Soil Science and Technology
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Lecture – 35
Fertilizers

Welcome friends to this last lecture of week 7 and we will cover Fertilizers which are very very important topic, which is very important topic and then in this lecture we will basically cover only the inorganic fertilizers. However, we will not have you know we will we will not cover the manures in this lecture, which is basically the organic forms of fertilizers or organic fertilizers.

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So, the concepts which we will cover in this lecture is basically what is fertilizers and then classification of fertilizers, different straight fertilizers, liquid nitrogenous fertilizers and different customized fertilizers like you know and also different micro nutrient fertilizers.

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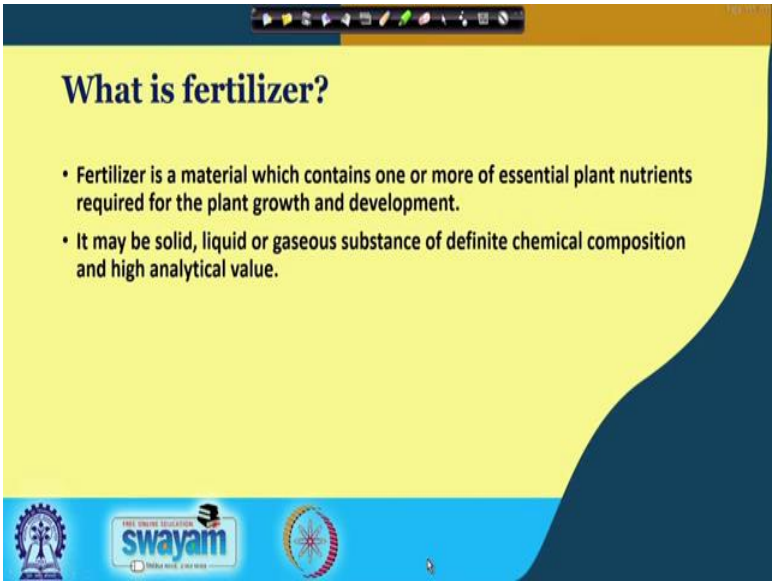

So, what is fertilizer? Fertilizer is a material which contains one or more essential plant nutrients, required for the plant growth and development.

So, basically we apply fertilizer to maintain the soil fertility status. Soil fertility is the ability of the soil to supply the plant, the required amount of nutrients and to maintain the soil fertility we have to apply the soil fertilizer; we have to apply the different chemical and organic fertilizers; however, in this lecture we will be discussing only the chemical fertilizers.

So, the fertilizers may be solid, liquid or gaseous substances of definite chemical composition and high analytical value, and we will see what are the different classify you know what are the different classes of fertilizers.

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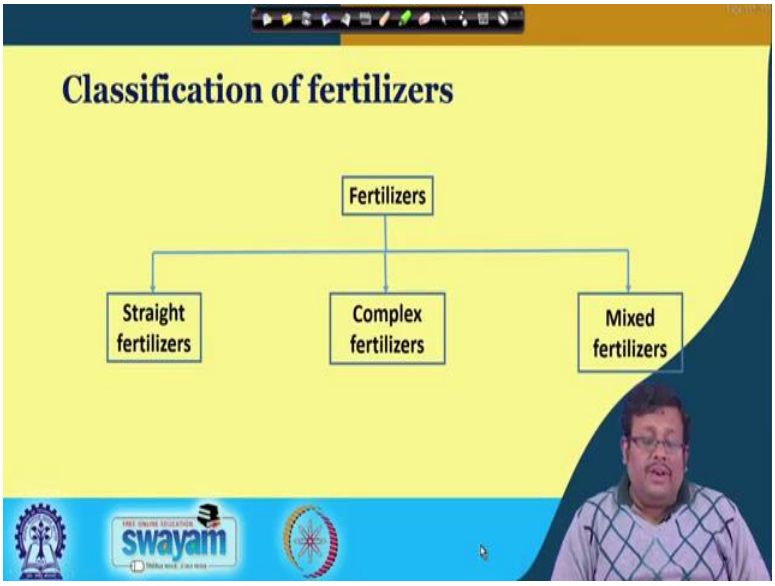

So, if we classify the fertilizers they will be there will be three major classes. One is straight fertilizers, second complex fertilizer and finally, mixed fertilizers.

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So, straight fertilizers are those which can supply only one primary nutrient namely, nitrogen or phosphorous or potassium example urea, ammonium sulphate, potassium chloride and potassium sulphate. So, these are basically the straight fertilizers because they can supply only one primary element. You can see here in case of urea it can supply only nitrogen, in case of ammonium sulphate only supply nitrogen which is a primary

nutrient and also in case of potassium chloride, it will supply potassium in case of potassium sulphate it is also only potassium. So, these are called the straight fertilizer. So, what is the complex fertilizers?

Complex fertilizer contain two or three primary nutrients of which, two primary nutrients are in a chemical combination and these fertilizers are usually produced in granular form example diammonium phosphate, nitrophosphate etcetera. So, the complex fertilizer you will see two or more primary nutrient; it could be either nitrogen phosphate or phosphate potassium or nitrogen phosphate potassium.

So, it has to be a minimum of two macro nutrient and also they are present in chemically combined form. Example is DAP or diammonium phosphate where you can see nitrogen and phosphate are fixed in you know are chemically combined finally, mixed fertilizers.

Now, mixed fertilizers are basically the physical mixtures of straight fertilizers and they contain two or three primary nutrient elements, and mixed fertilizer are made by thoroughly mixing the ingredients either mechanically or manually.

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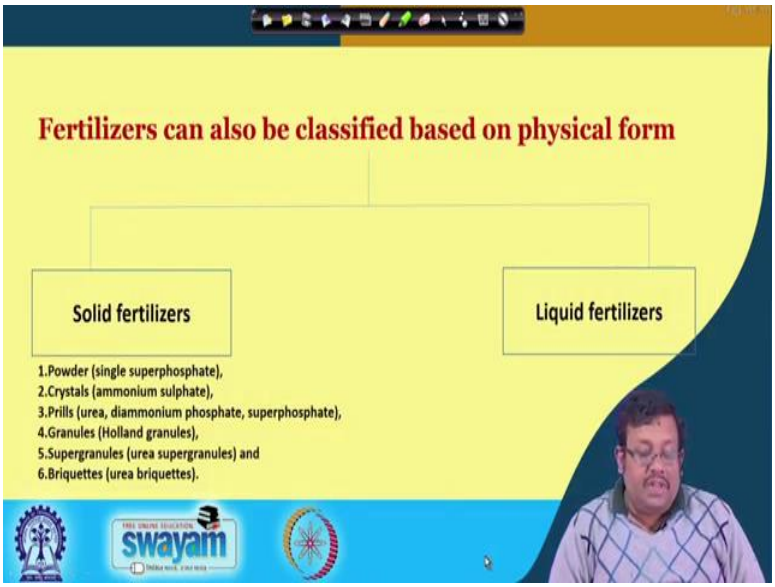

So, also fertilizer can be classified based on its physical forms. So, basically there are two types of you know physical based on the physical forms, we can classify the fertilizer into solid fertilizer and liquid fertilizers. We will discuss liquid nitrogenous fertilizer later one; however, let us discuss about the solid fertilizers.

