Soil Fertility and Fertilizers
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Lecture 38
Organic Manures, Manufacturing, Properties and Fate of N, P, K and Micronutrient Fertilizers (CONTD.)

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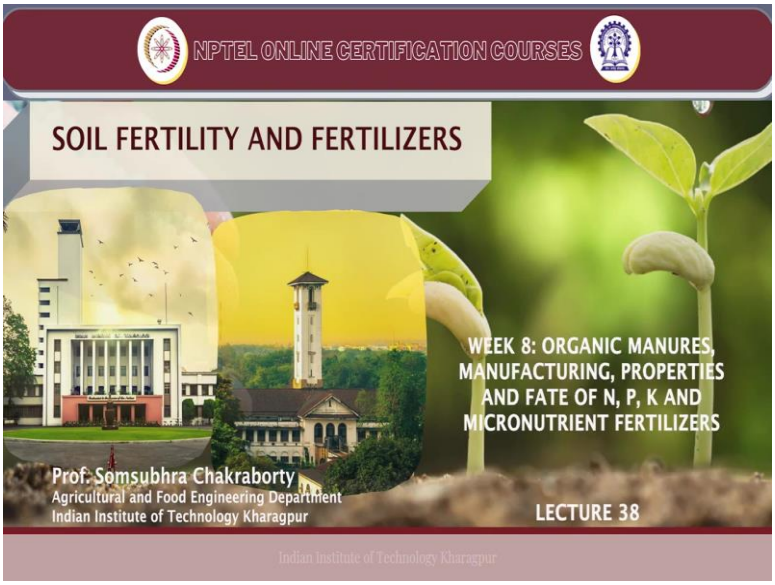

Welcome friends to this third lecture of week 8 of NPTEL online certification course of Soil Fertility and Fertilizers. In this week, we are discussing about Organic Manures, Manufacturing properties and fate of nitrogen phosphate and potassium and micronutrient fertilizers. So, in our previous lectures of this week, we have discussed about manures, then green manuring we have discussed we have briefly discussed about biofertilizers. In this lecture, we are going to cover the following concepts.

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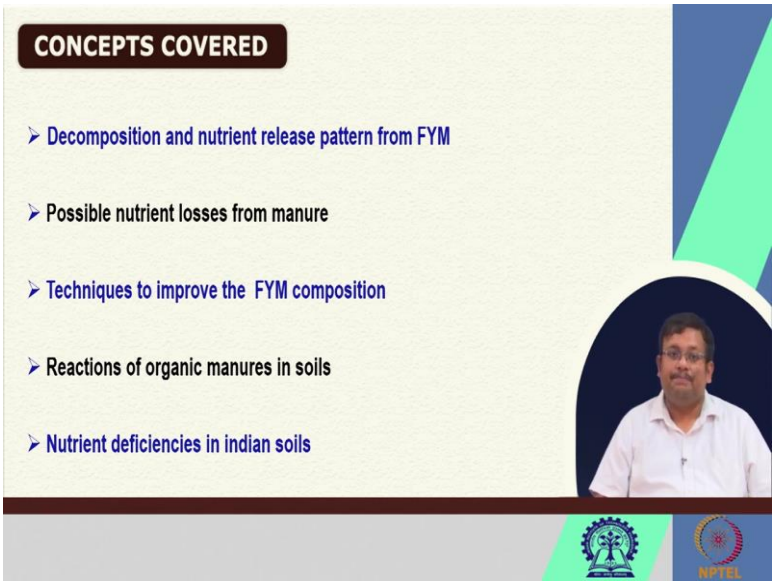

These concepts are decomposition and nutrient release pattern from farm yard manure, then possible nutrient losses from manure and then techniques to improve the farm yard manure composition and then the reactions of organic manures in soil and the nutrient deficiencies in Indian soil. So, these are some of the major concepts which we are going to cover first of all, we are going to discuss how these FYM when we apply in the soil that decompose and release different nutrients through different processes. And then we are going to discuss what are the possible ways of nutrient losses from manure and then what are the reactions of organic manures in soils.

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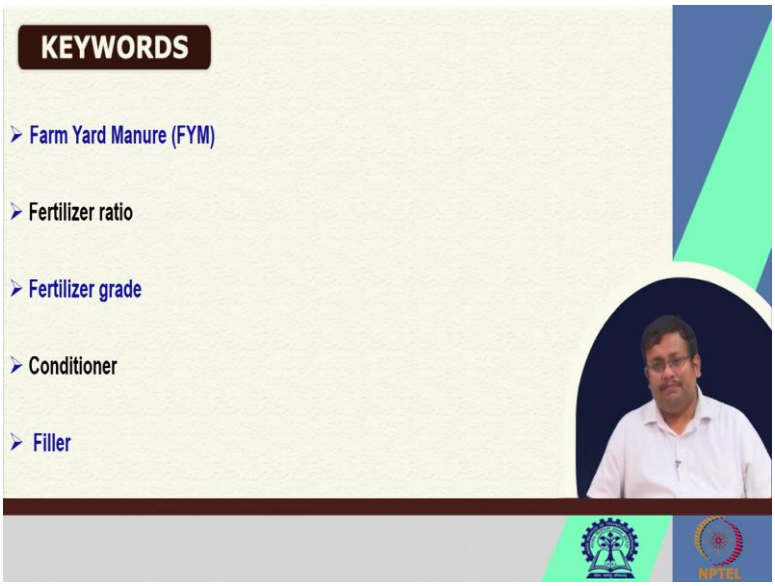

So, if you see the keywords of this lecture, of course, we are going to discuss on farm yard manure. Then we are also going to discuss the fertilizer ratio, fertilizer grade, we are going to discuss about conditioners and fillers and what are their uses? So, we are going to discuss them in details.

