Soil Science and Technology
Prof. Somsubhra Chakraborty
Department of Agricultural and Food Engineering
Indian Institute of Technology, Kharagpur

Lecture - 38
Soil Organic Matter

Welcome friends to this new lecture of Soil Science and Technology. And in this lecture, we will be trying to finish this soil testing and then we will be starting the Soil Organic Matter. So, in the last two lectures, we have talked about different aspects of soil testing; obviously, it is a very huge, we know, topic. And we know; obviously, we cannot cover each and every, you know, little bit step of little bit aspects of soil testing. But before wrapping the soil testing, let us discuss some advanced methods of soil testing.

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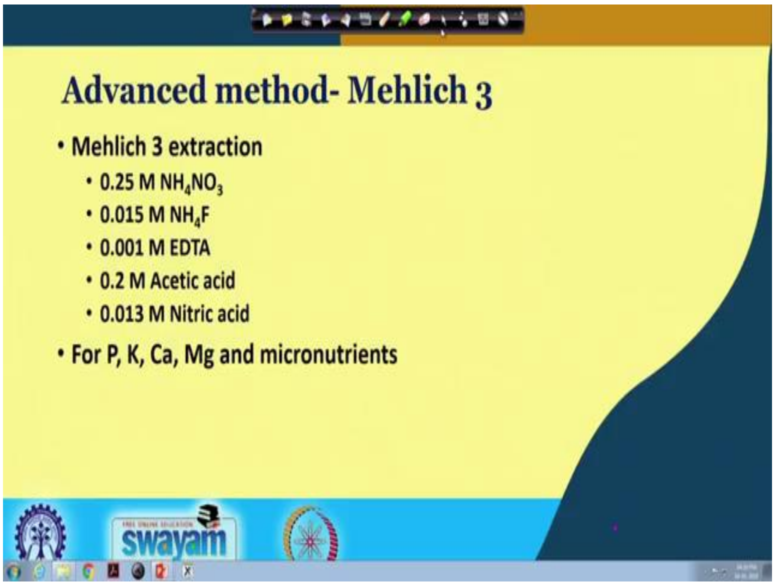

Advanced method- Mehlich 3

- Mehlich 3 extraction
  - 0.25 M NH_4NO_3
  - 0.015 M NH_4F
  - 0.001 M EDTA
  - 0.2 M Acetic acid
  - 0.013 M Nitric acid
- For P, K, Ca, Mg and micronutrients

So, you have known that from our last lectures that we have got, you know, individual extractant for extracting the specific nutrients. However, there is an, you know, advanced method of we call it Mehlich 3 extraction. And Mehlich 3 is basically combination of different chemicals, it is a collection of different chemicals. And which helps in, you know, extracting not only the first person potassium, but also calcium, magnesium and micronutrients.

So, it is a very much comprehensive method for extracting different, you know, available nutrients. So, Mehlich 3 extraction basically reagent basically composed of these 0.25 molar of ammonium nitrate and then 0.015 molar of ammonium fluoride, 0.001 molar of EDTA, 0.2 molar of acetic acid and 0.013 molar of nitric acid. So, it is basically composed of individual these components.

And each individual component has a specific role for extracting these micronutrients and macronutrients. So this is an advanced method. So, once we extract this Mehlich 3 using this Melich 3 extractant; obviously, the next step is to measure their concentration. For measuring their concentrations, generally nowadays the most advanced method is, the most advanced method is ICP-OES.

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ICP-OES

The full name of ICP-OES is Inductively Coupled Plasma Optical Emission Spectroscopy. Now, this is an advanced method which basically works on optical emission spectroscopy. Another method which is available also we call it Atomic Absorption Spectroscopy or AAS. So, there are two methods generally, you know, scientist are using one is called AAS, another is ICP. But ICP is much more, you know, precise I would say.

And so let us discuss what is ICP. The full name of ICP is basically inductively coupled coupled plasma and then optical emission spectroscopy. So, why we are calling it, you know, inductively coupled plasma? We will see in the next slide.

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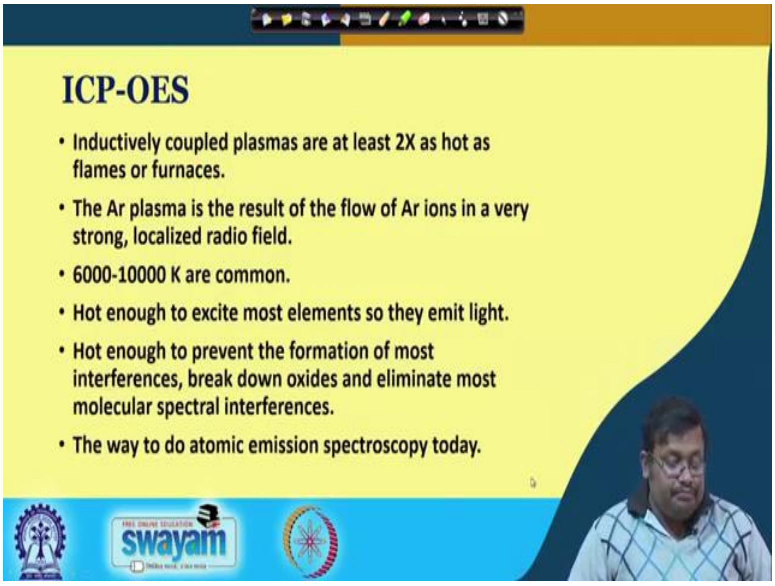

ICP-OES

- Inductively coupled plasmas are at least 2X as hot as flames or furnaces.
- The Ar plasma is the result of the flow of Ar ions in a very strong, localized radio field.
- 6000-10000 K are common.
- Hot enough to excite most elements so they emit light.
- Hot enough to prevent the formation of most interferences, break down oxides and eliminate most molecular spectral interferences.
- The way to do atomic emission spectroscopy today.

So, ICP-OES is basically inductively coupled plasma. And they are at least two times as hot as flames or furnaces. So, if you remember in case of flame photometry the source of excitation is generally the flame which is generated through LPG gas. However, in case of ICP we generate the flame or plasma instead we generate the plasma instead of flame which is two times as hotter.

