**Soil Fertility and Fertilizers**
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**Lecture: 35**
**Soil Health and Quality, Problem Soil, Land Capability Classification (Contd.)**

Welcome friends to this 5th lecture of week 7 of NPTEL online certification course of soil fertility and fertilizers. And in this week we are talking about soil health and quality and problems soil and land capability classification.

Now, in our previous lectures we have discussed about soil degradation, what is the degradation status of world soil as well as Indian style, how Anthropocene activities can degenerate soil also we have discussed about the soil health and soil health indicators, what is soil quality what are the soil quality index? How to calculate the soil quality index? What are the linear methods and nonlinear methods of scoring and how to calculate different types of soil quality index?

And then we have discussed about the soil health card and soil implication of soil health card, what are the different aspects of soil health card and then model village program we have discussed also we have discussed about soil acidity causes of soil acidity, what are the ways through which we can manage soil acidity we have discussed.

We have also started discussing about soil affected soil what are the 3 different types of salt affected soil we have discussed like saline soil, alkali soil and saline alkali soil and what are their characteristics? How we can differentiate them and what are there ill effects we have discussed. So, in this lecture we are going to discuss how to correct the soil salinity or soil sodicity? What are the ways through which we can correct the soil salinity and soil sodicity and then we are going to discuss about phytoremediation of salt affected soils.

And finally, we are going to discuss a new thing that is land capability classification how we can classify land or designated land based on its quality? So, we are going to discuss all of these.

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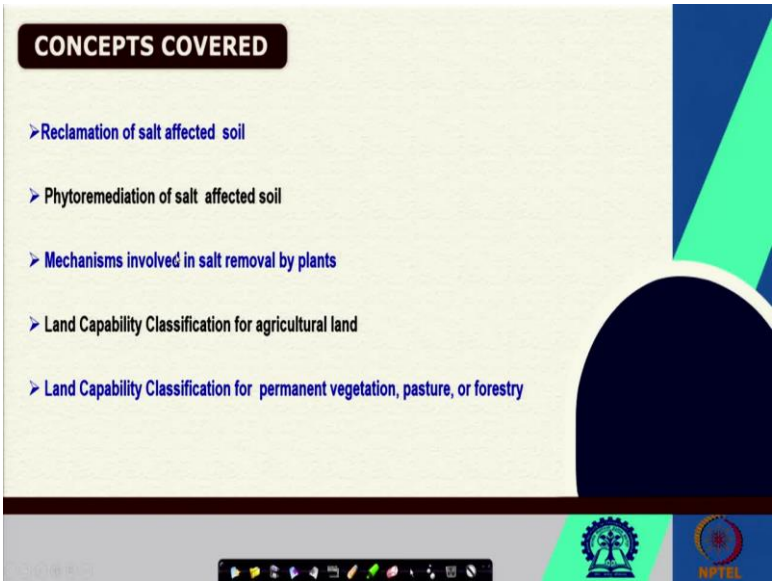


These are the concepts which we are going to cover in this lecture. First of all, reclamation of salt affected soil, then phytoremediation of salt affected soil, then mechanism involved in salt removal by plants, the land capability classification for agricultural land and then land capability classification for permanent vegetation, pasture and forestry. So, these are the concepts which we are going to cover in this lecture.