So, solid fertilizer can be found in powder form example, single superphosphate which is the most common phosphatic fertilizer in India most popular phosphatic fertilizer in India you know also we call SSP we will discuss that later on. Then crystals of you know example is ammonium sulphate, then prills of fertilizer example urea, diammonium phosphate and super phosphate and then the granules which are Holland granules, and then super granules, urea super granules and briquettes are like urea briquettes.

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So, these are some pictures of the commonly used fertilizers in India. For example, you can see ammonium sulphate it contains only 20.6 percent of nitrogen, then single super phosphate which contains only 16 percent P_2O_5 of phosphorous pent oxide and then DAP which contains 18 percent nitrogen and 46 percent of phosphorous pentoxide, whereas MOP the last one this is the MOP. This one is murate of potash or MOP which is contains which contains 60 percent of potassium oxide or K_2O.

Now, remember guys, whenever we are presenting the phosphate contain and potassium contain in fertilizer we generally express them in terms of either phosphorous pentoxide or P_2O_5 or K_2O or potassium oxides.

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Now, you can see these are some urea granules, and this is the most common nitrogenous fertilizer in India and it is the it is the most rich nitrogenous fertilizer contain 46 percent of nitrogen and we will discuss that later on.

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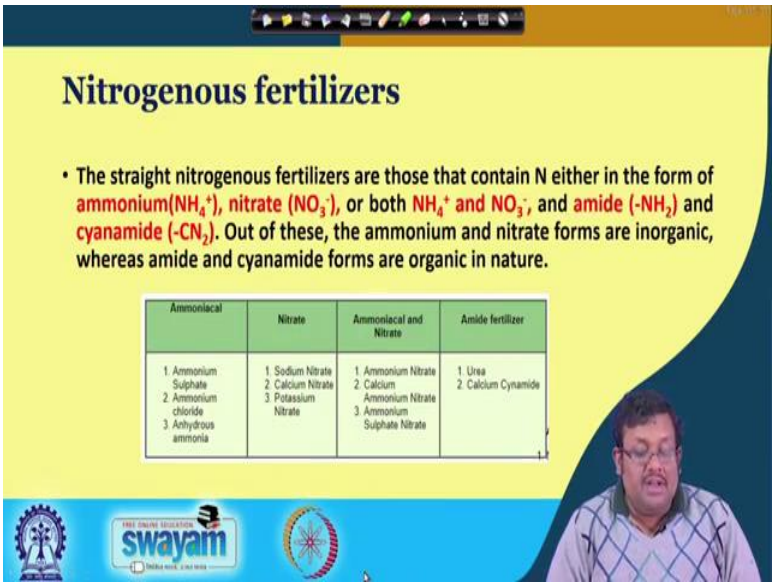

So, let us start with the nitrogenous fertilizer first. So, the straight nitrogenous fertilizers are those which contains nitrogen either in the form of ammonium it is NH^4 plus or nitrate or both ammonium and nitrate and amide form or cyanide form or so, cyanamide form.

So, out of this the ammonium and nitrate forms are inorganic whereas, amide and cyanamide forms are organic in nature some examples are given below. First of all ammonium sulphate: some ammoniacal forms of ammoniacal form containing nitrogenous fertilizer ammonium sulphate, then ammonium chloride, then anhydrous ammonium.and in case of nitrate sodium nitrate then calcium nitrate, potassium nitrate and in case of combined ammoniacal and nitrate form you can see ammonium nitrate, calcium ammonium nitrate or CAN or ammonium sulphate nitrate and in case of amide fertilizer; obviously, urea and calcium cyanamide.

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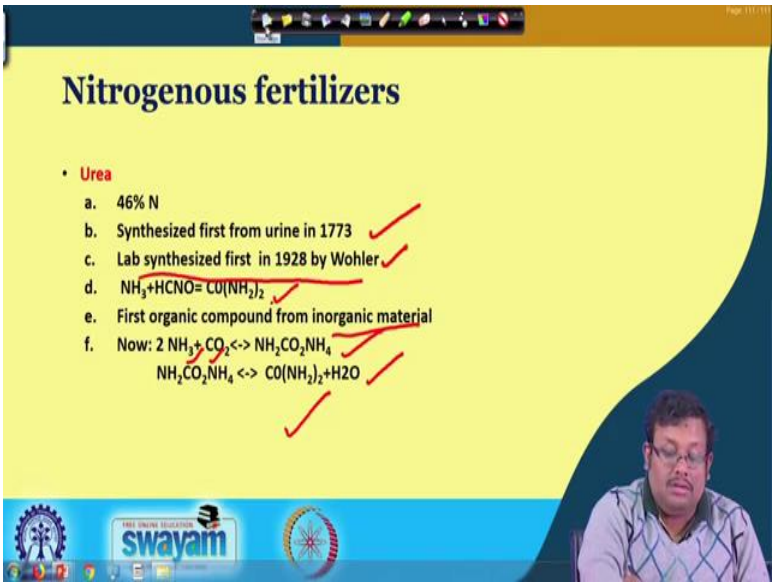

So, example by the way the cyanamide can be also divided in the into sub divided into the cyanamide form. So, both this urea and calcium cyanamide are organic in nature. So, let us start with urea; obviously, contains 46 percent of nitrogen and this was first produced you know from urine in 1773, and in the lab it was first synthesized in 1928 by Wohler German scientist Wohler, where in the you know basically chemically combined this NH3 with HCNO to get this urea and this is the first organic compound form from two inorganic materials and now basically we produce this urea by combining this ammonia and carbon dioxide to form this ammonium carbonate, and this ammonium carbonate further decomposes to form water and this urea.

