Soil Fertility and Fertilizers
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Lecture: 27
Soil Testing and Soil Fertility Evaluation Methods (Continued)

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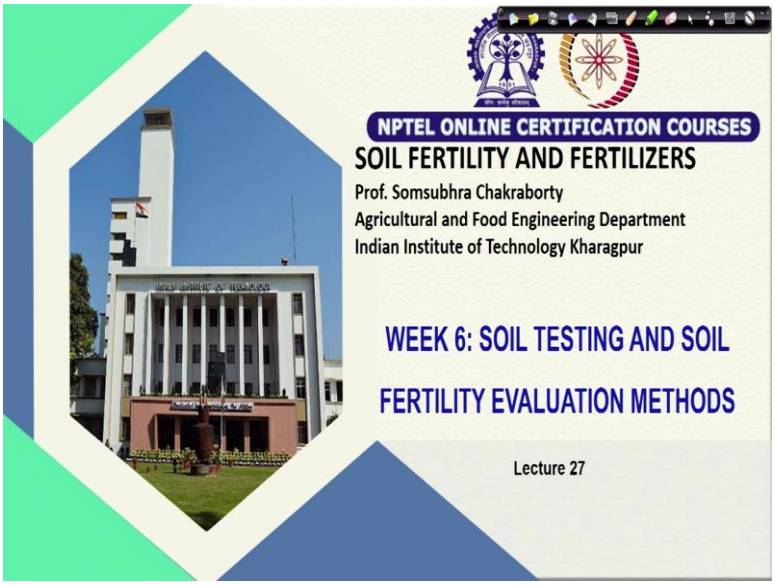

Welcome friends to this second lecture of week 6 of NPTEL online certification course of Soil Fertility and Fertilizers. In this week, we are discussing about soil testing and soil fertility evaluation methods. In our first lecture, that is lecture number 26, we have discussed about plant tissue testing, how to use the plant as a diagnostic plant nutrition content as a diagnostic tool.

And also we have discussed about DRIS concept and how we can use the ratios of different nutrients to identify the most limiting nutrient. So, in this lecture, lecture number 27, we are going to discuss about the soil testing and also the different types of soil sampling methods, we are going to discuss in details.

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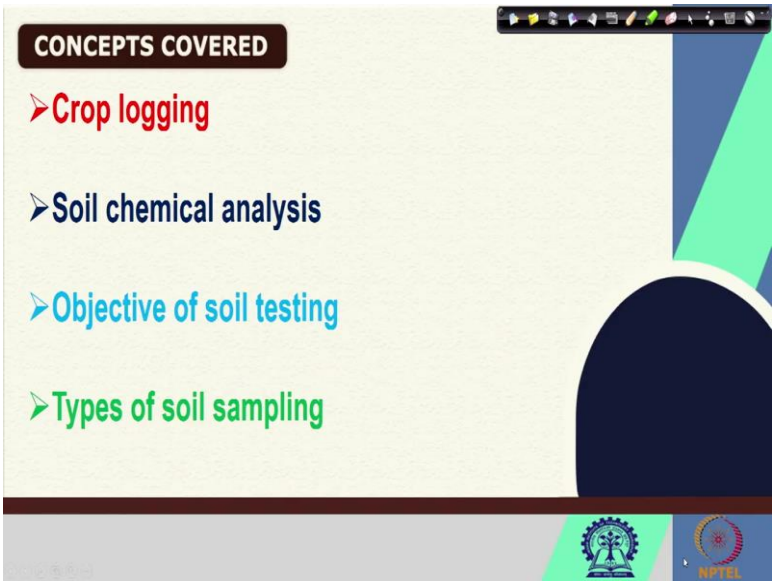

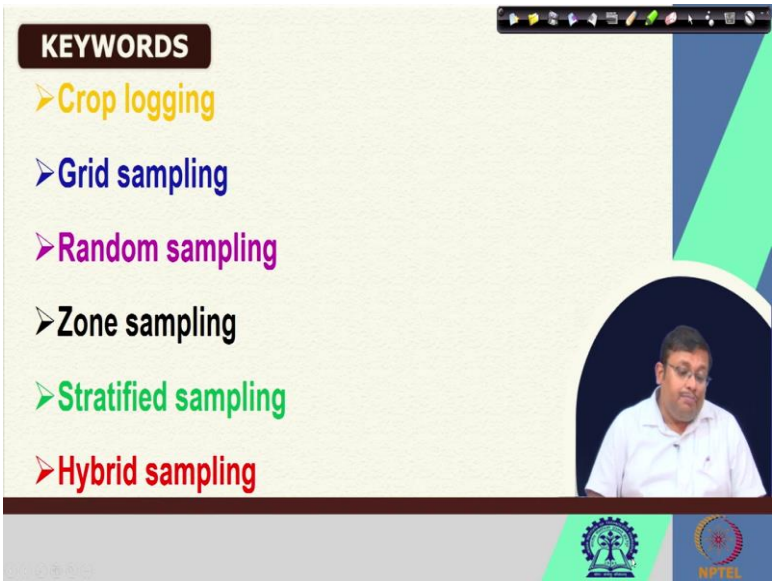

So, these are the concepts which we are going to discuss in this lecture like crop logging, then soil chemical analysis, then what are the objectives of soil testing and then different types of soil sampling. So, let us first start with the crop logging however, I also should mention that these are the some of the keywords for this lecture like crop logging, grid sampling, random sampling, zone sampling, stratified sampling and hybrid sampling.

So, we are going to discuss what are the ways through which we can collect the soil sample so, that we can ensure that there is perfect representation of the variability of the land but at the consideration of your available resources.