And this is basically argon plasma and the argon plasma is a result of the flow of argon ions in a very strong localized radio field which we created around the torch ICP torch, we call it ICP torch. Now; obviously, we get a 6000 to 10,000 Kelvin of temperature which is very common. And it is very hot enough to excite most element so they can emit the light. Because most of the elements will they, you know, will be energized and they will go to the upper, you know, higher energy state and then they will revert back to their ground state and in doing so they will emit some energy which will be measured. So, this high temperature is hot enough to prevent the formation of most of the interferences and breakdown the oxides and eliminate most molecular and spectral interferences. So, this high temperature is very much important for removing any type of interferences that could be possible in other methods.

So, the way to do the atomic emission spectroscopy is basically now it is in advanced countries in a more advanced laboratories they use this method for measurement of these available nutrients.

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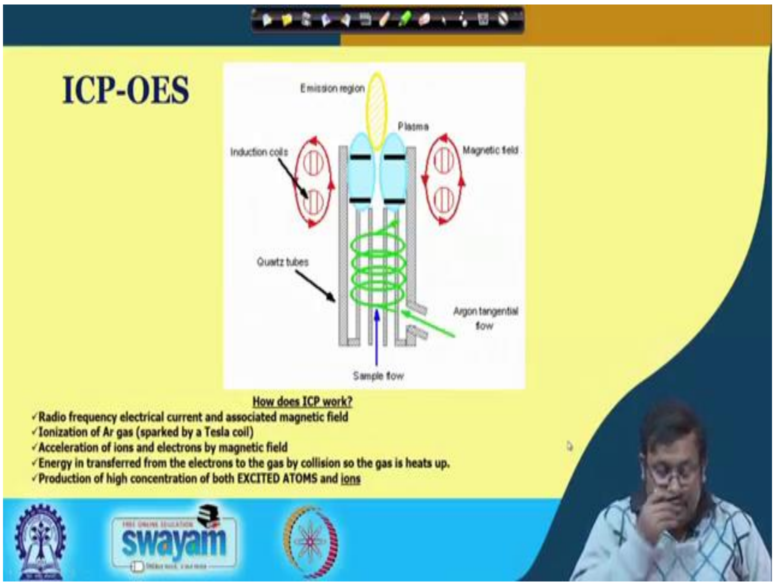
ICP-OES

How does ICP work?

- ✓Radio frequency electrical current and associated magnetic field
- ✓Ionization of Ar gas (sparked by a Tesla coil)
- ✓Acceleration of ions and electrons by magnetic field
- ✓Energy in transferred from the electrons to the gas by collision so the gas is heats up.
- ✓Production of high concentration of both EXCITED ATOMS and ions

So, you are seeing here a ICP torch. Now how it works? In the ICP torch, you will see some concentrated quartz tubes, you know, concentrated. Now generally we generally the argon is flow which is, you know, we call it argon plasma. So, argon is flow through a tangential flow and sample is injected from here.

And you can see there are two coils, induction coils and magnetic field. So, radio frequency electrical current and associated magnetic field is given. So, radio frequency electrical current and associated magnetic field is given. And we generally use a Tesla coil to spark or ionize this argon. And ultimately the argon will ionize to form electrons.

And these electrons, the electrons which are produced from this ionization of argon will be accelerated by this magnetic field. And obviously, the energy will be transferred from the electrons to the gas by collision so the gas is heats up.

So, basically, we are incorporating the argon here and this argon is moving through these quartz tubes. And while it is moving through this quartz tubes, we are ionizing it through a Tesla coil which is creating electrons. And these electrons basically moving through, we know we know, in high acceleration in the influence of magnetic field. And as a result of a, as a result of that, high energy is transferred when these electron is collided with the gas and as a result the gas is heats up. So, at the top you can see, the plasma is generated. So, this is the emission region. So, production of high concentration of both excited atoms and ions. So, this is the principle behind this, you know, inductively coupled plasma.

Ultimately there will be two detectors; and this detector will, you know, will measure the emitted light intensity. And from there, it can measure the concentration of a particular element. So, the element which are present in the sample so we are incorporating that. When these are coming in contact with the plasma; obviously, they will be going to, they will be excited and going to the high energy state. And as a result, they will emit the energy which will be further measured by the detectors. So, this is the principle behind ICP-OES

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Soil testing kit

- ☐Portable soil testing kits enable farmers to take it to fields and take measurements
- ☐Most common kits helps us to find the pH and primary nutrients (N,P and K)
- ☐Kits can also help in finding all nutrients- but its expensive
- ☐Soil sample is first taken using a spade or trowel

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And finally guys, I would like to show you another, you know, portable tool generally we use in the field the soil testing the scientist generally use in the field. We call it soil testing kit. Now, it is a portable kit which enable farmers to take it to the fields and take the measurements. And most common kits helps us to find the pH and primary nutrients N, P, K and with organic carbon.

And kits can also help in finding all the nutrient, but it is expensive. So, soil sample is first taken using a spade or trowel. And then you will see inside the kit, inside the soil testing kit you will see several types of small tools; starting from cuvettes, starting from, you know, test tubes. And then and using and you have to put the soil sample within the test tube.

And there will be several chemicals and you have to add those chemicals directly into the test tube and then you have to develop a colour by a mixing these reagents. And this colour will be finally compared with the standard colour chart which is given within the soil testing kit. And from that, you can qualitatively ascertain what is the nutrient status of that field. So, this is the very quick and rough method; obviously, this is a qualitative method, it is not a very much accurate quantitative method.

But it is very much useful when you are considering onsite evaluation of soil fertility. And from that you do not need to go for soil drying and soil grinding. And there are some, you know, scoops are already there, which can measure around 2 or 2.5 gram of soils. You can use wet soils directly and you can we can and these testing kit can be used for measurement of most of the routine soil tests. So guys, so this is about the soil testing kit.