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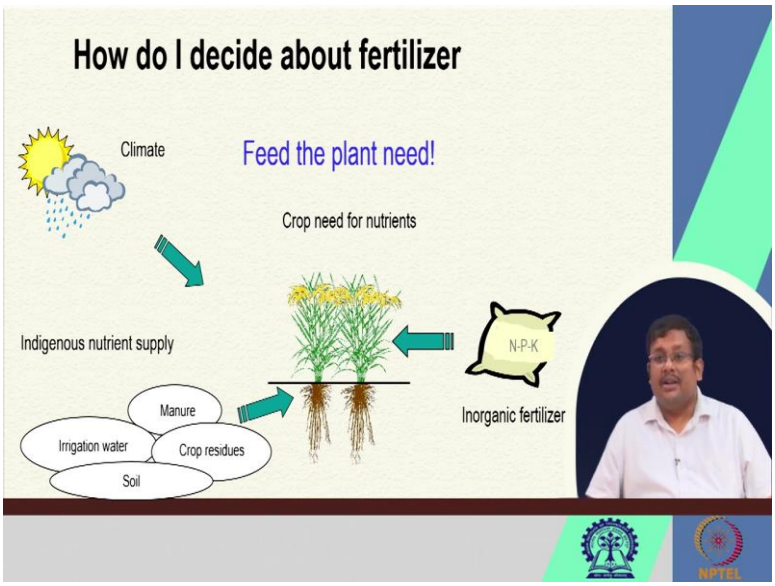

So, before we discuss the pattern of nutrient release, when you apply organic manure in the soil, we should have an idea about how to decide how much fertilizer we will need to meet the plant requirement. So, the crop need for nutrients based on climatic parameters as well as the indigenous nutrient supply.

Now, in the indigenous nutrient supply of course, we have to take care of manures, then crop residues then the native soil fertility and also the irrigation water because some of the nutrients are also coming through irrigation water. So, when we consider the climatic parameters as well as the indigenous nutrient supply in the soil, then only we can decide the inorganic fertilizer which will be required to meet the crop requirements.

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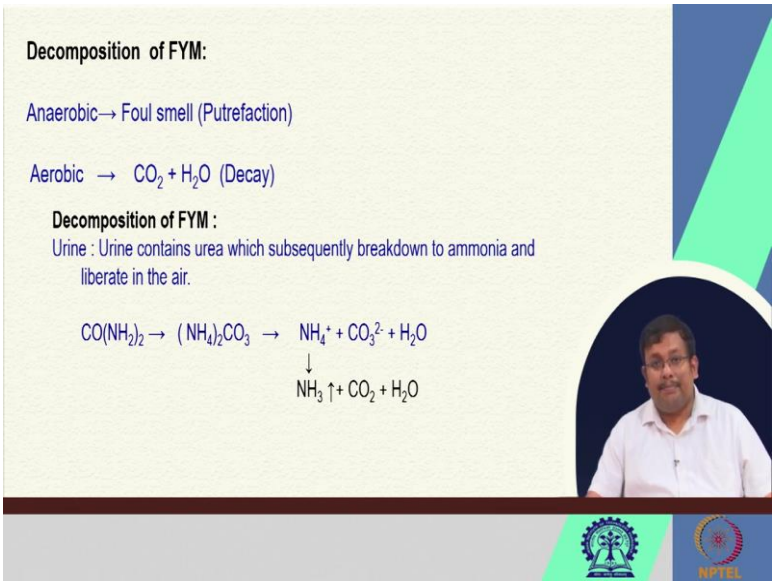

Now, if you consider the decomposition of FYM, the decomposition of FYM can be occur in 2 different conditions. One is anaerobic condition and other is aerobic condition. Now, in the anaerobic condition, we generally see that the decomposition of organic matter or FYM is also accompanied by some foul smell, which is due to putrefaction.

Now, putrefaction is basically decomposition of proteinaceous compounds. In the aerobic condition of course, the FYM will undergo decay and produce the carbon dioxide and water H2O. Now the decomposition of FYM when you consider urine is also a very important component of FYM as we can remember, now, the urine contains urea which subsequently breakdown to ammonia and liberate in the air. So, if you see this is the urea when it decomposed, it decomposed into the ammonium ion and carbonate ion and these ammonium ion basically released into the atmosphere in the form ammonia gas.

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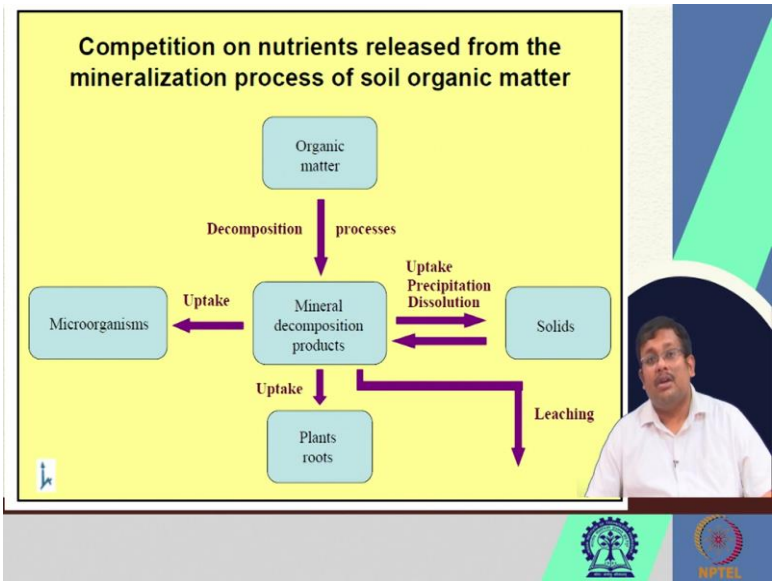

Now, if we see the competition on nutrients released from the mineralization process of solid organic manner, this flowchart will give us an idea about the fate of different nutrients which released due to decomposition of FYM or any manure. So, if you consider the organic matter or manure and then the decomposition process creates the minerals from these decompose products.

Now, 1 fraction of those minerals are being uptaken by the microorganisms, native microorganisms which are present in the soil, another fraction of the minerals will be uptaken by the plant roots for meeting their nutrient requirement. And another part will undergo precipitation or dissolution in the form of in the solid components of the soil and the rest of the part will undergo leaching losses.

So, these are different processes through which these minerals are consumed. Again microorganisms will consume a part of the minerals which are released due to decomposition, plant roots will absorb or uptake a part of the minerals due to the decomposition process and then a part of will loss through leaching and another part will be either precipitated or precipitate in the form of solids and the opposite mechanism of precipitation is dissolution, where these minerals will be dissolved from the solid and ultimately it will come into the soil solution. So, this is these are the competition on nutrients the released from the mineralization process of soil organic minute soil organic matter.