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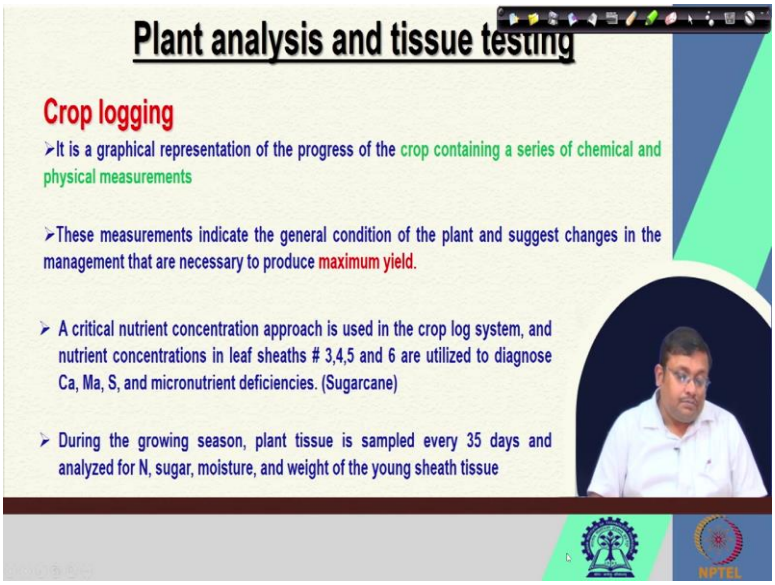

So, let us start, what is crop logging? Now, crop logging is basically a graphical representation of the progress of the crop containing a series of chemical and physical measurement. So, basically in this crop logging, we do a series of chemical and physical measurement and we graphically represent the progress of the crop in terms of those parameters. So, these measurements indicate the general condition of the plant and suggest changes in the management that are necessary to produce the maximum yield.

So, if we can see the temporal changes of different nutrient concentration and also crop physiological parameters also, then we can identify okay we need to add these nutrients at this point of time.

So, a critical nutrient concentration approach is used in the crop log system, we already know what is CNC and nutrient concentration in leaf sheaths for example, in case of sugarcane, the nutrient concentration in leaf sheaths number 3, 4, 5 and 6 are utilized to diagonals to calcium, magnesium, sulphur and micronutrient deficiencies. Based on this critical nutrient concentration approach and during the growing season, plant tissue is sampled every 35 days and analyzed for nitrogen, sugar, moisture and weight of the young tissue, young sheath tissue. So, this is how this crop logging is executed.

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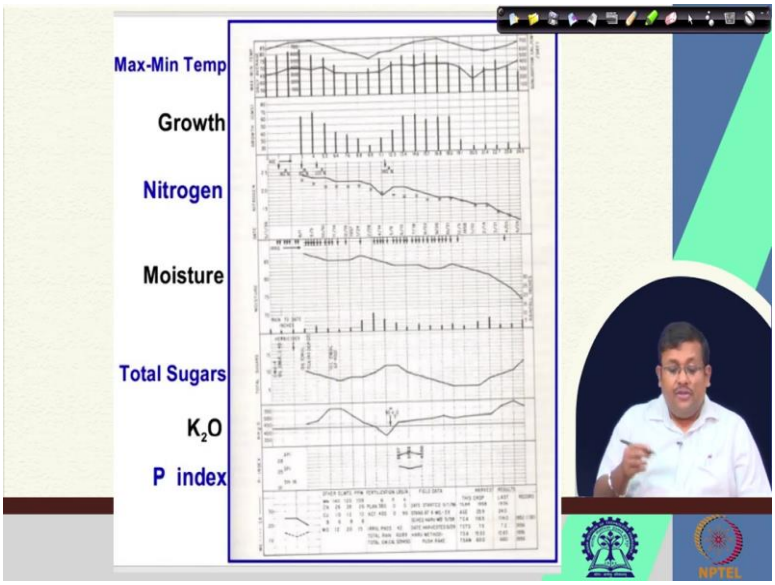

So, if you see this graph we can clearly see that we can have the maximum minimum temperature and changes in the growth of the crop, the nitrogen concentration, moisture content and also total sugar, potassium oxide and also phosphorus and phosphorus index. So, these are different types of measurements, physical and chemical measurements we take and then graphically represent to identify those stages where we require any intervention. So, this is all about Crop logging.

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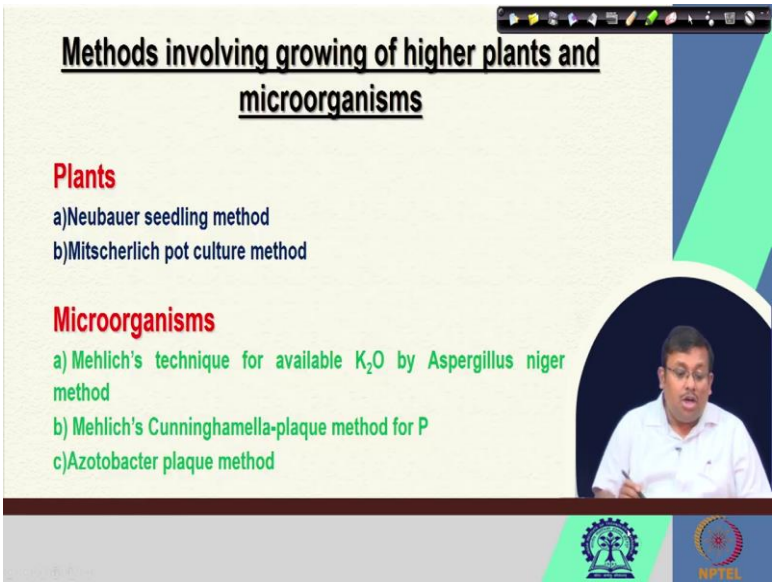

Another method you must remember we have discussed briefly mentioned that is there is a method of involving growing of higher plants and microorganisms. So, here basically we

grow different types of seedlings or different microorganisms to identify the deficiency or sufficiency of a particular nutrient.

Some examples you can see Neubauer seedling method, then Mitscherlich pot culture method these are plant based methods whereas, microorganisms based methods you can see Azotobacter plaque method then Mehlich's Cunninghamella-plaque method for phosphorus, then Mehlich's technique for available K2O by Aspergillus niger methods. So, these are some of the microorganisms based method for identifying the soil and crop nutrient status.