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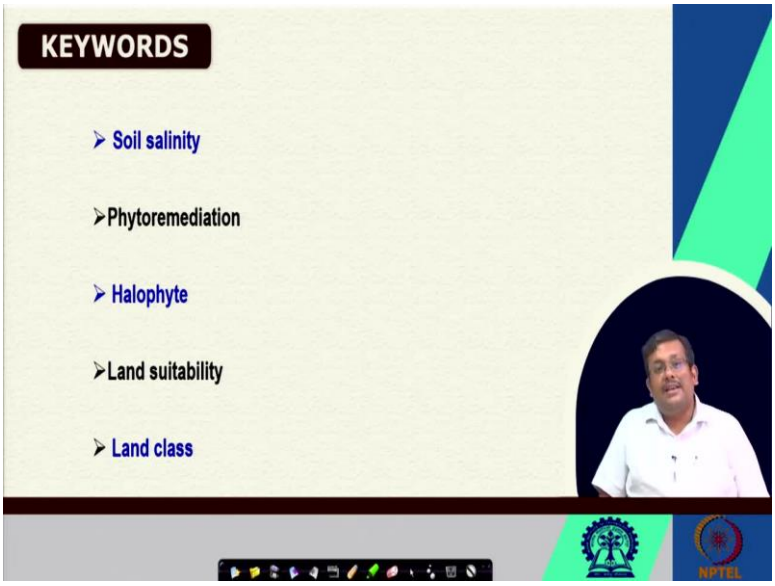


These are some of the keywords of this lecture like soil salinity, then phytoremediation, halophyte, land suitability, land class, these are some of the keywords of this lecture.

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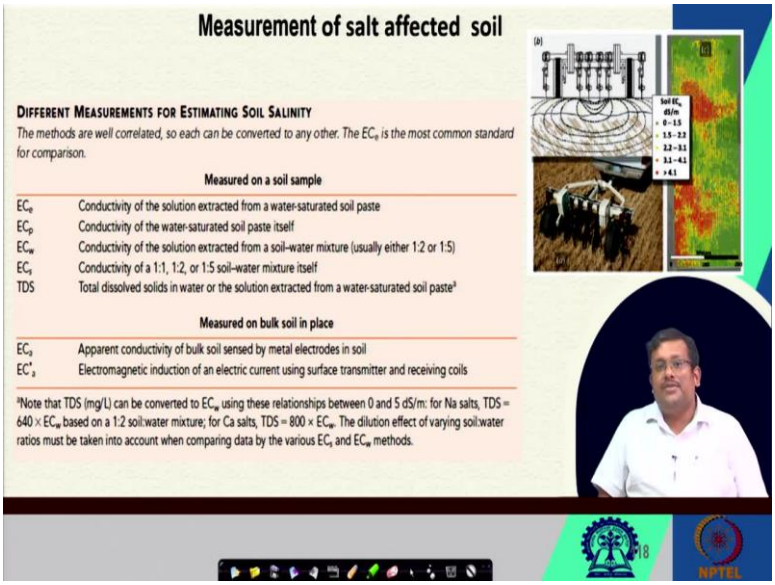


Now, if we go ahead and see what are the methods of measurement of salt affected soil? There are different ways to which we can measure the salinity of the soil. We have already discussed in our soil testing discussion, but measurement of soil samples I have again jotted down those. So, you can see that ECe represents conductivity of the solution extracted from the water saturated soil paste, then ECp is conductivity of the water saturated soil paste itself, then conductivity ECw is conductivity of the solution extracted from the soil water mixture usually either 1 is to 2 or 1 is to 5 and then EC5 is conductivity of a 1 is to 1, 1 is to 2 or 1 is to 5 soil water mixture itself.

And TDS is total dissolved solids in water or the solution extracted from a water saturated soil paste. So, these are the parameters which generally measure on soil sample and then ECa and EC star a so these are measured on bulk soil in place so ECa basically apparent conductivity or bulk soil sensed by metal electrodes in soil whereas ECa is basically electromagnetic induction of an electric current using surface transmitter and receiving coils. So, these are different ways to which we can measure the soil salinity.