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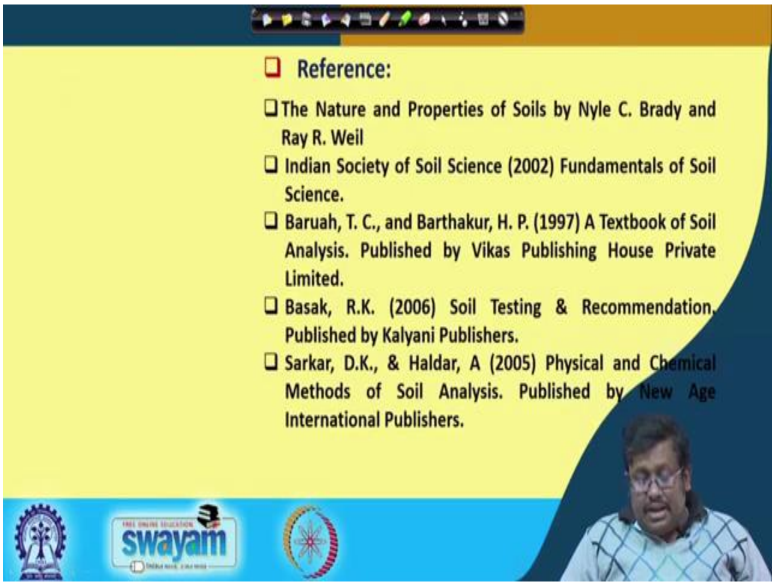

❑ Reference:

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- ❑ Indian Society of Soil Science (2002) Fundamentals of Soil Science.
- ❑ Baruah, T. C., and Barthakur, H. P. (1997) A Textbook of Soil Analysis. Published by Vikas Publishing House Private Limited.
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I hope that and these are the references. I hope that you have got a basic overview of soil testing. And you got an idea of different aspects of soil testing. Obviously, I did not complete I did not cover all the important aspects because the limitation of time. But however, I would expect that you will go ahead and, we know, consult different books and different scientist for measurement of soil samples on other parameters.

So, let us wrap up here and these are the references. So, in the next topic will be very important that is soil organic matter and climate change.

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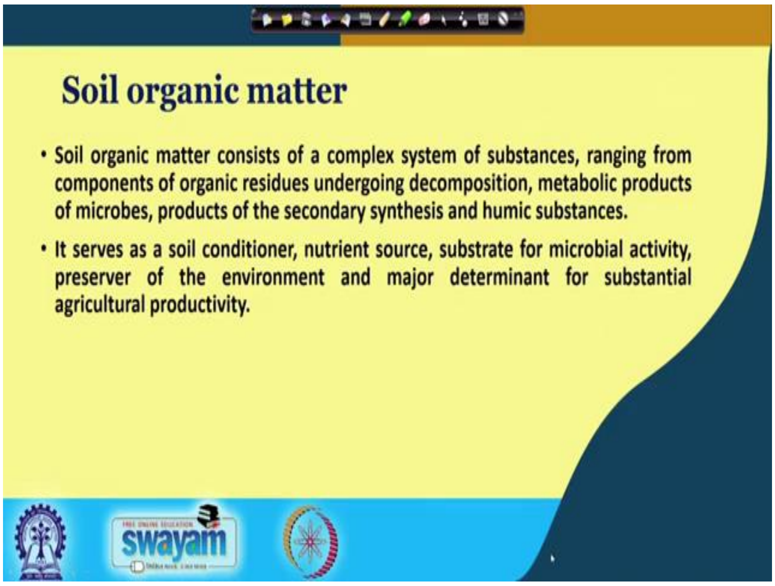

Soil organic matter

- Soil organic matter consists of a complex system of substances, ranging from components of organic residues undergoing decomposition, metabolic products of microbes, products of the secondary synthesis and humic substances.
- It serves as a soil conditioner, nutrient source, substrate for microbial activity, preserver of the environment and major determinant for substantial agricultural productivity.

So, let us see what is soil organic matter? Obviously, soil organic matter consists of a complex system of substances which is ranging from components of organic residues undergoing decomposition, metabolic products of microbes and then products of secondary synthesis and humic substances. So, this is a complex mixture of different, we know, organic fractions.

Now, this organic matter, soil organic matter is basically present in the soil if you if you remember, in the first lectures we have talked about that volumetrically it constitutes about 5% in the soil. But it is very important as, you know, since it has got high amount of cation exchange capacity as well as high amount of nutrient holding capacity.

And so the organic matter or organic, we know, matter contains several organic fractions starting from the fresh litters which is present over the soil surface. Then decaying organic matter, then a stabilized form of organic matter which is resistant to further decomposition, we call it humus. And remember that, the humus is the major fraction of organic matter that is responsible for soil physical, chemical and biological properties. So, we will discuss the humus in details later on. So, basically soil organic matter serves as a soil conditioner, nutrients source, substrate for microbial activity, preserver of the environment and major determinant of substantial agricultural productivity. Why? We will see.

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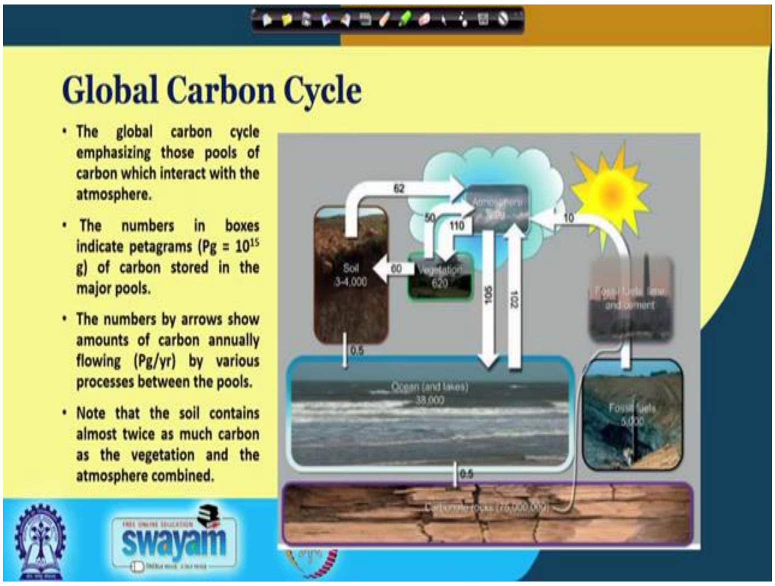

Global Carbon Cycle

- The global carbon cycle emphasizing those pools of carbon which interact with the atmosphere.
- The numbers in boxes indicate petagrams (Pg = 10^{15} g) of carbon stored in the major pools.
- The numbers by arrows show amounts of carbon annually flowing (Pg/yr) by various processes between the pools.
- Note that the soil contains almost twice as much carbon as the vegetation and the atmosphere combined.