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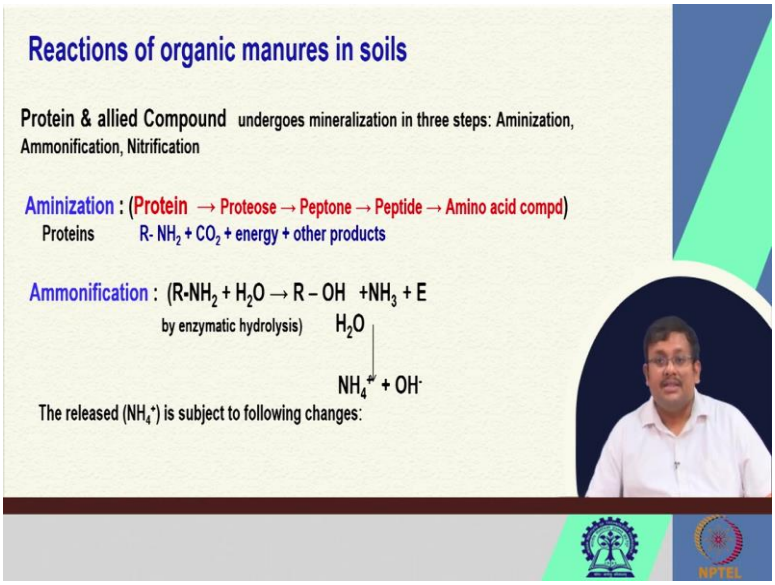

Now, let us see the reactions of organic manures in soils. Now, proteins and allied compounds undergoes mineralization in generally 3 steps, one is Aminization, second is Ammonification and third is Nitrification. If you remember the nitrogen discussion which we already did in our previous lectures, we have already discussed these processes. Just to briefly recall Aminization in the Aminization process, the protein first convert into proteose and this proteose will convert into peptone. From the peptone it converts into peptide and from the peptide we will get the amino acids compound and ultimately these amine compounds are formed.

Now, these amine compounds undergo their Ammonification process by enzymatic hydrolysis. Now, due to the enzymatic hydrolysis, ultimately, we will be seeing the presence of Ammonium ion, Ammonia gas and this ammonia gas will react with water to produce the Ammonium hydroxide which will further dissociate to form the Ammonium ion and hydroxyl ion. Now, this released Ammonium and due to the Ammonification process is also subjected to different types of changes, what are those changes, we can see in the next slide.

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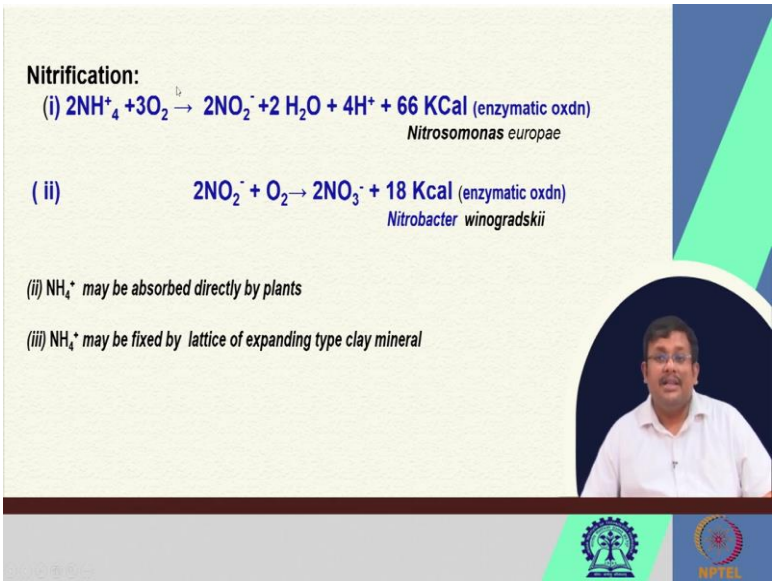

So, in the first step, these Ammonium will be reacting will be oxidized to form the nitrite and these nitrite and subsequent formation of protons and 66 kilocalories of energy this is an enzymatic oxidation and Nitrosomonas is the major bacteria that mediates this first reaction. In the second reaction subsequently these nitride will be further oxidized to nitrate and it will produce 18 kilocalories of energy. So, and this process will be mediated by nitrobacter bacteria.

Now, you should remember that this is a nitrification process, if you remember our nitrogen discussion, so, these nitrification during this nitrification process, the Ammonium ion gets converted into nitrate and plants uptake these nitrate ion from the soil. Now, remember that these Ammonium ions can also be absorbed directly by the plants for example in case of rice, because in the rice, there is no oxidized condition and Ammonium cannot get chance to oxidized into nitrate.

And as a result, this Ammonium ion can be absorbed by rice to meet their nitrogen demand. Also, this Ammonium ion can be fixed by lattice of expanding type of clay minerals. So, this type of fixation can be occurred for Ammonium ion and as a result these. So, these are the fates of Ammonium ions in the soil.

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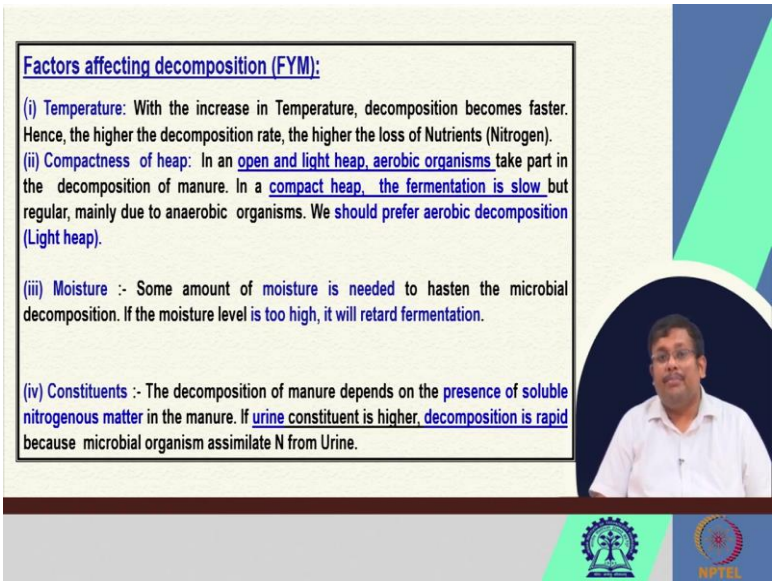

Now, let us see the factors affecting decomposition of FYM. First of all, the temperature is one of the major factors. So, with the increase in temperature decomposition becomes faster. Hence, the higher the decomposition rate the higher their loss of nutrients specifically nitrogen. Second is compactness of heap, if you remember, we generally prepared the FYM in heap so, how compact that heap is also determined that decomposition of FYM. Now, in an open and light heap aerobic organism mainly dominates and in the decomposition of manure however, in a compact heap the fermentation is slow, but regular and in this condition, they are mainly mediated by anaerobic organisms.