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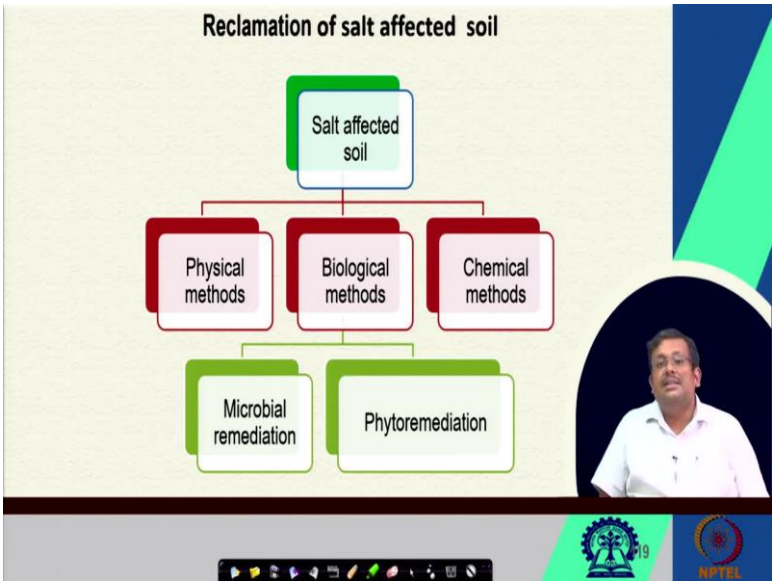


Now, let us see the reclamation of salt affected soil, if we see if we consider the reclamation of the salt affected soil, there are 3 types of methods which are important for reclaiming the salt affected soil, first of all physical methods second one is biological methods and the third category is chemical methods. Now, there are different types of physical methods or management interventions, which you can use.

However, in case of biological methods, this biological methods are of 2 types, one is microbial remediation, another one is phytoremediation. So, microbial remediation and phytoremediation, we are going to focus on phytoremediation in our upcoming slides.

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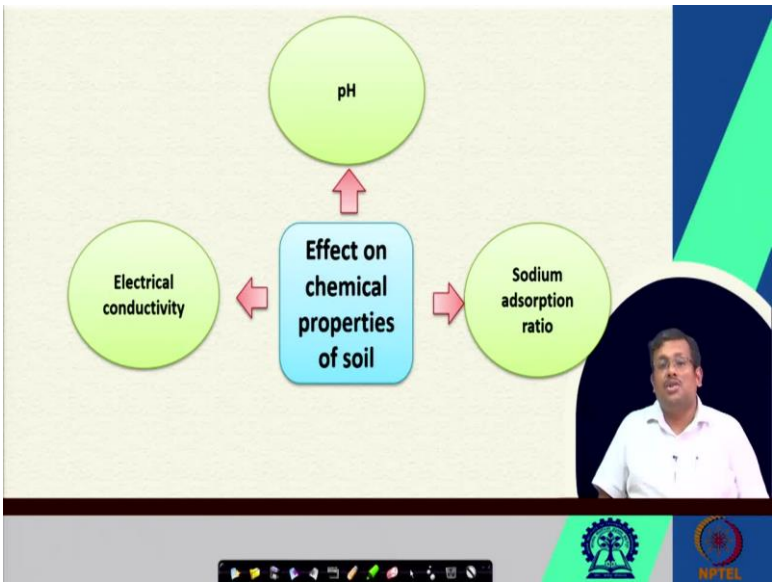

So, if you see the effect on chemical properties of the soil, we can see that salinity impacts not only the electrical conductivity, but also impact the pH and sodium absorption ratio we have already seen that. So, salinity, reclaiming salinity is of very important.