So, if we consider the global carbon cycle; obviously, the carbon is recycled within this major reserve. You can see soil, then ocean and lakes, then carbonate rocks, then fossil fuels, then atmosphere, vegetation. These are some big big pools of or major pools of carbon in the earth and surrounding atmosphere. And you can see that how these movement of carbon is maintained from one pool to another pool.

Obviously, the global carbon cycle, you know you know, you can see here the numbers which you are seeing inside the box are basically indicating the pentagrams of carbon stored in that major pool. So, in case of soil; obviously, 3 to 4000 pentagrams of carbon stored in, you know, carbons. So the number by arrow shows the amount of carbon annually flowing in pentagram per year by various processes between these pools.

So, also you have to note down that the soil contains almost twice as much as carbon as the vegetation and the atmosphere combined. So this is very very important. So, you can have a basic idea about how this carbon is moving from one pool to another pool and it is very huge huge amount. And obviously, soil is considered as one of the major important pool of carbon global carbon cycle which contains twice as much as carbon as the vegetation and the atmosphere combined.

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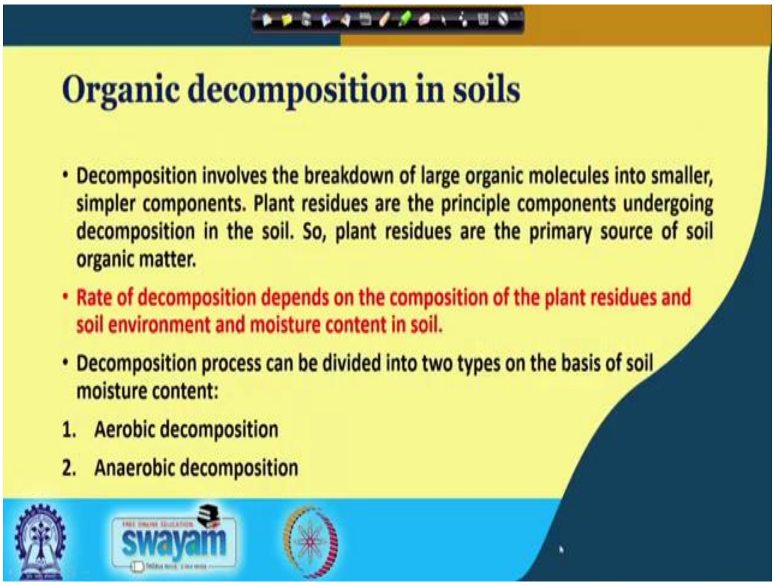

Organic decomposition in soils

- Decomposition involves the breakdown of large organic molecules into smaller, simpler components. Plant residues are the principle components undergoing decomposition in the soil. So, plant residues are the primary source of soil organic matter.
- Rate of decomposition depends on the composition of the plant residues and soil environment and moisture content in soil.
- Decomposition process can be divided into two types on the basis of soil moisture content:

1. Aerobic decomposition
2. Anaerobic decomposition

So, let us see what is organic matter decomposition in soil. So, decomposition basically involves the breakdown of large organic molecules into smaller, simpler components. Plant residues are the principle components, you know, undergoing decomposition in the soil. So, the plant residues are the primary source of soil organic matter. Obviously, plants are present in huge amount in the soil surface.

So, they are the primary source of soil organic matter. Now, the rate of decomposition depends on the composition of the plant residues and the soil environment and moisture content in the soil. So, decomposition process can be divided into two major category; one is aerobic decomposition another is anaerobic decomposition.

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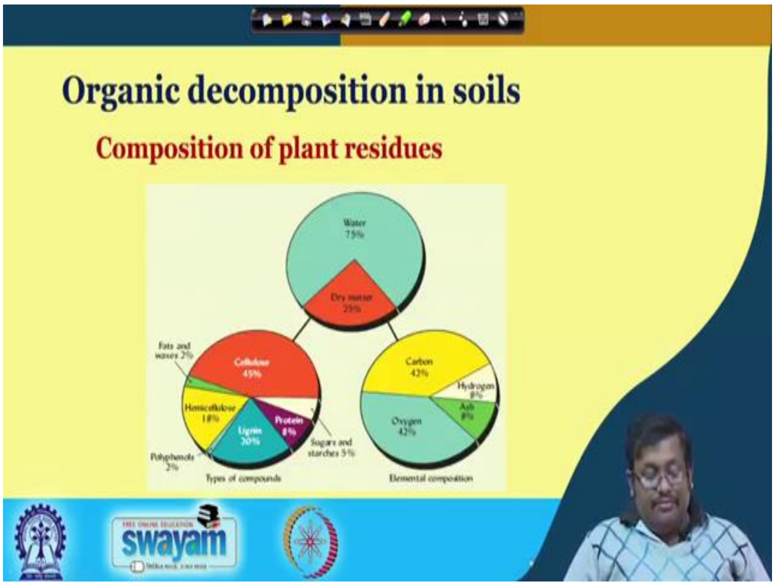

Organic decomposition in soils

Composition of plant residues

Now, if you see if you consider the organic matter composition in the soil decomposition of the soil, obviously, you have to talk about the composition of plant residue because this is one of the major indicator of how these different fractions of organic, you know, organic matter will undergo decomposition. So, volumetrically you can see; there are, you know, composition of plant residues.

Obviously, you can see there are 75 percent of water here where a dry matter is only 25 percent. So, if you see the dry matter; obviously, the dry matter contains 42 percent of carbon and then 8 percent of hydrogen and then 8 percent of ash and oxygen 42 percent or in another words if we if we concerned about the type of compounds, obviously, you see the majority is cellulose which is the 45 percent followed by lignin that is 20 percent, Hemicelluloses 18 percent, polyphenols 2 percent, fats and waxes 2 percent and sugars and starch is 5 percent and proteins 8 percent. So, these are the chemical composition or biochemical composition of the plant residues. And; obviously, depending on that, you know, organic matter decomposition or rate of organic matter decomposition varies obviously.