So, we should always prefer aerobic for decomposition or light heap for rapid decomposition. Third important component or third important factor is moisture. So, some amount of moisture is needed to hasten the microbial decomposition. Now, if the moisture level is too high, it will retard the fermentation process.

Fourth factor is constituents of FYM. Now, the decomposition of manure depends on the presence of soluble nitrogenous matter in the manure. If urine constituent is higher decomposition is rapid because microbial organisms that simulate nitrogen from urine So, based on the composition of FYM also, the decomposition rate of FYM is also governed.

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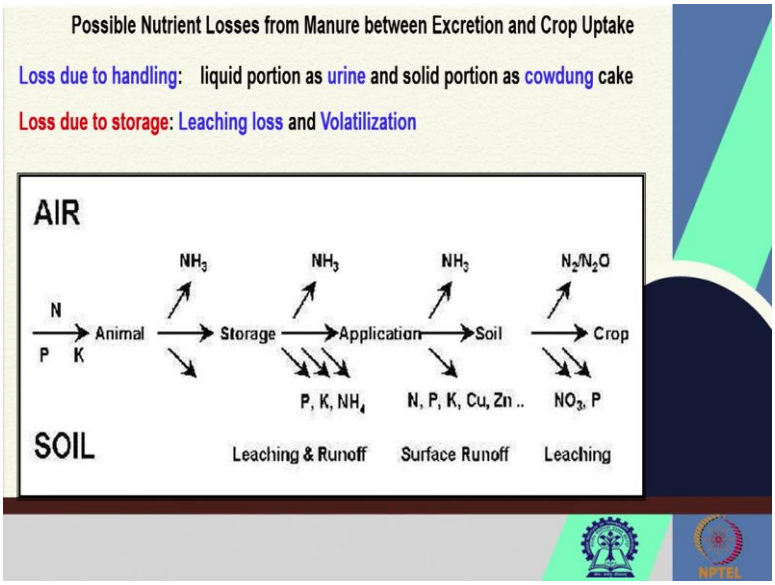

Now, if we see the possible nutrient losses from manure between excretion and crop uptake, there are 2 major ways to which the nutrient losses from manure one is loss due to handling that is liquid portion such as urine and solid portion as cow dung cake. So, during the handling process, when there is a loss of nutrient that is also that is a major factor of major component of nutrient losses from manure. Second important way through which nutrients can be lost from manure is lost due to storage. So, during the storage, there are 2 processes through which the there is nutrient loss, one is leaching loss and that is volatilization.

So, if you see here, when there is excretion from the animal, there will be of course, there will be volatilization of ammonia and during the storage process, there will be volatilization of ammonium and also leaching and runoff of phosphorus, potassium and ammonium during the application process also there will be volatilization loss of ammonia and surface runoff of N, P, K, copper zinc and other micronutrients and also during the crop also when we apply to the soil and crops are growing, they are also can be we can see the loss of nitrate and phosphate due to leaching and also loss of nitrogen gas or nitrous oxide into the atmosphere. So, these are the possible nutrient losses from manure between excretion and crop uptake.

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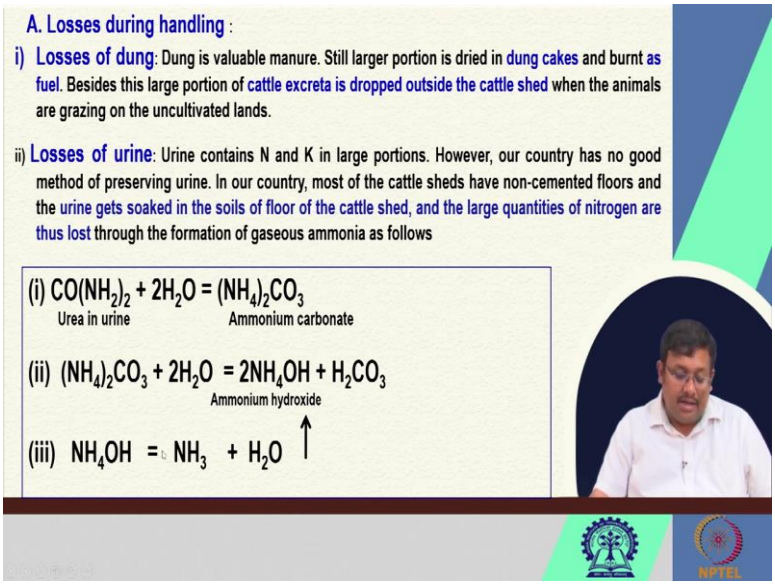

Now, what are the losses during the handling process? So, dung which is one of the cow dung which is one of the important component of (())(14:46) manure is mainly used as dung cakes and burned as fuel. Beside this a large portion of the cattle excreta is dropped outside the cattle shed when the animals are grazing on the uncultivated lands. So, that creates the loss of this cow dung, which is an important component of the farm yard manure. Second most important laws during handling is losses of urine.

Now urine contains, cow urine mainly contains nitrogen and potassium in large portions. However, in our country, we have no good method for preservation of cow urine. In our country, most of the cattle sheds have non-cemented floors and the urine gets soaked into the soils of the floors of the cattle shed and the large quantities of nitrogen is lost through the formation of gaseous ammonia and these are the reactions.