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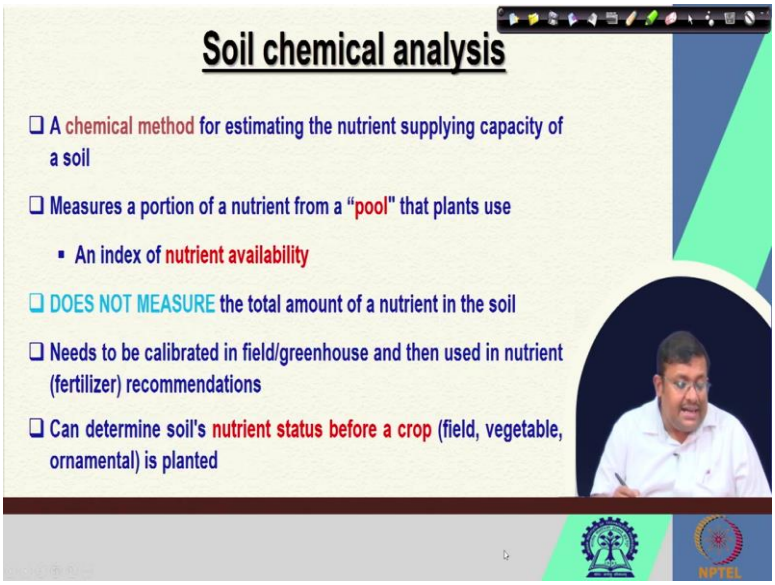

Now, let us go ahead and see the soil chemical analysis. So, the soil chemical analysis is basically it is a chemical method of estimation of the nutrient supplying capacity of a soil, this is very important and this is the most widely accepted method for evaluation of soil fertility.

Remember that in this soil chemical analysis method it is consist of different steps. The first step is soil sampling which is the most important step, then soil processing, then chemical extraction measurement and then interpretation and fertilizer recommendation. So, these all these steps are important for soil chemical analysis and unless you interpret the results that will not be considered as a full soil testing or proper soil testing because the whole soil testing always include the nutrient concentration interpretation and also the fertilizer recommendation.

So, in this soil chemical analysis, we generally measure a portion of the nutrient from a pool that plants use. Remember that this method does not measure the total amount of nutrient in

the soil. For example, in case of nitrogen that nitrogen can be present in both organic forms and inorganic forms and maximum amount of nitrogen almost 95 to 98 percent is available in the soil in the organic forms in the protein form, but plant cannot take that nutrient.

So, the available forms of these nutrients are only nitrate and ammonium. So, when you go for the soil chemical analysis, you only measured the nitrate and ammonium to interpret or to identify the nitrogen uptake or nitrogen supplying capacity of the soil.

So, that means, this soil chemical analysis measures a pool of the total nutrient that plants use or in other words, we generally measure the available nutrients that is why the soil chemical analysis is known as an index of nutrient availability. Remember one another important point is these soil chemical analyses needs to be calibrated in field or greenhouse and then used in nutrient or fertilizer recommendation and it can determine soil nutrient status before a crop, it can be either field crop or vegetable crop ornamental crop is planted and this is remember, please remember these soil chemical analyses is utmost important for before you grow a crop. So, these are some of the important points.

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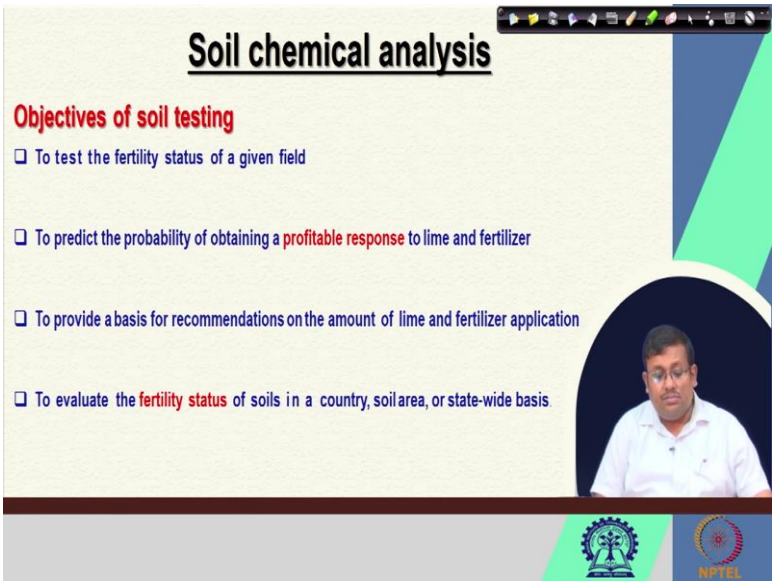

Now, what are the objectives of soil chemical analysis or soil testing? First of all, the most important objective is to teach the fertility status of a given field. So, farmers want to test their soil and I want to and they want to identify whether the nutrient content of their soil is high, medium or low. So, this is the first important objective of soil testing.

Secondly, to predict the probability of obtaining a profitable response to lime and fertilizer. So, this is the second objective of soil testing. Third objective is to provide a basis for

recommendations on the amount of lime and fertilizer application. Lime is a, it is an amendment which we apply to correct soil acidity and also fertilizer we generally apply to correct the nutrient deficiency.

So, we need a basis for this recommendation of lime and fertilizer application. So, soil testing or soil chemical analysis gives us that particular basis. Fourth one is to evaluate the fertility status of soil in a country, soil area or statewide basis. So, we can apply these soil chemical analyses to identify the fertility of the status of the soil fertility status for a given area or broader area. So, these are some of the objectives of soil testing.

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Now, if you see the three major purpose of soil analysis first of all to determine the level of availability of the nutrients, secondly to predict the fertility of the soil and finally, to evaluate the status of each nutrient element. So, these are the three major purposes of soil analysis.