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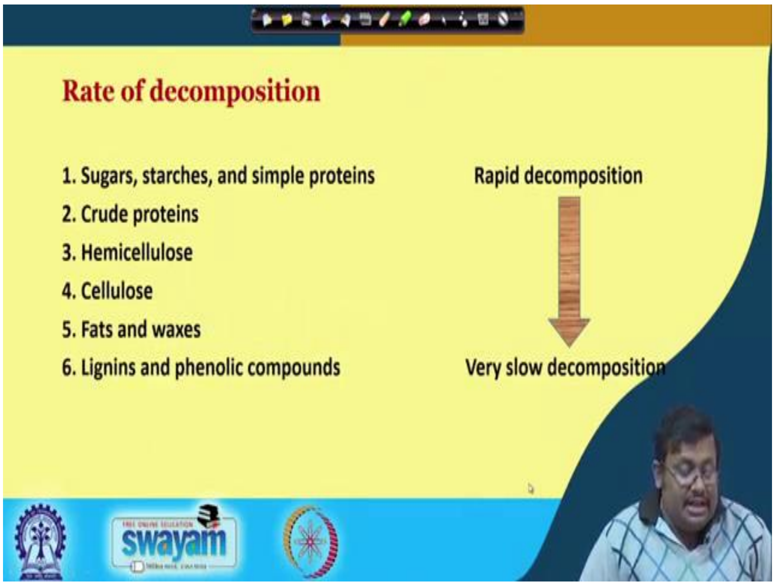

Rate of decomposition

1. Sugars, starches, and simple proteins
2. Crude proteins
3. Hemicellulose
4. Cellulose
5. Fats and waxes
6. Lignins and phenolic compounds

Rapid decomposition

Very slow decomposition

So, rate of decomposition; obviously, depends on these factors. For example, you know, you can see that there in the plant residues; obviously, there are sugar, starches and simple proteins, crude proteins, hemi cellulose, cellulose, fats and waxes, and lignin and phenolic compounds are there. Remember that, this sugar, starches and simple proteins are under, you know, generally undergo rapid decomposition. And as we go from the top to bottom; obviously, their resistant to decomposition increases.

So, lignins and phenolic compounds are the most resistant to decomposition and followed by fats and waxes, cellulose and hemicellulose. So, these are very very important aspects you have to take care of, you have to consider. And so the rate of decomposition; obviously, depends on the composition of the particular organic matter.

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Decomposition in aerobic soil

- Plant carbon compounds are enzymatically *oxidized* to produce carbon dioxide, water, energy, and decomposer biomass. Essential nutrient elements such as nitrogen, phosphorus, and sulfur are *released* and/ or immobilized by a series of specific reactions that are relatively unique for each element.

$$R\text{—}(C, 4H) + 2O_2 \xrightarrow[\text{oxidation}]{\text{Enzymatic}} CO_2\uparrow + 2H_2O + \text{energy } (478\text{ kJ mol}^{-1}\text{ C})$$

Carbon- and hydrogen-containing compounds

- New compounds are *synthesized* by microbes as cellular constituents or as breakdown products or secondary metabolites.
- Some of the original plant compounds, their breakdown products and microbial compounds become physically or chemical *protected* from further microbial decay via interactions with the soil environment.

So, let us talk about the decomposition of organic matter in aerobic soil. So, plant carbon compounds are enzymatically oxidized as you can see in this reaction, it is enzymatically oxidized to produce, you know, carbon dioxide and then water and energy huge amount of energy and decomposer biomass obviously. So, essential nutrients such as nitrogen, phosphorus, sulphur, are released and are immobilized by a series of specific reactions that are relatively unique to that element.

We have already discussed about those in our previous lectures. So, new compounds are; obviously, synthesized by microbes as cellular components or as a breakdown products or secondary metabolites. And some of the original plant compounds, their breakdown products and microbial compounds become physically or chemically protected from further microbial decay and via interaction with the soil environment.

So, these are some important aspects or important dynamics which occur in the aerobic decomposition of soil aerobic decomposition of organic matter. So, again here this is an organic matter; obviously, where aerobically decomposed in the presence of enzymes and producing carbon dioxide, water, energy and biomass of the decomposers.

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Decomposition in anaerobic soil

- The decomposition process is slower than the aerobic soil.
- Wet, anaerobic soils tend to accumulate large amounts of partially decomposed organic matter for two reasons:

1. Under low-oxygen or anaerobic conditions, decomposition takes place much more slowly than when oxygen is plentiful.
2. Certain products of anaerobic metabolism are toxic to many microbes, acting as a preservative for organic matter.

- The end products still contain much energy. For this reason, alcohol and methane, which are produced by anaerobic decomposition, can serve as fuel.
- Some products are toxic to the plant growth and contributor to the climate change.

So, let us talk about decomposition in anaerobic soil. Obviously, this decomposition process is slower than that of aerobic soil. And it generally, you know, you can see this type of decomposition in wet and anaerobic condition. And because of this slow decomposition in this anaerobic process, this type of soil that is wet and anaerobic soil tends to accumulate large amount of partially decomposed organic matter.

Because of mainly two reasons under low oxygen anaerobic condition, the decomposition takes place much more slowly than that when the oxygen is plentiful. And secondly, certain products of anaerobic metabolism are toxic to many microbes and acting as a preservative for organic matter. So, the end product, you know, still contains the energy.

So, that is why alcohol and methane which are the major end products of these anaerobic decomposition produced, you know, are used as a fuel. But remember that some products are toxic to the plant growth and contribute to the climate change, specifically the methane which is a very very important greenhouse gas.