So, you can see this is a urea in the urine, which reacts with the water to produce this Ammonium carbonate and these Ammonium carbonate reacts with water to produce these Ammonium hydroxide, these Ammonium hydroxide will further dissociate to form these Ammonia and water. So, these Ammonia will release into the atmosphere.

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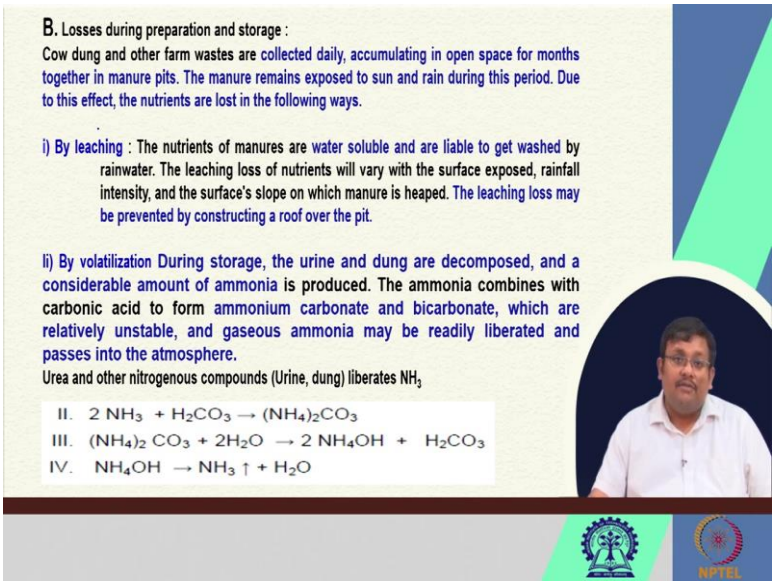

Second is the losses during preparation and storage. So, cow dung and other farm wastes are collected daily, accumulating in open space for months together in manure pits, and the manure remains exposed to sun and rain during this period and due to this effect, the nutrients are lost in the following ways first of all, through leaching, so, the nutrients of manure are mainly water soluble and does the against easily washed by rainwater.

So, the leaching loss of nutrients will vary with the surface exposed rainfall intensity and the surface slope on which the manure is heaped. So, if we can construct a roof over the manure pit, that can, that can reduce the leaching loss because that can prevent the rainfall to leach all the nutrients of the manure. Second is another way of loss of nutrients during the handling is volatilization. So, during store the urine and dung are decomposed and a considerable amount of Ammonia is produced.

So, the Ammonia combines with carbonic acid to form Ammonium carbonate and bicarbonate which are relatively unstable and gaseous Ammonia may be readily liberated and passes into that atmosphere. So, urea and other nitrogenous compounds generally liberates Ammonia we can see here so, Ammonia reacts with carbonic acid to produce Ammonium carbonate, these Ammonium carbonate reacts with the water molecule to produce Ammonium hydroxide and carbonic acid and these Ammonium hydroxide will further dissociate to form ammonia which release into the atmosphere and water. So, these are the 2 processes through which the there are losses of nutrients during the preparation and storage.

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Now, the question comes, how we can improve the composition of FYM. So, we can improve or maintain the composition of a FYM by mainly generally 3 methods one is storing in a pit. Secondly, use in Biogas or Gobar Gas plant and third is use of chemical preservatives.

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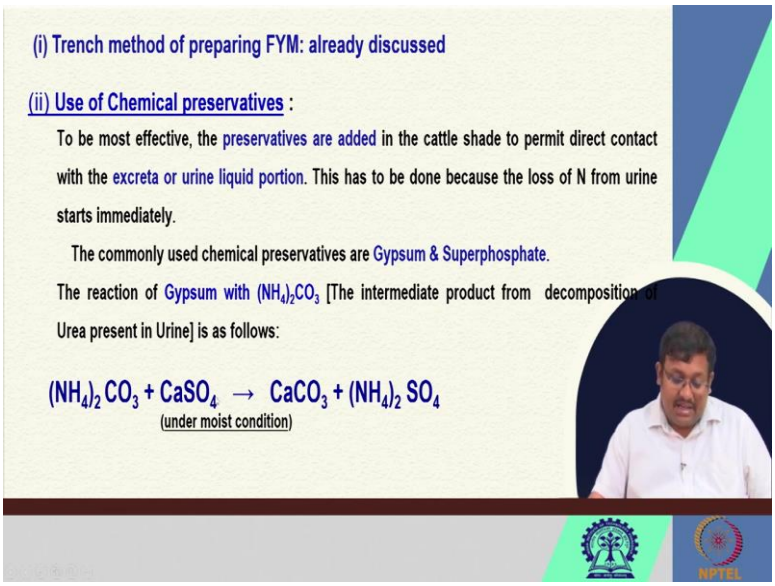

So, if we, we have already discussed the trench method for preparing FYM, so I am not going to further discuss the trench method is the best method for preparation of farmyard manure. Another way of maintaining or improving the quality of the farm yard manure is the use of chemical preservative. So, to be more effective, these preservatives are added in the cattle shed to permit the direct contact with the excreta or urine liquid portion. This has to be done because the loss of nitrogen from urine starts immediately.

So, the commonly used chemical preservatives are gypsum and super phosphate. So, the reaction of gypsum with Ammonium carbonate we can see here is as follows. So, it is Ammonium carbonate plus gypsum calcium sulfate it will produce calcium carbonate and this Ammonium sulfate at this reaction will undergo in the moist condition.