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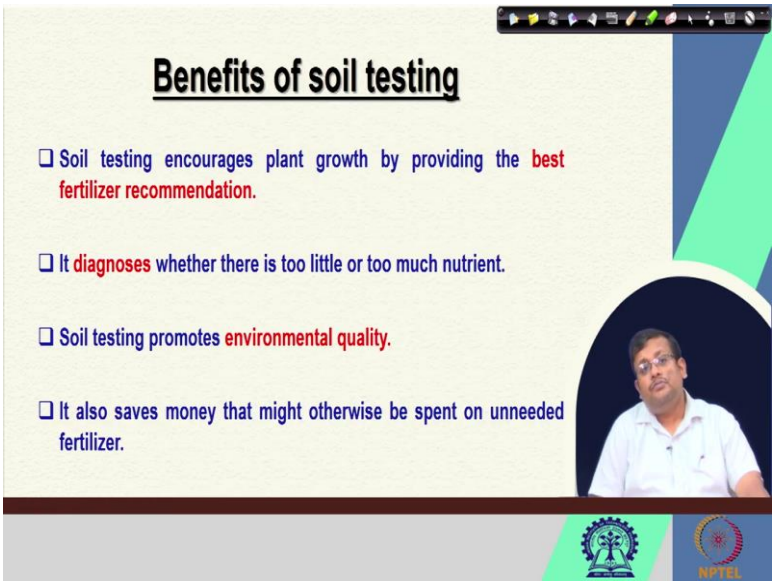

Now, what are the benefits of soil testing? Soil testing generally encourages plant growth by providing the best fertilizer recommendation. So, because of soil testing one can identify whether that soil is deficient or sufficient in a particular nutrient. So, if that soil is deficient then if you apply the recommended fertilizer dose that can encourages plant growth, it diagnoses whether there is too little or too much nutrient. Soil testing promotes environmental quality because if we applied too much nutrient without considering the proper judicious dose of nutrient then that can create environmental hazard.

For example, if we apply the nitrate fertilizer that can create, nitrate can, nitrate is really very mobile in the soil and most of the nitrate can leach or move away from the soil by a surface runoff and then they can go to the water body and create the health hazards. So, soil testing gives the basis for particular nutrient application and in that way you can it can ensure that environmental quality. It also saves money that might otherwise be spent or unneeded fertilizer. So, to prevent the unnecessary fertilizer application, these soil testing is also very much required.

So, again, first of all, it gives us the basis for fertilizer recommendation, it diagnosis whether we have soil has too little or too much of a nutrient and it ensures the environmental quality and also it increases the profit by saving the money that can be spent by an unnecessary fertilizer application.

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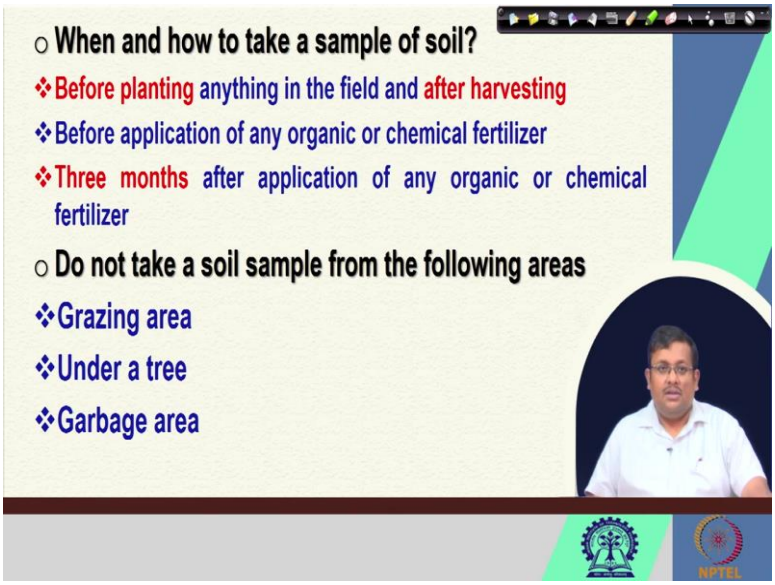

So, the next question comes to our mind when and how to take a soil sample? Remember that soil sampling should be done before planting anything in the field or after the harvesting the previous crop and also we should sample the soil before application of any organic or chemical fertilizer because based on soil testing we should apply the organic or chemical fertilizer.

So, soil testing should be done after harvesting a crop and before planting the next crop and also before application of organic and chemical fertilizers. Also, if you apply if you have applied any organic or chemical fertilizers and you should wait three months and then you can do the soil sampling.

Remember that soil sampling is the most important step of soil testing and much of the problem, I mean most problem in soil testing comes from faulty soil sampling. So, there are specific guidelines for soil sampling. So, you should not collect the soil sample from a grazing area or area under the tree or where the garbage will or any fertilizer bags or farmyard manure or any other manure are piled up.

So, you should not collect the soil samples from those areas, you should not collect the soil samples from the borders of the field, you should not collect the soil samples from a low lying areas where water is stagnant and you should not collect the soil samples from the area where already fertilizer has been applied.

So, these are the some of the important consideration you should remember when you go for soil sampling. In Indian condition, we generally recommend at least you do soil testing once in three years. So, these are these should be the frequency and timing of soil sampling.

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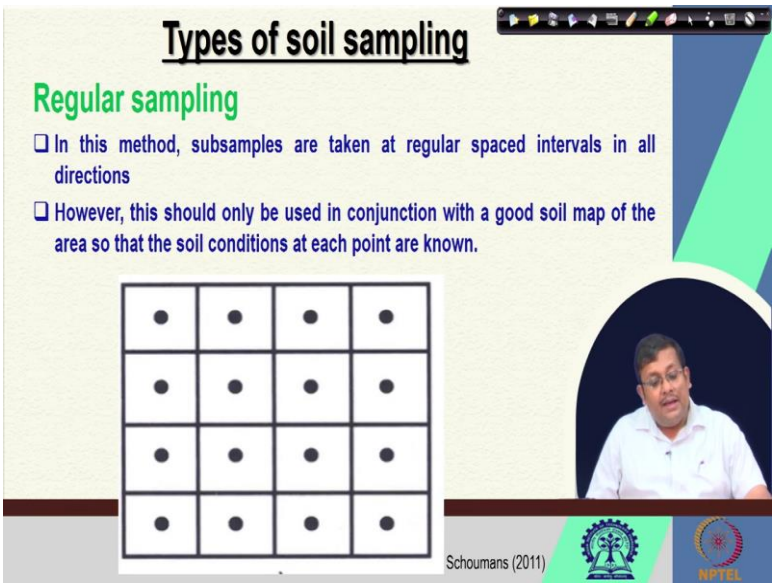

Now, let us discuss how to sample the soil. One thing you should remember that soil is highly heterogeneous. So, soil from one area varies widely from the soil of other area. So, when you take the soil sample, you must remember that your sample must be representative of the variability of that area. So, there are a couple of methods of soil sampling first method is regular sampling.