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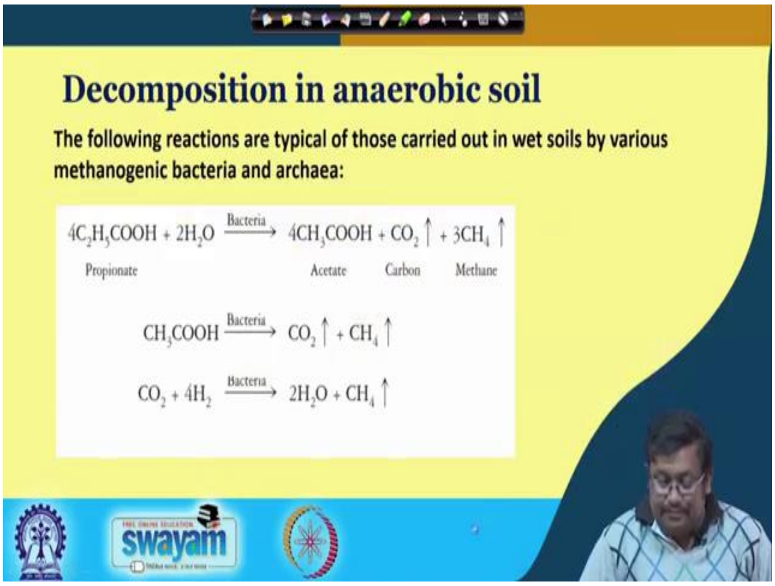

Decomposition in anaerobic soil

The following reactions are typical of those carried out in wet soils by various methanogenic bacteria and archaea:

$$4C_2H_5COOH + 2H_2O \xrightarrow{\text{Bacteria}} 4CH_3COOH + CO_2\uparrow + 3CH_4\uparrow$$

Propionate Acetate Carbon Methane

$$CH_3COOH \xrightarrow{\text{Bacteria}} CO_2\uparrow + CH_4\uparrow$$

$$CO_2 + 4H_2 \xrightarrow{\text{Bacteria}} 2H_2O + CH_4\uparrow$$

Now, the following reaction you can see here first of all propionate is reacting with in the presence of bacteria producing acetate, carbon and methane. In the anaerobic decomposition it is again important. And here you can see, acetic acid is anaerobically decomposed to produce the methane and this carbon dioxide is again, you know, reacting with hydrogen to produce a methane.

So, this methane is a very very notorious greenhouse gas and which increases the greenhouse gas effect in our earth. So, obviously this anaerobic decomposition is not environmental friendly, per say. But this methane can be also used for as an energy source.

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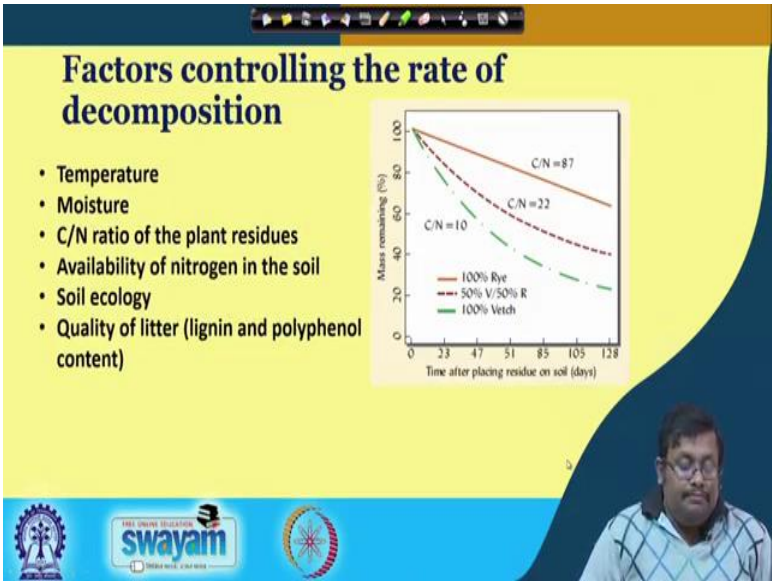

Factors controlling the rate of decomposition

- Temperature
- Moisture
- C/N ratio of the plant residues
- Availability of nitrogen in the soil
- Soil ecology
- Quality of litter (lignin and polyphenol content)

So, what are the factors? Obviously, you know, the bacteria which generates methane are called methanogenic bacteria. And remember that there are several methanogenic bacteria or methanogens which plays a key role in this anaerobic decomposition of organic matter.

So, let us see what are the factors which control the rate of decomposition. Obviously, there are, you know, several factors starting from temperature, then moisture, then C/N ratio of the plant residues, then availability of nitrogen in the soil and then soil ecology and quality of litter, lignin and polyphenol content. All these are very very important as far as the rate of decomposition is concerned.

So, in this graph, we can see this is a relation between time after planting residues on soils in days and at the biomass remaining. So, you can see here there are three different crops here. So, first of all this line this solid line is basically is representing rye. And this green is basically represented by vetch.

And in case of vetch; obviously, the C/N ratio is very very low, you know, only 10 and in case of rye it is 87. So, obviously from our previous lecture we know that when there is a, you know, when the C/N ratio is low, obviously, the mineralization is encouraging, you know, it encourages the mineralization.

And that is why you can see the decomposition of organic matter is quite rapid in case of vetch as compared to the rye because in case of rye the C/N ratio is quite wide. And as a result, mineralization and decomposition is quite slow. And when we make the 50 percent, we know, vetch with 50 percent of rye; obviously, you can see some intermediate trends. So, that shows that the C/N ratio of the plant residues is very very important which controls the rate of decomposition of organic matter.