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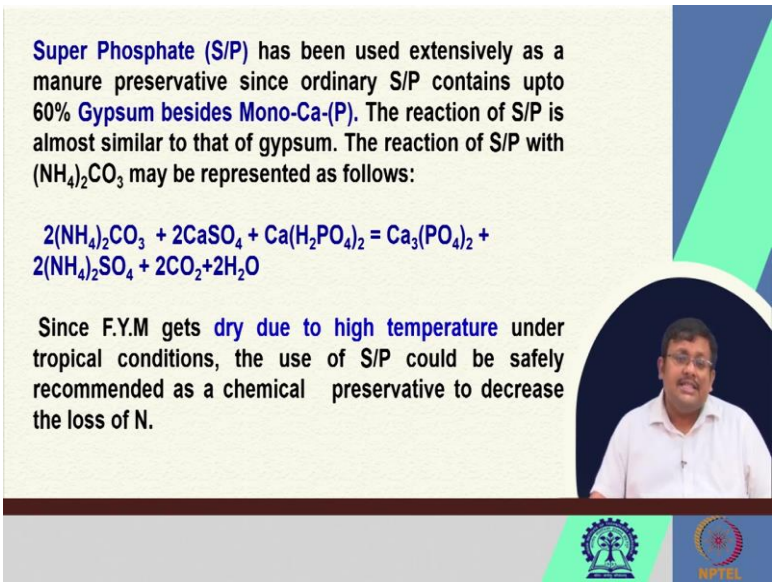

Now, also super phosphate has been also used extensively super phosphate or single super phosphate has been used extensively as a manure preservative, since ordinary super phosphate contains up to 60 percent gypsum besides monocalcium phosphate. So, this ordinary super phosphate or single super phosphate contains both the gypsum as well as mono calcium phosphate. So, the reaction of single super phosphate is almost similar to that of gypsum, the reaction of super phosphate with Ammonium carbonate can be represented here.

So, this you can see Ammonium carbonate and then these calcium sulfate and mono calcium phosphate, which are coming from the single super phosphate are reacting with these Ammonium carbonate to produce this calcium phosphate and this Ammonium sulfate and this carbon dioxide and water. So, since FYM gets dry due to high temperature under tropical condition, the use of single super phosphate or super phosphate could be safely recommended as a chemical preservative to decrease the loss of nitrogen. So, this is how we can maintain the quality of the farm yard manure.

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Now, what is the effect of organic method on soil properties, we can classify the effects on improvement of soil Physical properties, improvement of Chemical properties and improvement of Biological activities. So, if we consider the improvement of soil Physical properties, that application of organic matter or manure can improve the soil structure by when these manure or (())(21:50) decomposed, the decomposition product acts as a binding agents of the soil particles and thereby they improve the aggregation and ultimately the soil structure. Secondly, that improve the water holding capacity.

Since organic matter has huge amount of porosity, they are they can help in holding a huge amount of water. So, as a result of the application of organic matter, the water holding capacity generally increases, it application of organic matter also improves soil aeration because it improves the soil porosity when there is an improvement of soil porosity that improves the air movement and air exchange. Fourth one is the reduction of soil loss through erosion as these organic matter acts as a binding agents to maintain the aggregate stability as a result, there is reduction in soil loss through erosion.

If we consider the improvement of soil chemical properties, by addition of organic matter we can see it can supply essential plant nutrients in balanced ratio, it can slow down the release of nutrients and it can also give the high residual value for the subsequent crops. And if we consider the improvement of biological activity of course, when you apply the organic matter that stimulates soil flora and fauna.

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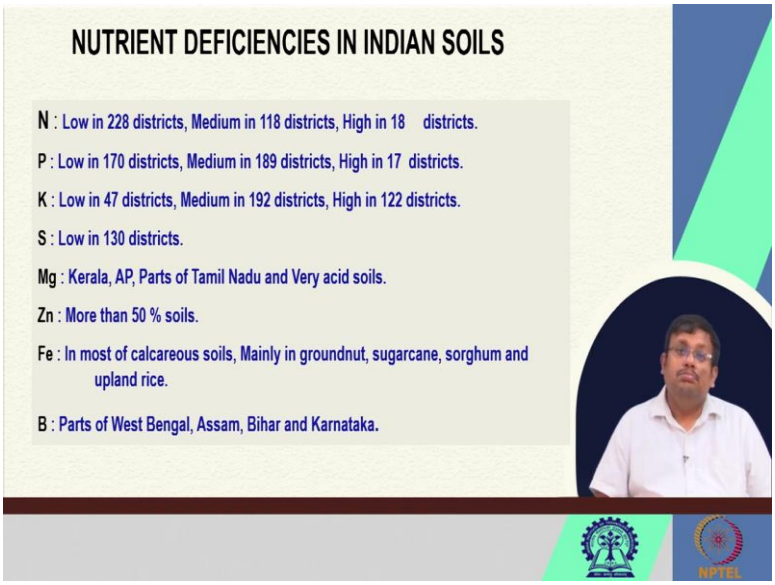

Now, let us see the nutrient deficiencies in Indian soil of course, you can see that nitrogen is deficient in 228 districts medium in 180 districts and high in only 18 districts. Similarly, we can see that nutrient deficiencies for phosphorus potassium, sulfur, magnesium, zinc, iron and boron. So, our soils are deficient in several macro and micronutrients.

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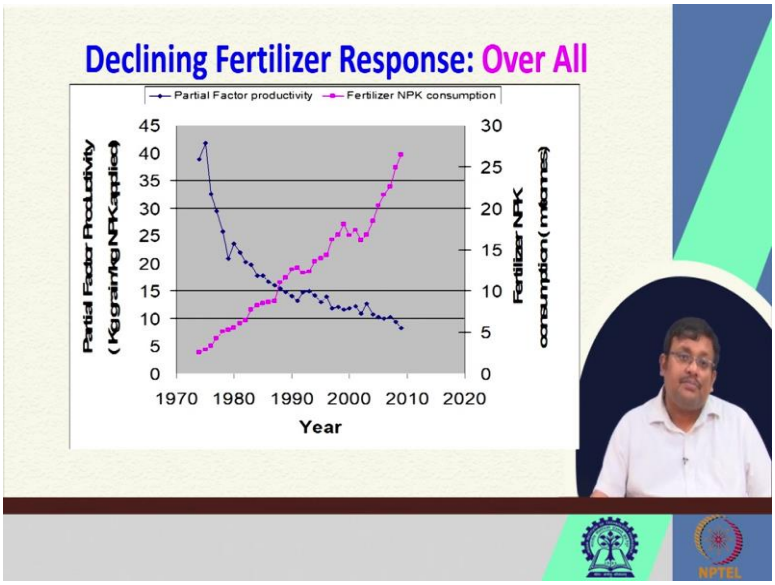

So, also we can see, although the fertilizer consumption is increasing for last 50 years, we can see the partial factor productivity that is the kg of the grain per kg of fertilizer application this is continuously decreasing. So, we despite the increase of fertilizer, consumption we are seeing the reduction of partial factor productivity.