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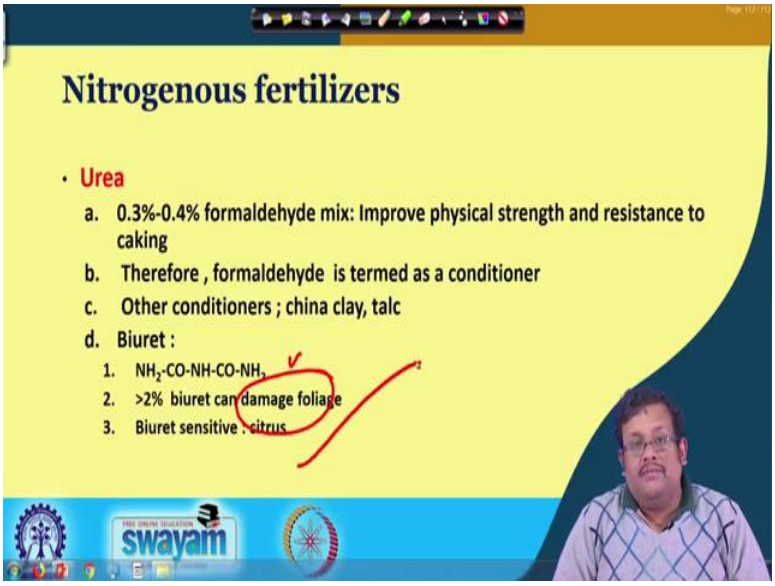

So, urea also needs some 0.3 to 0.4 percent formaldehyde mix because it improves the physical strength and resistance to caking. So, urea is very very soluble in water and also very very susceptible to caking; that means, if you leave it, it will easily observe the moisture from the atmosphere and forms the cakes.

So, we to improve the physical condition and to prevent the caking generally 0.3 to 0.5 percent of formaldehyde is basically mixed with urea and that is why it is called a conditioner. What are the other conditioner? The conditioners are china clay talc etcetera. Now also urea also contains a chemical called biuret this is a formula of biuret and this biuret is very very you know toxic, when it is a greater than 2 percent and it basically damages the foliages and biuret sensitive crop is basically citrus.

Citrus is very very biuret sensitive. So, the level of biuret has to be monitored very carefully while producing the urea fertilizer.

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So, synthesis of nitrogenous fertilizer basically occurs through different process industrial different industrial process; obviously, the first process is the Cyanamide process where the end product is calcium cyanamide and it is not produced in India basically. Secondly, the electric arc process where the end process is end product is nitric acid.

Finally the Serpek process where end product is ammonia and the most common and popular is Haber Bosch process where end product is ammonia it is popular method for the production of direct ammonia from the atmospheric air and the power requirement is also less compared to cyanamide and arc processes. So, this is very very popular process.

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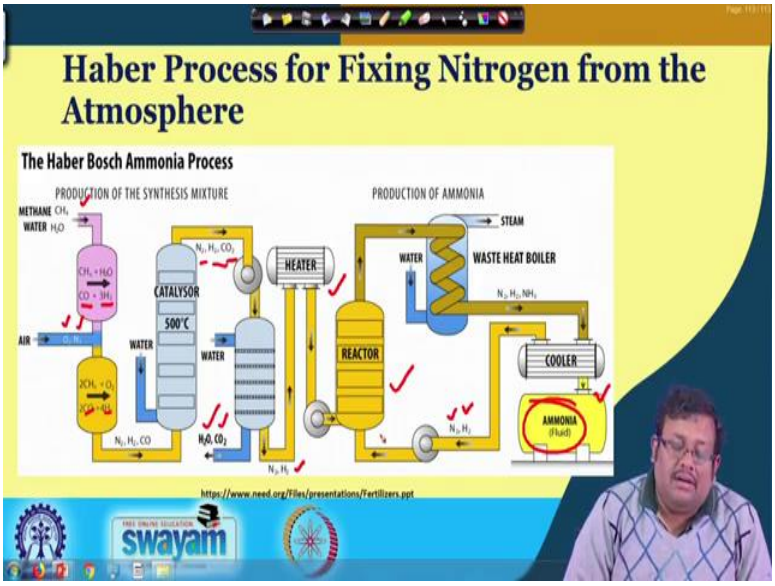

So,. So, this basically schematic diagram of the Haber process. So, Haber Bosch process. So, you can see here is not you know first of all that is a production to synthesis mixture. So, we basically the mixture of methane and water is inside water vapour is inserted, where this methane reacts with water vapour to produce carbon monoxide and hydrogen. And also in the subsequently you know oxygen and nitrogen is inserted in here through here, and you can see this carbon monoxide and this hydrogen and this nitrogen goes through here and ultimately through the catalyser at 500 degree centigrade, ultimately it produces the nitrogen hydrogen and carbon dioxide..

And this hydro you know this water and carbon dioxide get released from here ultimately producing the nitrogen and hydrogen, and these nitrogen and hydrogen goes towards the heater and ultimately goes towards the reactor, which where it forms the liquid ammonia and this you know unused NH_2 you know nitrogen and hydro you know hydrogen basically goes back to the reactors.

So, there is you can see ultimately it is a production of ammonium fluid. And this ammonia fluid is basically the raw material for different nitrogen fertilizer production industries we will see how they are helping in different nitrogen fertilizer production.

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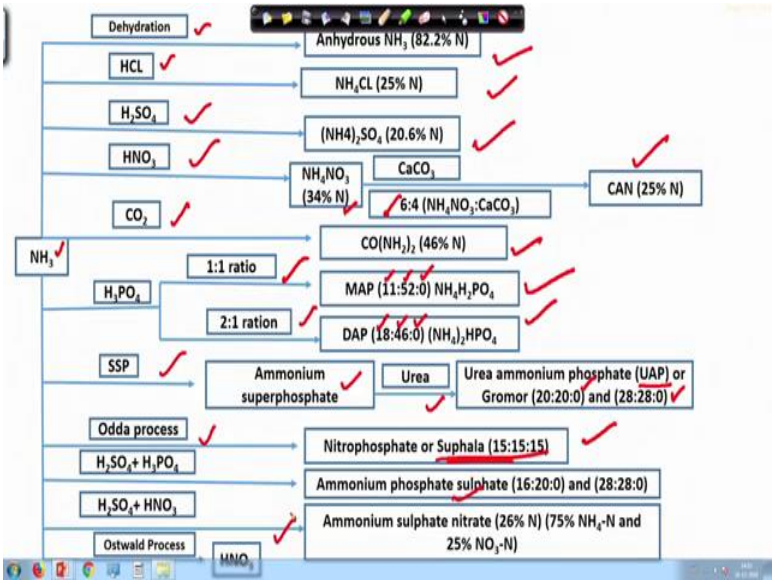

