisture from the tank.

Now, the tank is left undisturbed for 3 months. Meanwhile, water is added for every 1 or 2 weeks to maintain the moisture percentage of the tank now, if the tank develops any cracks, those can be filled with the slurry to maintain the quality of the compost. So, guys, this is how you prepare this NADEP compost we have now discuss the difference between manures and fertilizers. We have discussed about the bulky organic manure like farm yard manure, how to prepare the farm yard manure? And we have also discussed about the compost and several methods of compost preparation.

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The slide features a video inset of a man in a white shirt speaking. At the bottom, there are logos for IIT Bombay and NPTEL.

Let us wrap up this lecture here. These are some of the references which are used for this lecture. And let us wrap up this lecture here. In the next lecture, we are going to we are going to discuss the advantages and disadvantages of composting and also, we are going to learn about concentrated organic manure and then we are going to learn about green manure. Thank you very much. Let us meet in our next lecture.