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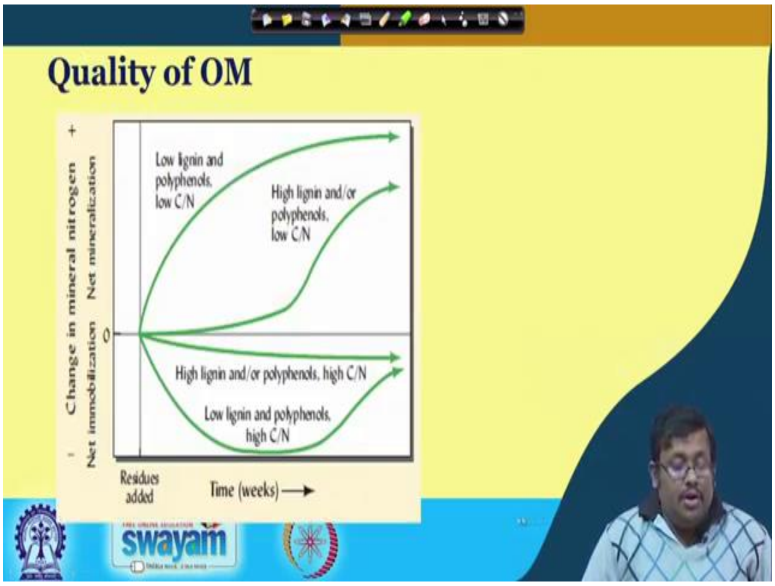

Quality of OM

So, another important is quality of organic matter. Obviously, you can see here this portion is basically, sorry, this portion is basically indicating the net mineralization and this is net immobilization. So, here you can see different graph showing [diff] decomposition rate or mineralization and immobilization rate for different components. So, you can see here different composition.

So, you can see here this basically shows low lignin and polyphenols and low C/N ratios. So, that is the ideal condition because you know that lignin and polyphenols are resistant to a decomposition. And when we have low C/N ratio; obviously, it will also encourage the mineralization. So, obviously, we are getting high amount of mineralization; however, when there is a high lignin and polyphenols and low C/N ratio, obviously, the increasing trend is, you know, we are getting, but it is somewhat low because of the presence of high lignin content. Now in case of high lignin and polyphenols and high carbon nitrogen high C/N ratio; obviously, there will be net immobilization. And low lignin and polyphenol and high C/N ratio; obviously, that will also go with net immobilization. So, that shows the quality of organic matter is very important determinant of rate of decomposition all right.

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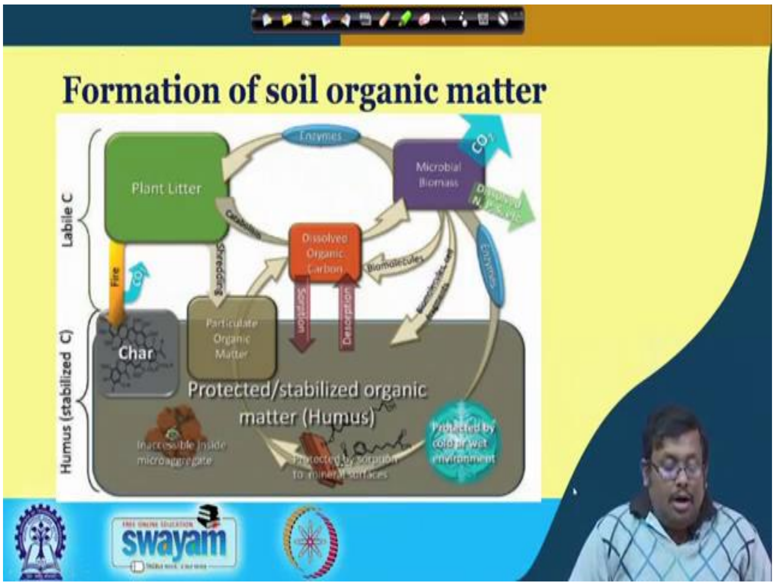

Formation of soil organic matter

So, now, you see how organic matter basically forms. So, this is a very good, you know, representation of, you know, formation of organic matter. So, let us see how it goes. So, for describing the slide I will go back and forth with the next slide. So, let us see.

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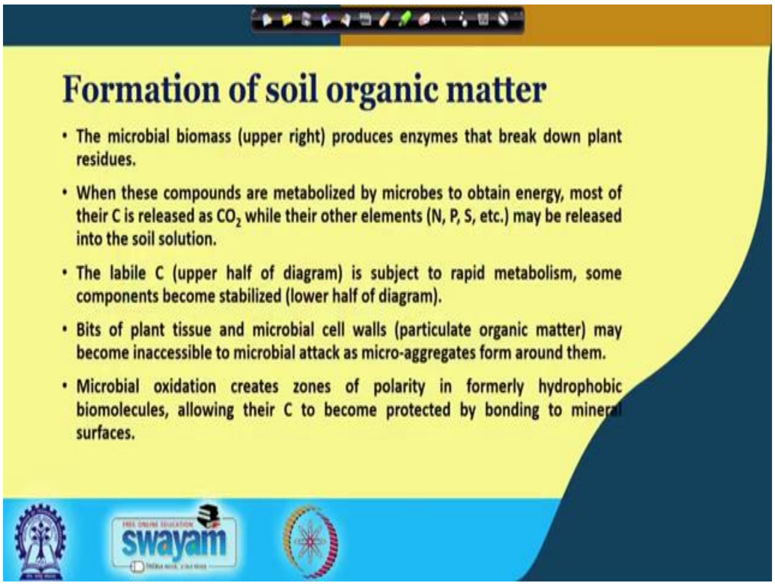

Formation of soil organic matter

- The microbial biomass (upper right) produces enzymes that break down plant residues.
- When these compounds are metabolized by microbes to obtain energy, most of their C is released as CO_2 while their other elements (N, P, S, etc.) may be released into the soil solution.
- The labile C (upper half of diagram) is subject to rapid metabolism, some components become stabilized (lower half of diagram).
- Bits of plant tissue and microbial cell walls (particulate organic matter) may become inaccessible to microbial attack as micro-aggregates form around them.
- Microbial oxidation creates zones of polarity in formerly hydrophobic biomolecules, allowing their C to become protected by bonding to mineral surfaces.

So, the microbial biomass or upper right is we can see this upper right the microbial biomass produces enzyme that breakdown plant residues. So, this microbial biomass basically produces, we can see, enzymes which basically decompose all the plant residues. So plant, you know, contain different types of components as you know that, you know, cellulose, hemicelluloses, starch, sugars, lignin.

So, basically they decompose all the components, these enzymes. And when these compounds are metabolized by microbes to obtain the energy, most of the carbon is released as carbon dioxide while the other element may be released into the soil solution. Now, we have already seen, in case of aerobic decomposition that carbon dioxide is generating due to this enzymatic oxidation.