So, this is a very good slide which shows the how you can produce different nitrogenous fertilizer from ammonia. So; obviously, the starting point is ammonia which we produce due to Haber Bosch process and you can see through the dehydration process you can produce anhydrous ammonia, which is 82.2 percent of nitrogen, then reaction with HCL or hydrochloric acid produce the ammonium chloride which is 25 percent of nitrogen, reacting with H_2SO_4 it produce the ammonium sulphate, which is a very important nitrogenous fertilizer 20.6 percent of nitrogen.

Then reacting with HNO_3 it produce the ammonium nitrate which contains 34 percent of nitrogen. Now this ammonium nitrate is highly explosive. So, to prevent the application and the and the market of ammonium nitrate, you know now they are produced another you know we generally produced another fertilizer called CAN, when CAN is basically the mixture of calcium carbonate and ammonium nitrate. So, in the in the ratio of ammonium nitrate and calcium carbonate in the ratio of 6 is to 4.

So, ultimately calcium ammonium nitrate if formed which contain 25 percent of nitrogen and when it is mixed with carbon dioxide ultimately it produces urea which is 46 percent nitrogen and ammonia when mix with $H_2P_2O_4$ in one is to one ratio it produces the mono ammonium phosphate, which has the grade of 11 is to 52 and then 2 is to 1 ratio it will produce DAP or diammonium phosphate and you can see here these are the 18-46-0 and

11-52-0; that means, this fertilizer 100 kg of this fertilizer will contain 11 kg of nitrogen 52 kg of P_2O_5 and 0 kg of K_2O.

Similarly, here it will be 18 kg of nitrogen and then 46 kg of P_2O_5 and 0 kg K_2 O. So, again when ammonia is mixed with a single super phosphate it will produce the ammonium super phosphate and ultimately when it reacts with urea it produce urea ammonium phosphate or UAP or Gromor which as a grade up 20 is to 20 is to 0 and 28 is to 28 is to 0.

And the also there is a process called Odda process and through odda process we generally produce the nitro phosphate or suphala. Suphala is very important phosphatic you now important fertilizer which as a grade of 15 is to 15 is to 15 and then when mixed with the you know H_2SO_4 and H_3PO_4, it produces ammonium phosphate sulphate and you know with these two grades that is 16 is to 20 and 20 is to 28 and mixing with H_2SO_4 and HNO_3 it is produced ammonium sulphate nitrate and also through Ostwald process it produces the nitric acid.

So, you can see whole bunch of different fertilizer can be produced from this ammonia which is produced through this Haber and Bosch synthesis.

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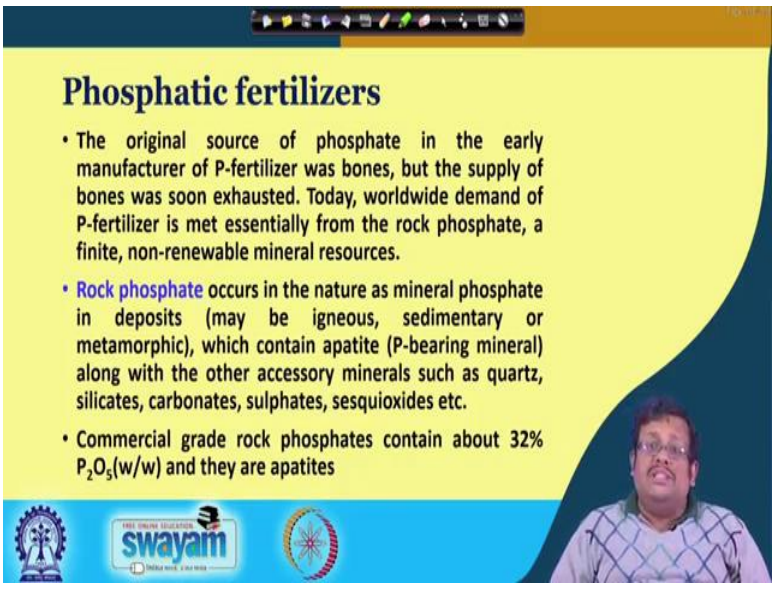

So, let us go ahead and see what is a phosphatic fertilizer what are the phosphatic fertilizer. The original source of phosphatic fertilizer in the early manufacture of

phosphatic fertilizer where bones are different animal bones which contain high amount of phosphate.

However due to the exhaustion of those bones you know worldwide demand of phosphate and also due to the high worldwide demand of phosphatic fertilizer, it is not it is right now it is produced from the rock phosphate. And this rock phosphate occurs in nature as mineral phosphate in very deposits mainly you know maybe igneous may be sedimentary or metamorphic, which contain apatite which is the phosphate bearing mineral along with the other accessory minerals such as quartz, silicates, carbonates, sulphates, sesquioxides etcetera and commercial grade rock phosphate basically contain 32 percent of P_2O_5.

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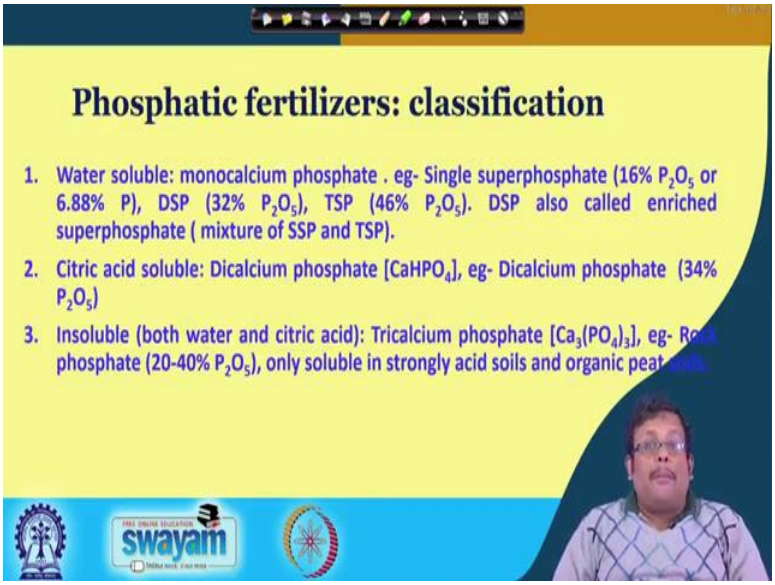

So, if we classify the phosphatic fertilizer you will see three different types. First of all water soluble phosphatic fertilizer examples are monocalcium phosphate and you know water soluble is monocalcium phosphate example is single super phosphate or SSP which contains 16 percent P_2O_5 or 6.88 percent of P. Then double super phosphate which contains 32 percent of P_2O_5, then triple super phosphate which also contains 46 percent of P_2O_5 and DSP also called enriched super phosphate, which is basically mixture of single super phosphate and triple super phosphate.