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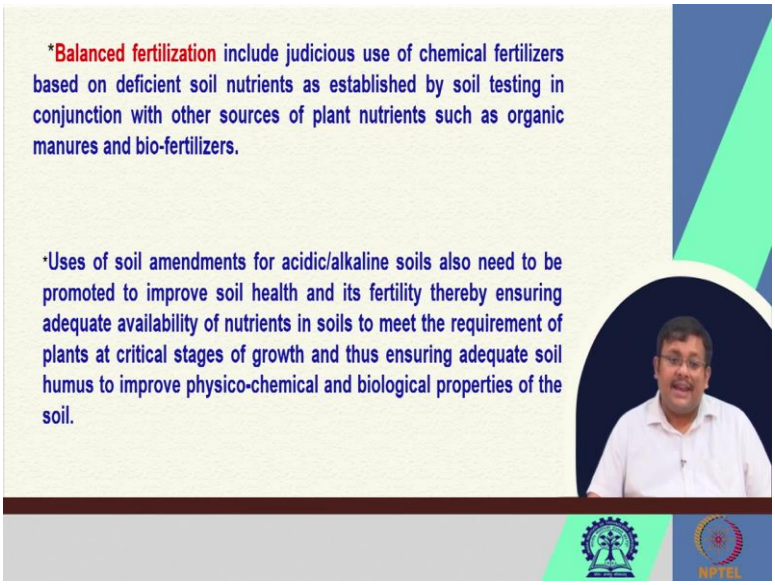

So, to counteract this, we need balanced fertilization. What is balanced fertilization? Balance fertilization includes judicious use of chemical fertilizers based on deficient soil nutrients as established by soil testing in conjunction with our other sources of plant nutrients such as organic manure and Bio fertilizers, and it uses soil amendments for acidic or alkaline soils to promote the soil health and its fertility, thereby ensuring availability of the nutrients in soils to meet the requirement of plant in critical stages of the growth ensuring adequate soil humors to improve the physic-chemical and biological properties of the soil. So, balance fertilization is the need of this hour and we should always promote this balance fertilization, so, that the soil resources can be managed sustainably.

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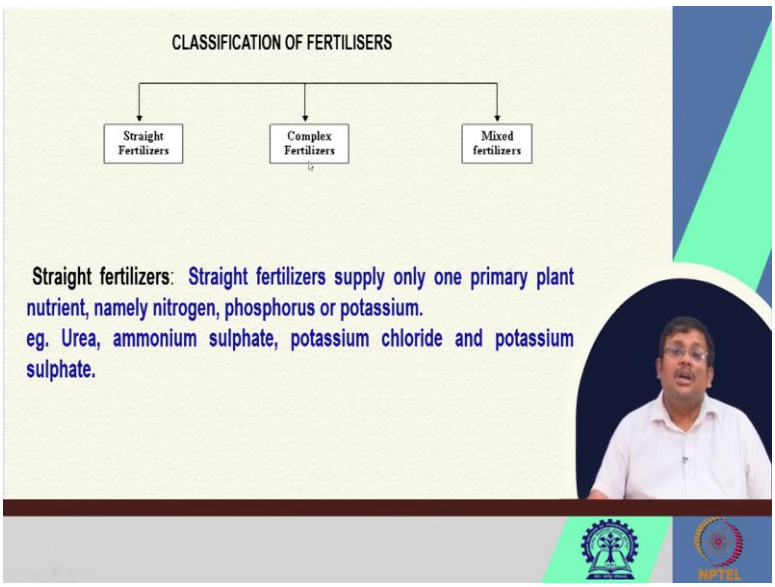

Now, if we see the classification of the fertilizers, here you can see the fertilizers is S I am using so, do not get confused. So, fertilizers you can use either S and Z both of them are fine. So, the classification of the fertilizers you can see they are either straight fertilizer complex fertilizer or mixed fertilizers. So, what are the straight fertilizers? Straight fertilizers applied was only one primary nutrient namely nitrogen, phosphorus, potassium, for example, Urea, Ammonium sulfate, Potassium chloride and Potassium sulfate. Potassium chloride is also known as muriate potash.

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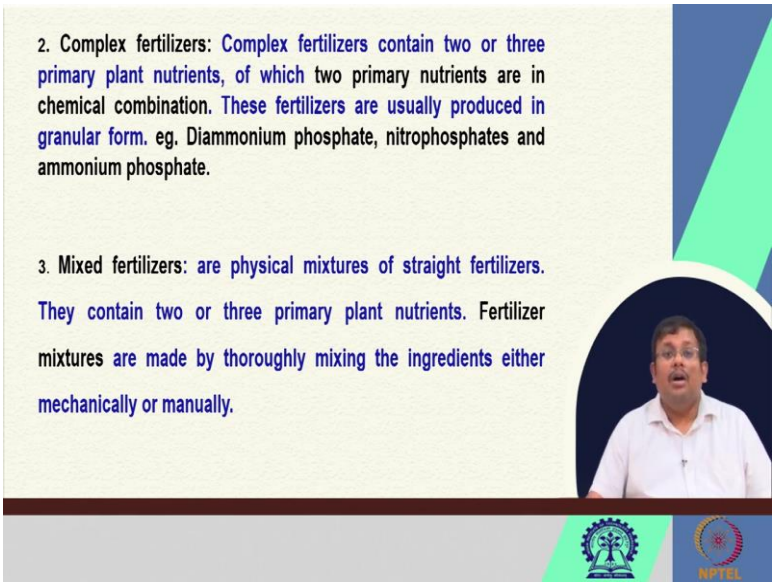

Second is complex fertilizers complex fertilizers contain 2 or 3 primary plant nutrients of which 2 primary nutrients are in chemical combination. So, these fertilizers are usually produced in granular form for example, Diammonium phosphate or DAP, Nitro phosphate and Ammonium phosphate. Third category is mixed fertilizers. So, mixed fertilizers are physical mixtures of state fertilizers. So, they contain 2 or 3 primary plant nutrients, fertilizer and mixture are made by thoroughly mixing the ingredients either mechanically or manually.