So, in this method, sub samples are taken at regular spaced intervals in all directions. So, as you can see in this picture or in this picture, you can see that the whole area divided into some cells and sub samples are taken at regular spaced intervals in all the direction. However, this should be only be used in conjunction with a good soil map of the area, so, that the soil conditions at each point are known. So, we should do the regular sampling but in conjunction with a good soil map of the area. So, this is the regular sampling, the next is random sampling.

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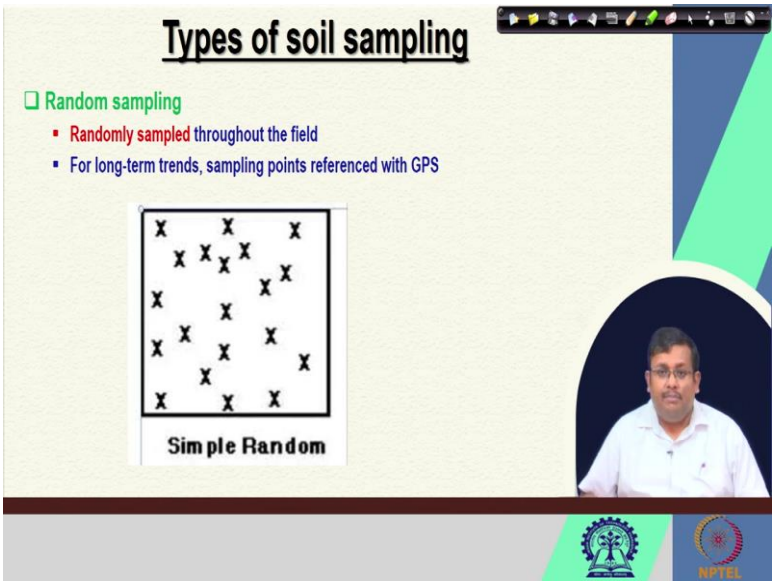

So, in this random sampling basically we take samples randomly throughout the field. And for long term trends, if we want to go back to this particular point and want to see what is the change or if we want to map then we can go for sampling points with GPS. So, all these GPS location can be gathered using a GPS receiver and we can use those GPS points or their locational latitude and longitude for producing the future maps of soil fertility. So, this is called a random sampling.

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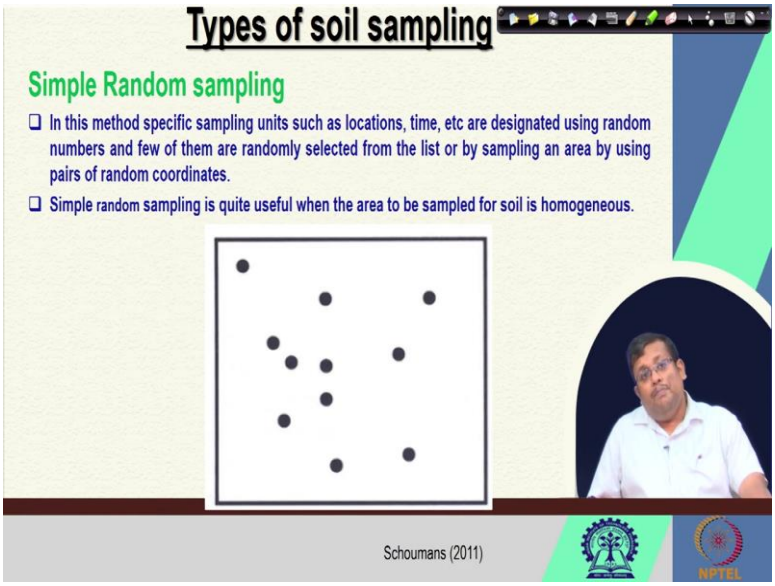

So, simple random sampling in this method. So, this simple random sampling is basically the random sampling. So, in this method specific sampling units such as location, time et cetera

are designated using random numbers and few of them are randomly selected from the least or by sampling an area by using pairs of random coordinates.

So, again, this is a random sampling method and random numbers and the samples are collected by random using random fashion and few of them are randomly selected from the list by sampling an area by using pairs of random coordinates. Simple random sampling is quite useful when the area to be sample for soil is homogeneous.

So, when the soil is very homogeneous, you can gather this, you can gather the soil sample randomly. However, that can create bias if the soil area or the area of interest is not homogeneous. So, if there is a variation in the soil and if you collect randomly there is always chance of locational bias. So, this is called simple random sampling.

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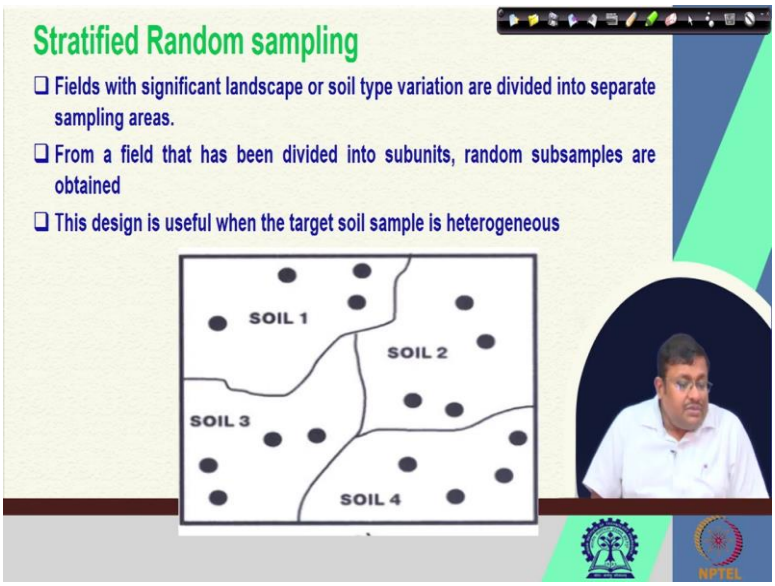

The third is stratified random sampling, what is stratified random sampling? Now, fields with significant landscapes or soil type variation are divided into separate sampling areas. So, you can see here there are significant variation in these suppose here you can see there are four zones.