Secondly citric acids soluble phosphate which is basically dicalcium phosphate $CaHPO_4$ and which contains 34 percent of P_2O_5 and insoluble which is both water and citric acid

soluble. So, tricalcium phosphate or examples you know tricalcium phosphate is an example you know you know rock phosphate is basically example of tricalcium phosphate which contains 20 to 40 percent of P_2O_5 and only soluble only you know soluble is strongly acid soils are organic peat soils.

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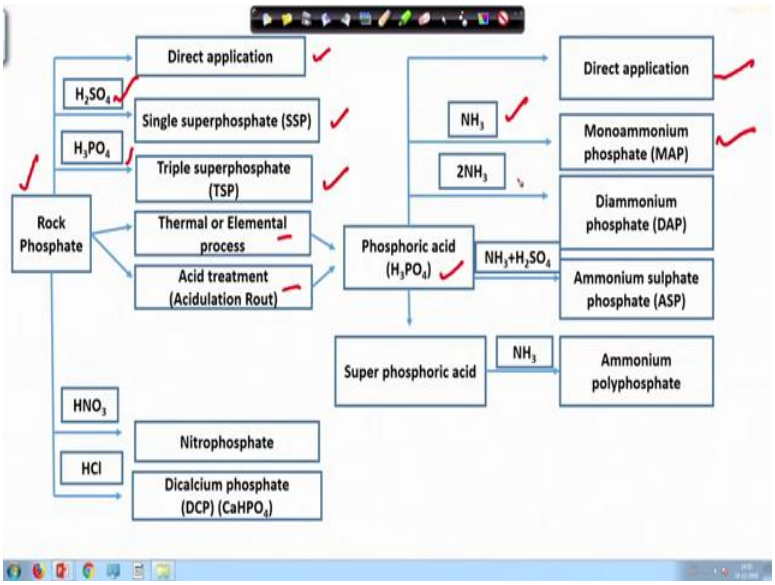

So, let us see how rock phosphate creates different types of phosphatic fertilizer. So, you can directly use this rock phosphate, because it is a acid soluble fertilizer or insoluble fertilizer you can directly apply to the highly acidic soil. When it mixed with the H_2SO_4 it will produce the single super phosphate, when it is mixed with H_3PO_4 it will produce the triple super phosphate.

And due to the thermal or elemental process and due to acid treatment, it will also produce the phosphoric acid and this phosphoric acid basically you can directly apply the phosphoric acid also you can mix the phosphoric acid react the phosphoric acid to produce the monoammonium phosphate, when it is reacting with 2 molecules of ammonia to it produce the diammonium phosphate or DAP, and also ammonia mix you know when phosphoric acid is mixed with ammonia and then H_2SO_4 and ultimately it produces DAP and ammonium sulphate phosphate ASP, and you can see here no.

The phosphoric acid I am sorry when phosphoric acid will be mixed with ammonia and H_2SO_4 it will produce ammonium sulphate phosphate and from phosphoric acid we will get super phosphoric acid, when it this super phosphoric acid further reacts with

ammonia it produce ammonium poly phosphate. So, you can see how these rock phosphate basically reacts with different compounds to form different types of phosphatic fertilizer.

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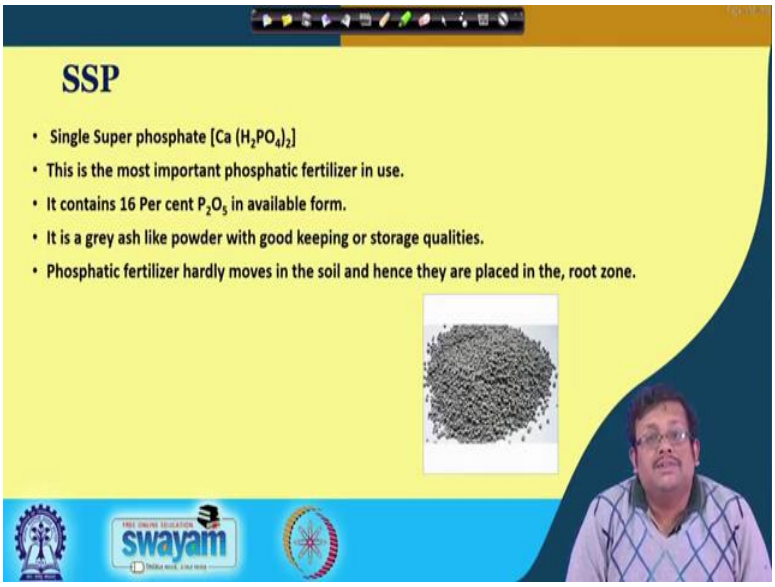

So, it is clear now. Now let us discuss about the single super phosphate. Now single super phosphate is basically the having the formula of this CaH_2PO_4 whole two and this is the most important phosphatic fertilizers in India in basically in use. And it contain 16 percent of P_2O_5 in available form, and it is a grey ash like powder with good keeping and storage abilities and finally, phosphatic fertilizer hardly moves in the soil and hence they are placed in the root zone we will discuss that later on.