And, you know, after carbon dioxide is released, the nitrogen, sulphur and phosphate they are already, you know, they dissolved and also released. So, may be released into the soil solution. So, the labile carbon that is upper half of the diagram, so, this is the labile carbon and this is the humus or stabilized form of carbon. Remember that this labile carbon is subjected to rapid metabolism. Some components become stabilized.

So, this labile carbon becomes, you know, rapid decomposed. And some component become stabilized and goes to this pool that is humus. And bits of plant tissue and microbial cell wall that is particulate organic matter may become inaccessible to microbial attack and micro aggregates from around them.

So obviously, some dissolve organic matter and plant tissue particulate organic matter they are protected by, you know, inside the micro aggregates and becomes inaccessible. So, they move from this labile pool to the stabilized pool. And microbial oxidation create zone of polarity in formerly hydrophobic biomolecules, allowing their carbon to become protected by bonding to mineral surfaces.

So, we can see protecting, they know, by sorption to the mineral surfaces; obviously, so this is another way. So, this is the whole dynamics of soil organic matter that goes on within the ecosystem. And you can see the labile pools in this fraction. Basically this fraction is basically the labile pool and this is the most stabilized pool or humus which is responsible for soil physical, chemical and biological activities.

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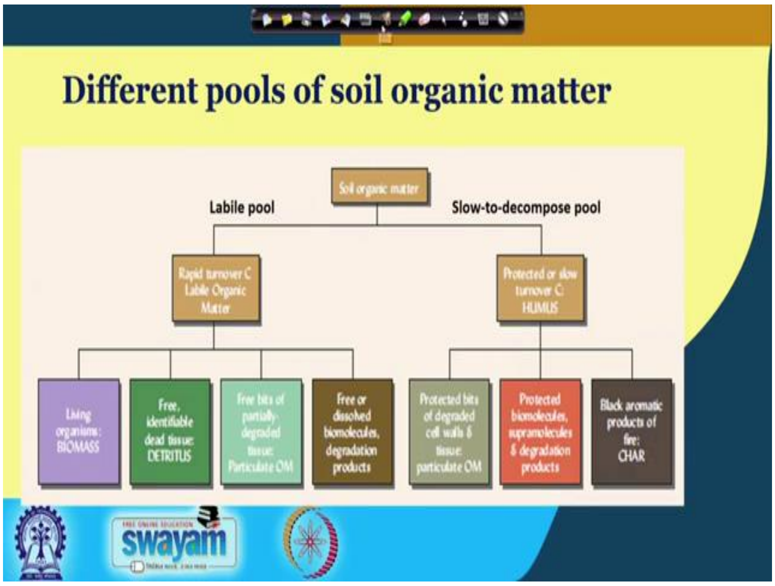

Different pools of soil organic matter

Soil organic matter

Labile pool

Slow-to-decompose pool

Rapid turnover C Labile Organic Matter

Protected or slow turnover C: HUMUS

Living organisms: BIOMASS

Free, identifiable dead tissue: DETRITUS

Free bits of partially-degraded tissue: Particulate OM

Free or dissolved biomolecules, degradation products

Protected bits of degraded cell walls & tissue: particulate OM

Protected biomolecules, supramolecules & degradation products

Black aromatic products of fire: CHAR

So, if we see now, if we divide the soil organic matter into labile pool and slow to decompose pool or stabilized pool, obviously, this labile pool shows rapid turnover of carbon or labile organic matter whereas this slow to decompose pool shows protected or slow turnover of carbon. We know that, humus is protected or slow turnover of carbon.

Humus is kind of stabilized product. So, for this labile pool; obviously, you know, we got some living organism biomass and then free identifiable dead tissues and detritus we call it detritus. And then free bits of partially degraded tissues or particulate organic matter. And then, free or dissolved biomolecules and degradation products all these comes into the labile pool.

And they can show rapid decomposition and changes. However, in case of humus; obviously, you can see protected bits of degraded cell walls and tissue that is particulate organic matter. And protected biomolecules or supra molecules and degradation products and black aromatic products of fire we call it char. So, these type of compounds and, you know, can be seen within a soil organic matter.

So, obviously, soil organic matter again we can divide it to labile pool and non labile pool or stabilized pool. And labile pool goes rapid decomposition or rapid changes; however, stabilized pool is more or less stable. Humus is important component in the stabilized pool. And in case of labile pool, you know, living organisms, free, identifiable, dead, detritus tissues and particulate organic matter all this represent the labile pool.

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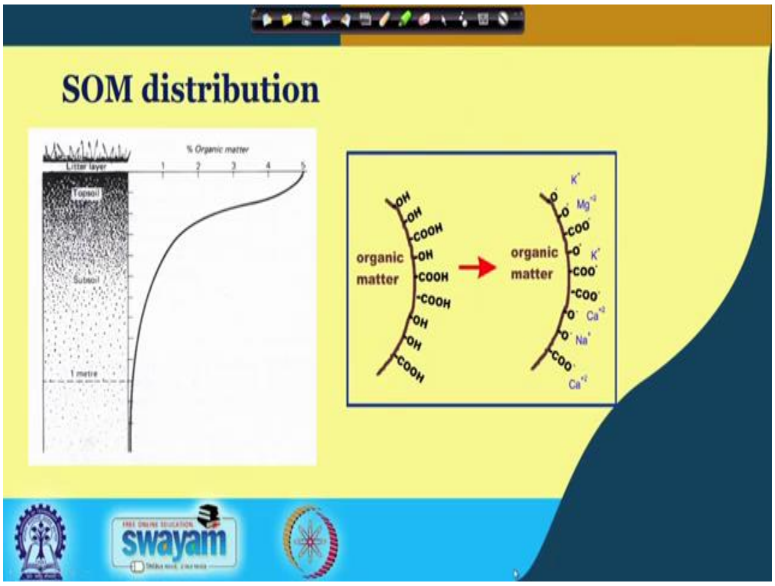

SOM distribution

So, guys we have covered this, you know, this slide up to, you know, let us wrap up here in this lecture. And in the next lecture, we will be trying to finish this organic matter. And then will be discussing about different organisms which are present in the soil.

So, thank you and let us finish this in the next lecture. Bye.