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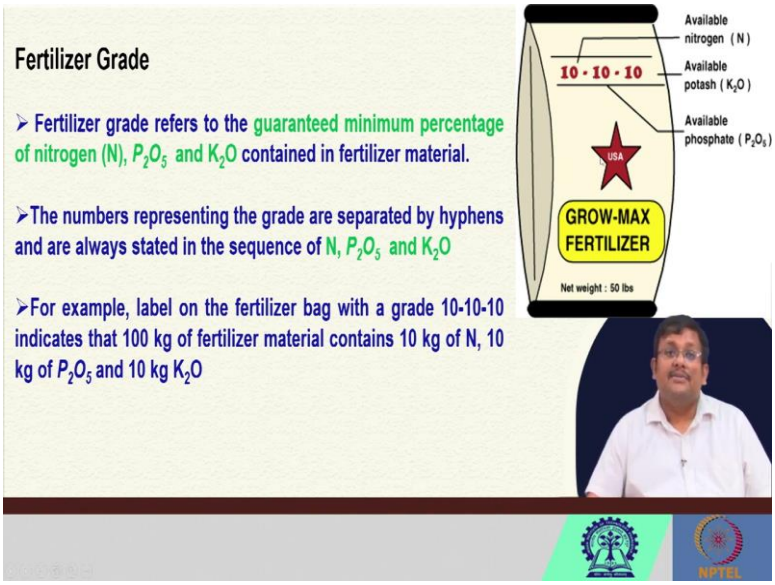

Now, the next concept is fertilizer grade, what is fertilizer grade? Now, fertilizer grade refers to the guaranteed percentage of nitrogen P2 O5 and K2O contained in fertilizer material. So, the numbers representing the grade are separated by hyphens that are always stated in the sequence N, P2 O5 and K2O, you can see in case of a bag of fertilizer as you can see here these type of numbers like 10 hyphen 10 hyphen 10.

So, that shows the available distance shows the available nitrogen, the second digit shows the available P2O5 percentage and the third digit shows the available K2O percentage. So, if we see that, for example, in this level 10 10 10 it means that 100 kg of this fertilizer contains 10 kg of nitrogen, 10 kg of P2O5 and 10 kg of K2O.

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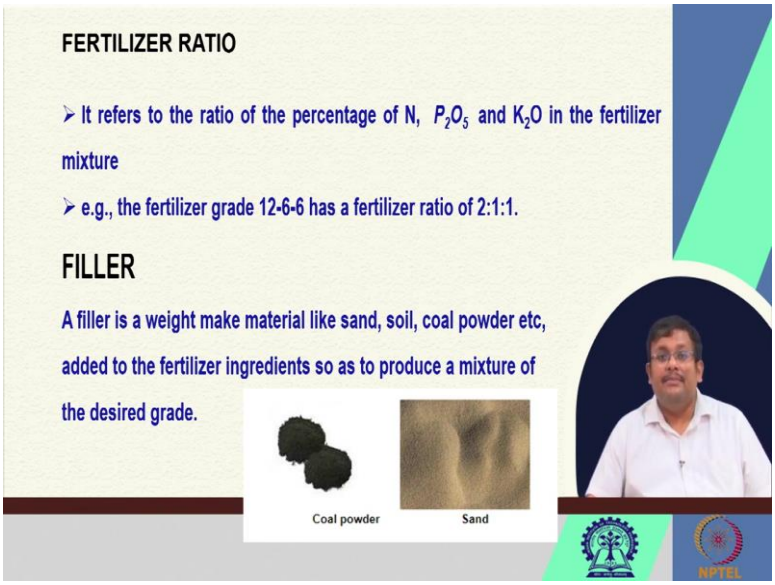

Another term is fertilizer ratio. So, it refers to the ratio percentage of nitrogen P2O5 and K2O in the fertilizer mixture. So, the fertilizer grade 12 6 6 has a fertilizer ratio of 2 is to 1 is to 1 another component of fertilizer is filler. So, filler is a weight making material like sand, soil, coal powder, et cetera which is added to the fertilizer ingredients so, as to produce a mixture of the desired rate. So, generally we add this coal powder or sand to make up the weight when we physically mix 2 or 3 fertilizer to produce a mix fertilizer grade.

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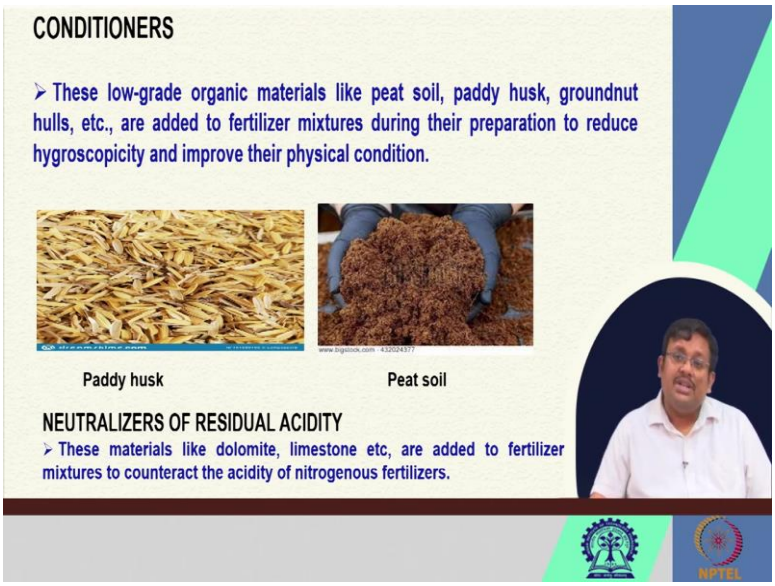

Another important component of fertilizer is conditioner. So, these low-grade organic materials like peat soil, paddy husk, then groundnut hulls et cetera are added to fertilizer mixtures during their preparation to reduce the hygroscopicity and improve the physical condition of the fertilizer. So, these are known as conditioners. And neutralizers of residual acidity. So, these materials like dolomite limestone et cetera are added to the fertilizer mixture to counteract the acidity of nitrogenous fertilizer. So, these are some of the important terms which are related to the fertilizer guys.

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So, these are some of the references and I hope that you have gathered some important information in this lecture. Please let me know if you have any questions. Let us meet in our next lecture. Thank you.