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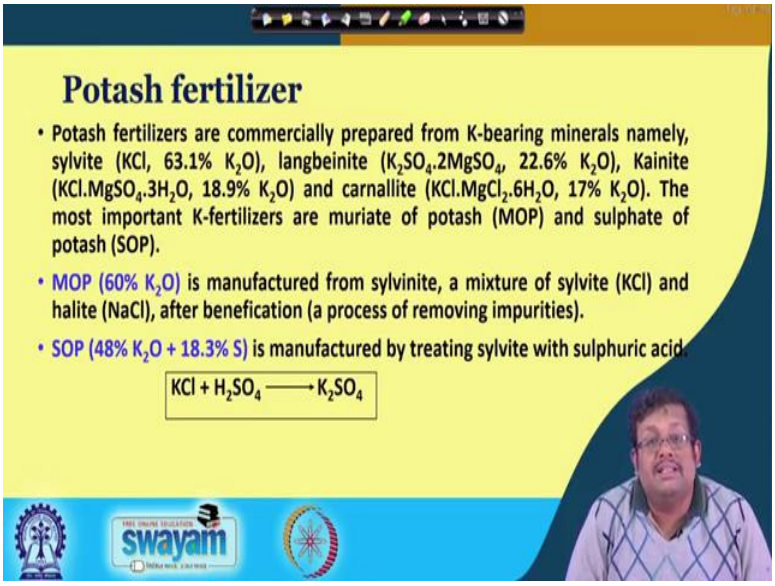

So, let us start with potassic fertilizer. Now potash fertilizer are commercially prepared from potash bearing minerals namely sylvite which is basically potassium chloride, 63.1 percent of K_2O langbeinite which is $K_2SO_4.2\ MgSO_4$ which contains 22.6 percent of K_2O and then kainite which contains KCl and Mg magnesium sulphate and it contains 18.9 percent of K_2O and carnallite which is basically potassium chloride and magnesium chloride which is contain which contain 17 percent of K_2O.

So, the most important potassium fertilizers are muriate of potash that is MOP and sulphate of potash that is SOP. So, muriate of potash basically contains 60 percent of K_2O and it is basically manufactured from sylvite and a mixture of you know mixture of sylvite and halite and after you know and there is a beneficiation process where you know they remove different types of impurities to form this MOP.

Now, remember one major thing that MOP contain 60 percent of K_2O. In case of sulphur you know you know sulphur of potash sulphate of potash and SOP which contains 48 percent of K_2O and 18.3 percent of sulphur and basically its manufactured by treating sylvite with sulphuric acid you can see here sylvite is KCl when it is mixed with H_2SO_4, then it forms a K_2SO_4.

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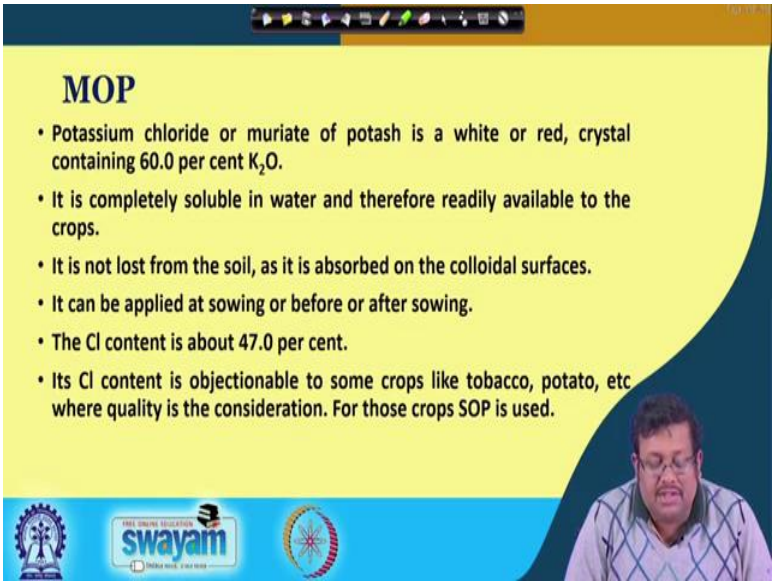

Now, MOP is potassium chloride or muriate of potash, it is a white or red or crystal contains 60 percent K_2O. Secondly, it is completely soluble in water and thereby readily available to the crops thirdly, it is not lost from the soils as it is a absorbed on the colloidal surfaces finally, it can be you know it can be applied at sowing or before or after the sowing.

The chloride content is about 46 percent and the chloride content is objectionable to some crops like tobacco potato etcetera where quality is the consideration. So, in for this crops only you know this is application of sulphate of potash is recommended.

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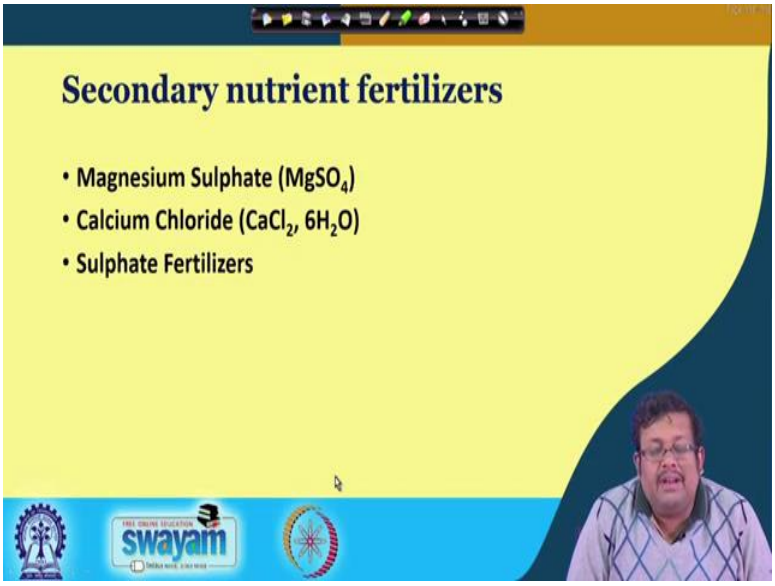

So, we have covered the primary nutrients, let us see some secondary nutrients.

So, some secondary nutrients examples are magnesium sulphate, you can see $MgSO_4$ calcium sulphate Ca you know calcium chloride that is $CaCl2,6H_2O$ and also different types of sulphate fertilizers, basically we apply for a correcting the sulphate deficiency specially for oil such crops like mustard. Now sulphur is a very much required for oil such crop like mustards.