So, in this for zones we can see significant variation of landscapes. So, from a field that has been divided into these sub units, we can go for random sub samples from each of these units. So, first you divide your field into some sub units based on the several features like landscape features and then you go ahead and collect the random sample from each of these subunits.

Now, this design is useful when the target soil sample is heterogeneous. So, when we go for simple random sampling that should be useful for a homogeneous area. However, in case of stratified random sampling, we should apply the stratified random sampling when the sampling area is heterogeneous.

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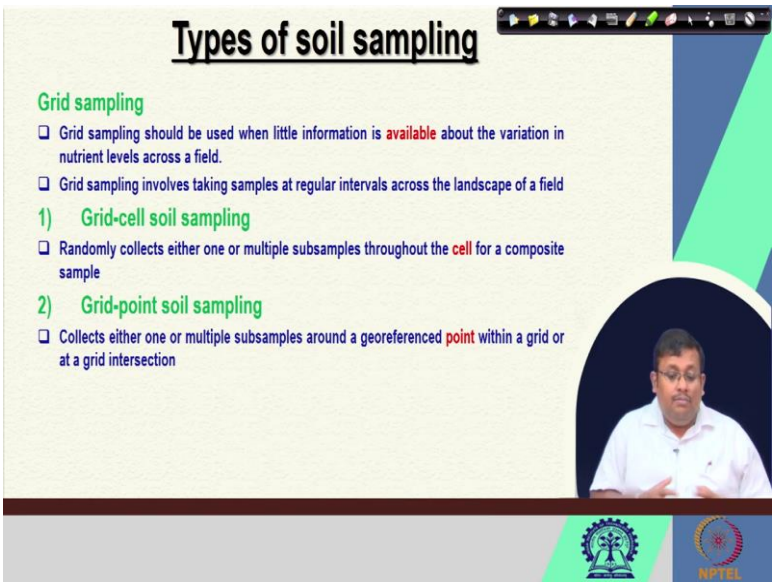

Now, there are other methods of soil sampling like grid sampling. So, what is grid sampling? Grid sampling should be used when little information is available about the variation in the nutrient level across the field. Suppose you do not know the special variability of the nutrients across the field. So, in that case, you go with the grid sampling.

Now, grid sampling involves taking samples at regular intervals across the landscape of a field. And there are two methods one is grid cell soil sampling and then grid point soil sampling. So, what is grid cell soil sampling? So, in case of grid cell soil sampling, we generally randomly collect either one or multiple sub samples, throughout the cells for a composite samples, I will show you the representation in the coming slide.

So, here in case of this grid cell soil sampling, generally, we collect one or multiple sub samples throughout the cell for a composite sample. So, we take towards the samples and then we mix them together to get a composite sample. Secondly is the grid point soil sampling. So, here, we collect either one or multiple sub samples around the geo reference points within a grid or at a grid intersections.

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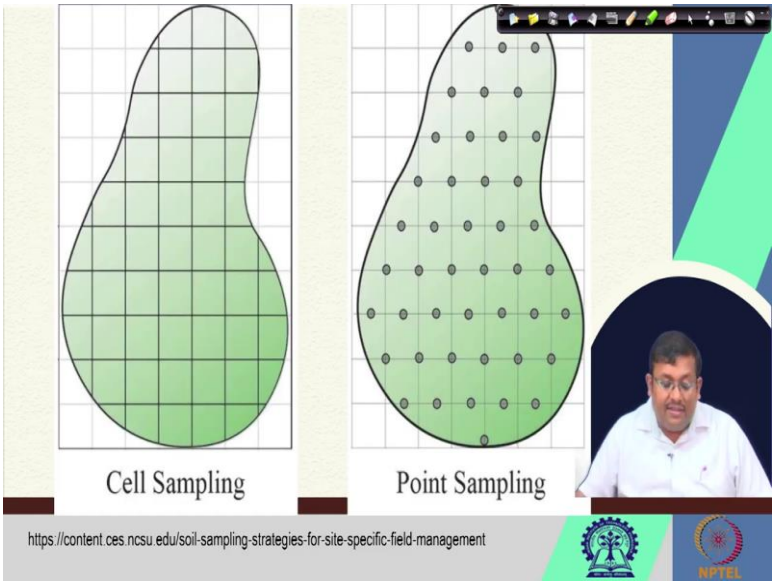

So, if we see the first figure shows the cell sampling, so, here you can see the whole area can be divided, can be divided into multiple cells, can be represented by multiple cells and within each cell, we can take two or three samples and then mix them together to get a composite samples. So, this is one. And the second is through grid points sampling. So, here you can see we are taking the samples at a particular location of the grid or at the intersection of the grids. So, this is difference between cell sampling and point sampling.

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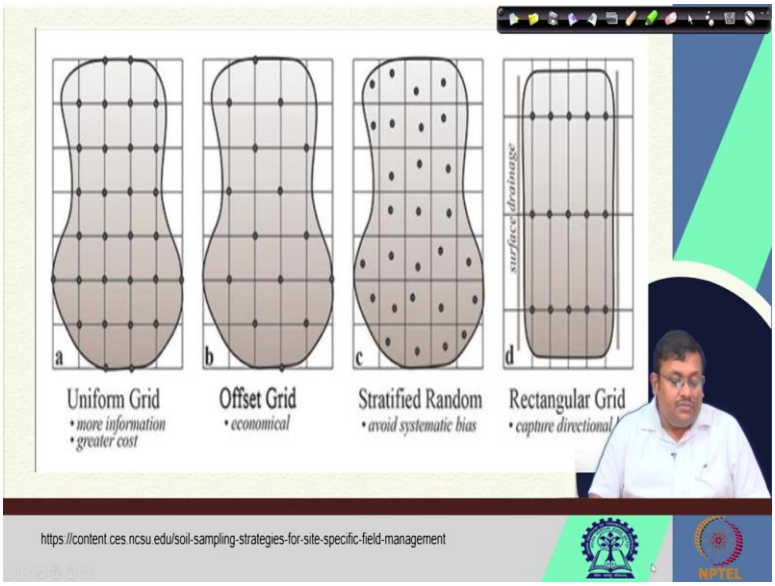

So, there are different types of grid sampling one is uniform grid, you can see of course, it gives more information and but it also involves higher cost, because we are involving so much of resources to collect these, these soil samples, which are higher in number. So, in

case of uniform grid of course, the number of samples will be more and in that case, there will be greater cost, but at the same time, we will get more information. The second one is called the offset grid, in which we are not collecting the soil samples from each of the group grid. Instead, we are taking the sample in alternate grids or in grids which are alternatively, we are taking the soil sample.