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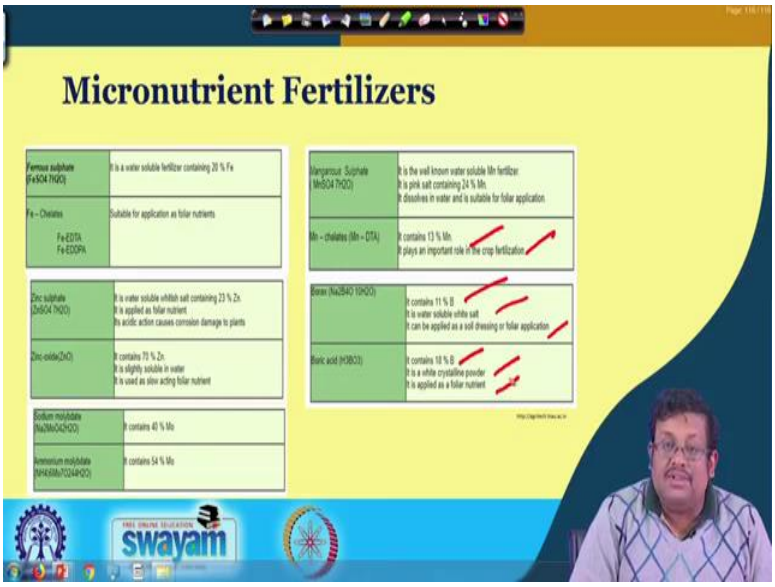

So, there are also different micro nutrient fertilizers also. You know there are 6 to 7 you know there are different micro nutrients and these micro nutrients are also applied sometime to foliar spray sometime to fertigation. Fertigation is joint application of fertilizer and irrigation water. So, we can apply this small you know micro nutrient fertilizer they require in a smaller quantity as compared to the macro nutrient fertilizers.

So, most of the time we apply through spray on to the crop and the crop basically hinges those you know micro nutrients directly through their leaves. So, you can see some examples first of all ferrous sulphate heptahydrate, it is a water soluble fertilizer containing 20 percent of iron and also iron chalets are important EDTA,EDDPA these are chaleting agency, which can basically chalet the iron and also they are suitable for application as foliar nutrient.

So, this chalets basically we apply through foliar application. Second is zinc sulphate heptahydrate and it is basically water soluble whitish salt containing 23 percent of zinc and it is applied as foliar nutrient and it is acidic you know action its acidic action causes corrosion damage to plants, then zinc oxide which contains 70 percent of zinc and it is slightly soluble in water.

Then sodium molybdate which supplies a molybdenum and molybdenum content is 40 percent and ammonium molybdate also it contains 54 percent of molybdenum and then manganous sulphate, manganous sulphate it is well known water soluble manganese fertilizers and you know it is pink salt containing 24 percent of manganese, and it dissolves in water and its suitable for foliar application and also manganese chelates Mn-DTA which contain 30 percent of which contain 13 percent of manganese and it place a important role in crop fertilization and borax; obviously, 11 percent of boron it is hot water it is water soluble white salt; obviously, and it can be applied through as you know as a soil dressing or foliar application you can directly spray into the crop.

Boric acid also which contains 18 percent of boron and it is a white crystalline powder, and it is applied through foliar nutrient. So, these are some important micro nutrient fertilizers. Similarly for copper also we have copper sulphate which is an important micro nutrient fertilizers.

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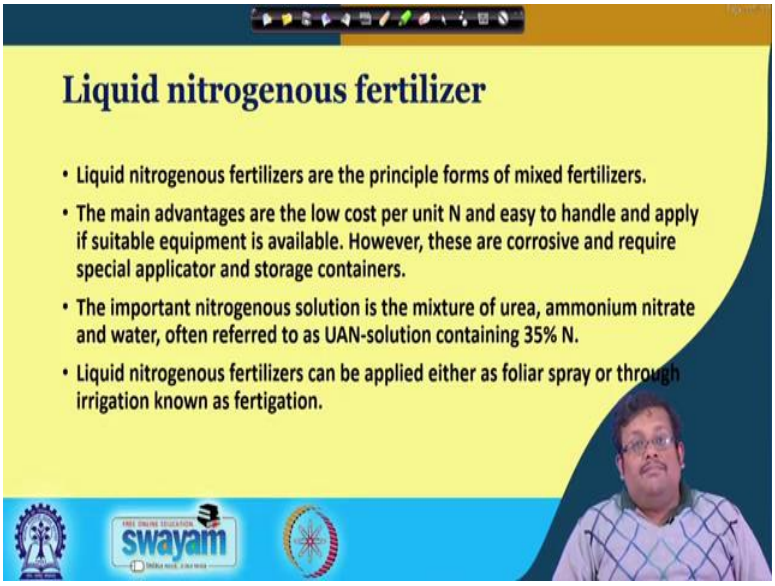

Liquid nitrogenous fertilizer, liquid nitrogenous fertilizers are the principle forms of mixed fertilizers and the main advantage are these are very low cost unit you know advantages are the low cost per unit nitrogen and easy to handle and apply you know if suitable equipment is available.

However these are corrosive and require special applicator and storage container, and the important nitrogenous solution is the mixture of urea, ammonium nitrate and water often referred to as UAN which is a you know solution containing 35 percent of nitrogen and liquid nitrogenous fertilizer can be also applied either as foliar spray, through irrigation and it is called the you know also through irrigation which is called the fertigation process.

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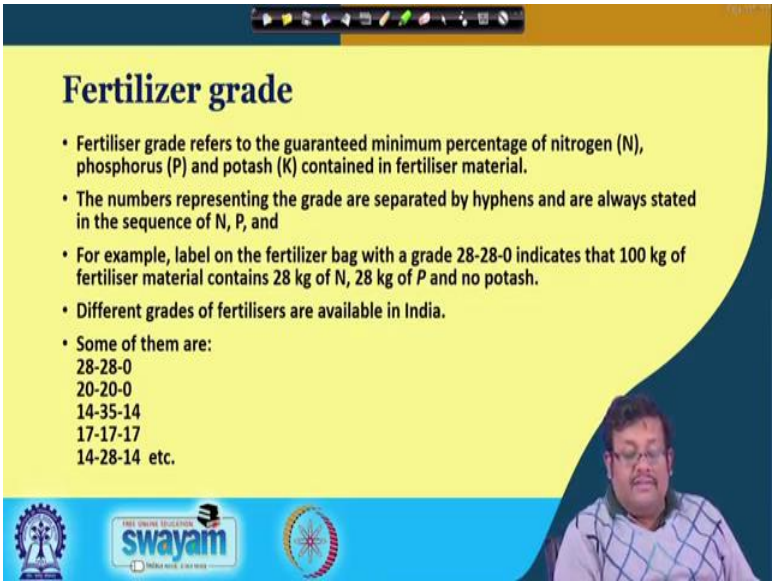

So, what is fertilizer grade? Fertilizer grade refers to the guaranteed minimum percentage of nitrogen phosphorous and potash containing in the fertilizer material. So, the number of number representing the grade are separated by hyphens and are always stated that the sequence of N and P. So, for examples label on the fertilizer bag with a grade up to 20 is to 28 is to 0 indicate the 100 kg of fertilizer material contain 28 kg of nitrogen and 28 kg of P and no potash.