So, here you can see we are taking soil sample here in this grid and then another sample here, another sample. So, we are taking the samples alternatively, so, this is called offset grid, of course, this is economical, because as compared to the uniform grid, because in case of offset grid the number of samples are drastically reduced.

Then, we can go with the stratified random. So, in the stratified random you can see we are collecting random samples within each grid. So, to avoid the systematic bias and the third and the fourth one is rectangular grid where we are collecting the samples and we are capturing the directional bias. So, these are different grid sampling methods.

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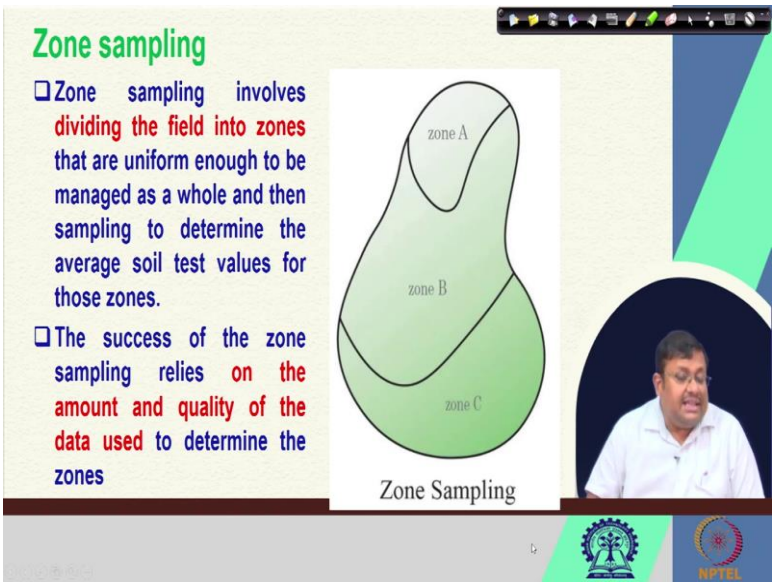

Another important concept is called the zone sampling, what is zone sampling? So, zone sampling involves dividing the field into zones that are uniform enough to be managed as a whole and then sampling to determine the average soil test values for this zone. So, the success so, what happens in case of zone sampling, we basically divide the soils into several zones which are relatively uniform and then we can do the sampling to determine the average soil test values in this zone.

So, the success of this zone sampling relies on the amount and quality of the data used to determine the zones. So, it is very important that for zoning or zone identification you should apply the highest quality data which is available. So, if you missing if you are missing some amount of area which shows or some area which shows some special variability that can create problem in cases of zone sampling. So, zone sampling should be done based on the correct data source and then once we define these zones, we can collect subsequent samples from each of these zones.

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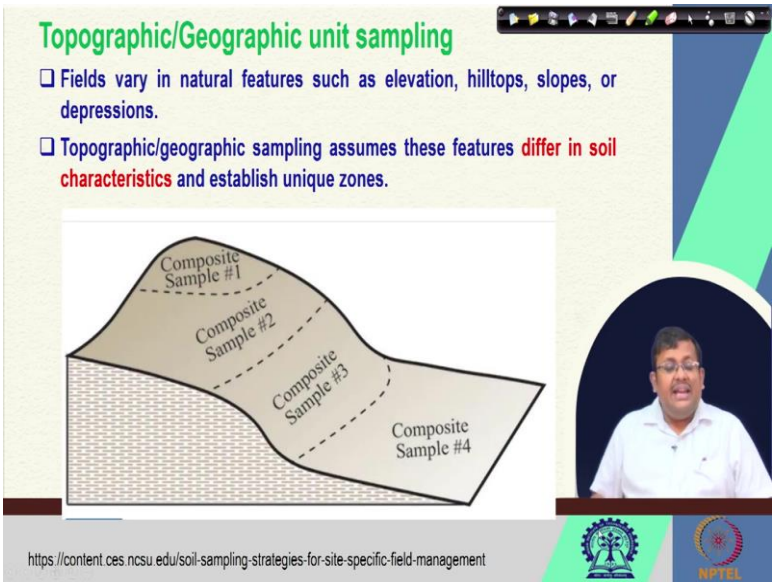

Then, another method is there that is called topographic or geographic unit sampling. So, we all know that fields vary in nature between such, in features such as elevation, hilltops, slopes or depressions. And this topographic or geographic sampling assumes that these features differ in soil characteristics and establish unique Zones.

Of course, we know that Jenny soil formation theory shows that really plays a very important role in soil formation, because variation of the relief can create different types of soils by changing the elevation. So, if we divide the fields based on their elevation and other features and then subsequently we can collect composite sample from each of these areas that will be known as a topographical geographic unit sampling.

Topographic and geographic unit sampling is also a very efficient method and gives the and also ensures capturing the variability which is occurring due to the variation of the slope. And so, these are some of the important features of soil chemical analysis and soil sampling methods.

However, in general, I will show you in our next lecture, that we generally recommend, you should collect at least 20 samples, 15 to 20 samples per hectare of area and generally, we recommend the farmers to collect the soil samples in his zig zag fashion to capture the maximum variability of the soil properties in the area of interest. So, we are going to discuss those in our next lecture, but let us wrap up this lecture with this hybrid sampling.

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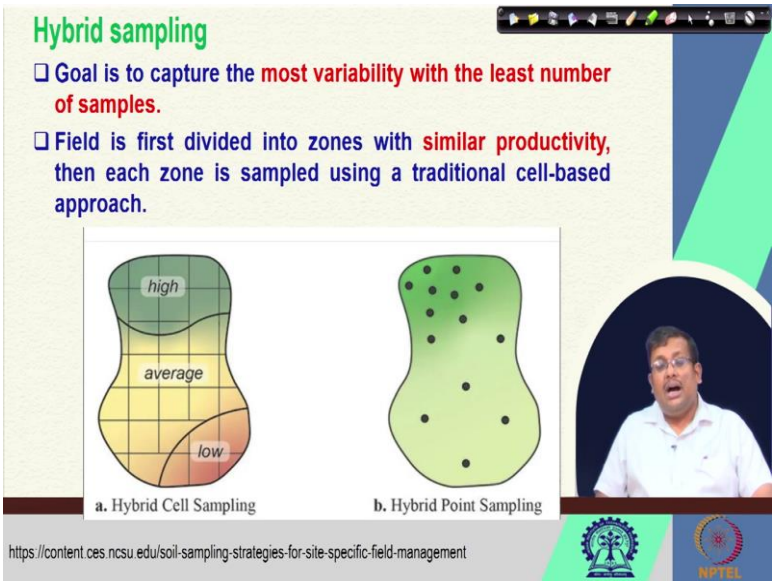

So, this hybrid sampling, the goal of this hybrid sampling is to capture the most variability with the least number of sampling. So, how we do that? So, field is first divided into zones with similar productivity. So, what do we do? So, we divide this field into several zones based on similar productivity then each zone sampled using a traditional cell based approach. So, you can see it is a hybrid approach here we are using both cell as well as the zones. So, this is a hybrid sampling approach.

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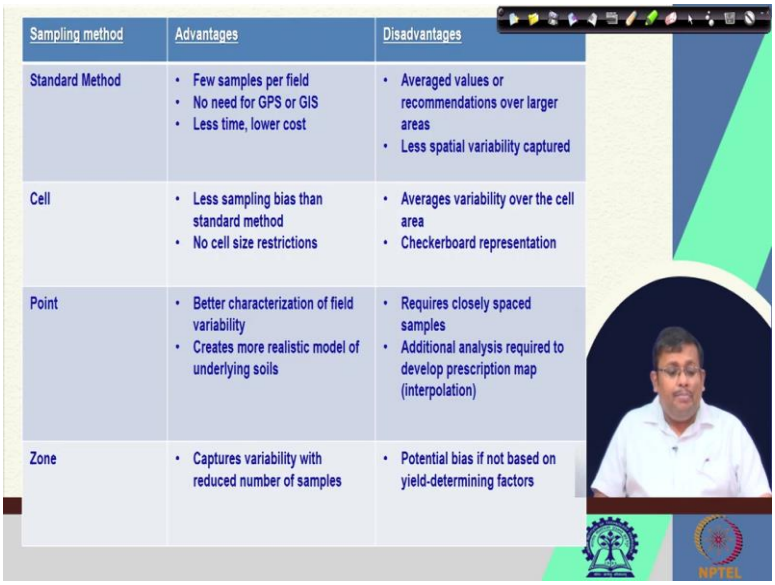

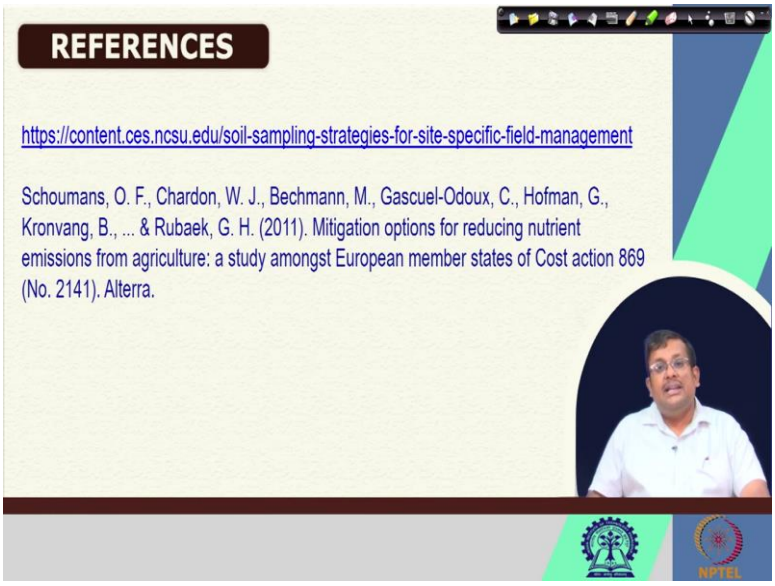

So, if we combine all these methods together what are the advantages and disadvantages? You can see in case of standard method, few samples per field are needed and no need for GPS on GIS and less time and lower cost. However, there are disadvantages first of all, average values or recommendation over larger areas. So, what generally in case a standard method they generally take a few soil samples and then analyze and then represent the whole area, but that can create several, that can create the problem of capturing the spatial variability, because for capturing the spatial variability, you need more samples.

The second method is cell based method, where less sampling bias than standard method is there and no cell size restrictions. So, these are advantages however, there are disadvantages also for example, average variability over the cell area. So, whatever the cell area it will, if it

is 2 meter by 2 meter or 1 hectare by 1 hectare, then the average variability over the cell area will be represented by one sample only. And it is also checkerboard representation.

Third one is point sampling it is better characterization of field variability and it creates more realistic model of underlying soils and what are the disadvantages, it requires closely spaced samples and additional analysis required to develop prescription map which is also known as interpolation maps.

In case of zone sampling, the advantage is it captures the variability with reduced number of samples. So, you can drastically reduce the number of samples by zone method. However, there is a disadvantage that potential bias is there, if not based on yield determining factors. So, these are several advantages and disadvantages of the different types of sampling methods.

And let us wrap up this lecture these are the references which are used for this lecture. And in our next lecture, we are going to discuss how to collect the soil samples and how to process the soil samples for subsequent analysis. Thank you.