So, different grades of fertilizers are also available in India some of them are 28-28-0, 20-20-0, 14-35-14, 17-17-17 and 14-28-14, by the way these forms of P is basically 28 kg of P_2O_5.

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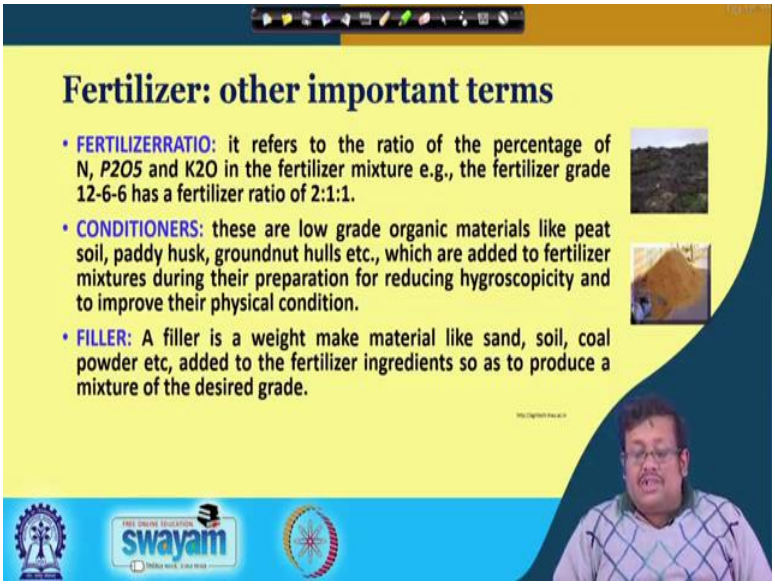

So, fertilizer some other let us let us discuss some other important terms also.

So, fertilizer ratio is the refers to the ratio of the percentage of the N,P_2O_5 and K_2O in the fertilizer mixture. So, basically the fertilizer grade of 12 is to 6 is to 6 as a fertilizer ratio of 2 is to 1 is to 1 then conditioner; conditioner are low grade organic materials like peat soil, paddy husk, groundnut etcetera which are added to the fertilizer mixture, during their preparation to reduce the hygroscopicity and to improve their physical condition you can see this is a peat soil and this is a saw dust and filler what is a filler?

Filler is a weight make material like sand like soil, coal powder etcetera and added to the fertilizer ingredients. So, as to produce a mixture of the desired grades.

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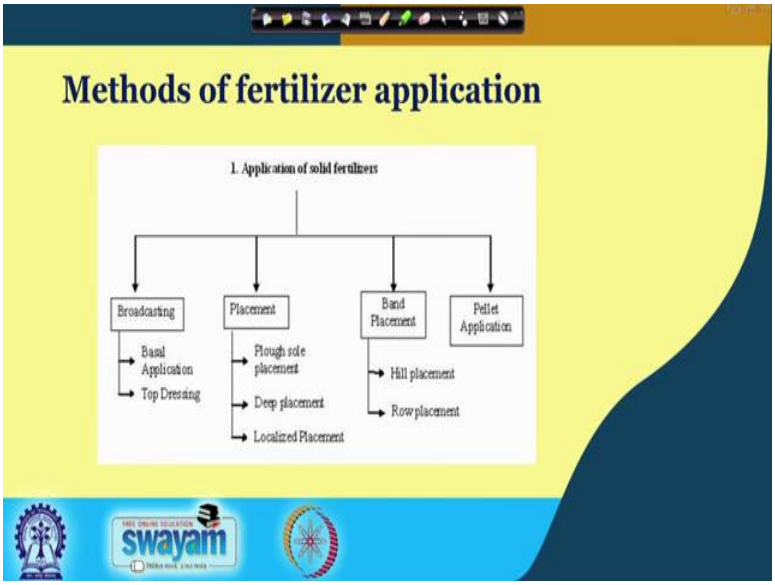

So, the last slide of fertilizer is the method of fertilizer application. Now there are several methods of fertilizer application the broad we know broad classify the majors major process are broadcasting, placement, band placement and pellet application.

Now, broadcasting are again divided into two parts one is called the basal application and another is top dressing. Now basal application is when you mix the fertilizer during the preparation of the land through the soil and this is called basal application. And top dressing is when we when we when we give the fertilizer when we spread the fertilizer in a standing crop, for specially in case of nitrogenous fertilizer like in case of close standing crop like you know rice, wheat etcetera then it is called top dressing.

Now, top dressing as some problem because you know there are some weed growth you know it encourages the weed growth, also sometime it cannot reaches the plant root for their uptake also. So, there are some drawback of top dressing also. So, these are two major type basal and top dressing again. Basal apply during the land preparation time and top dressing is when there is a crop standing.

So, placement we know there are also three types one is plough sole placement, then deep placement and localized placement. So, placement you know plough sole placement is during the ploughing time, when there is a fertilizer place just at the ploughed layer then it is called the plough placement. Deep placement generally occur in case of ammoniacal fertilizer they are placed in the deep anaerobic zones to reduce the

volatilization loss. And localized placement also generally we you know localized placement is also given for certain fertilizer around a plant or seed.

And band placement is also very much important band placement is of two types one if hill placement which is given for different orchids, and we know row placement is basically perform standing crop like sugarcane, where we know apply the apply the fertilizer in the rows and also some pellet application. Now pellet applications are basically done in case of urea, urea pellets are produced and. So, these are some application of solid fertilizers.

So, I hope that you have learned some new concepts of fertilizers, and their classification, how they apply this fertilizers and what are the different types of important macro nutrient, micro nutrient and secondary nutrient fertilizers what are the nutrient contents. So, guys we have finished this week 7 of lecture. So, we will we know in the next lecture we will start our week 8 of lectures.

So, thank you and let us meet next in the next lecture bye.