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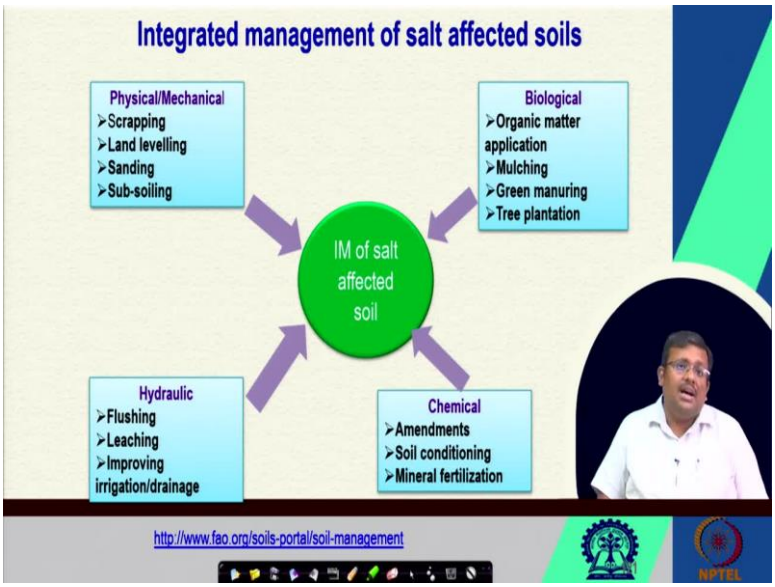


Now, if we see the integrated management of salt affected soil, there are physical or mechanical methods, there are biological methods there are chemical methods and hydraulic methods are also. Among the physical methods we can see scrapping, land leveling, sanding sub soiling these are some of the ways through which we can get rid of salt affected soil. Also, in case of biological methods we can see organic matter application just like in case of acidic soil, in case of salt affected soil also.

Application of organic matter can help in reclamation of salt affected soils. So, when we apply organic matter also mulching, green manuring, tree plantation these are some of the ways to which we can manage the salt affected soil. In case of hydraulic ways, flushing, leaching, improving irrigation or drainage are some of the ways to which we can manage the salt affected soil.

And chemical methods are amendments, application of different amendments, soil conditioning, mineral fertilization. So, these are some of the ways through which we can also manage the salt affected soils.

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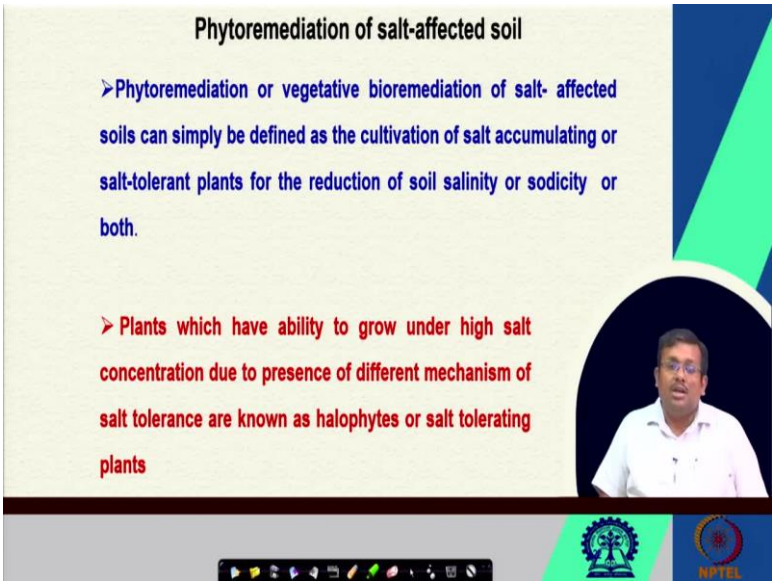


So, now, let us focus on phytoremediation of salt affected soil. Phytoremediation or vegetative bioremediation or salt affected soil can simply be defined as the cultivation of salt accumulating or salt tolerant plants for the reduction of soil salinity or sodicity or both. So, basically we generally grow some crops which are known to accumulate the salt or tolerate the salt concentration in the soil.

So, basically plants which have ability to grow under high salt concentration due to presence of different mechanism of soil tolerance are known as halophytes or salt tolerating plants. Now, if you go to the mangrove forest, you will see this halophytic plants which have developed their own physiological mechanism to withstand these high soil salinity. So, they can also use new metaphor to absorb the moisture. So, this type of modification we can see in these in this in these different plants which have grown in highly saline soils.

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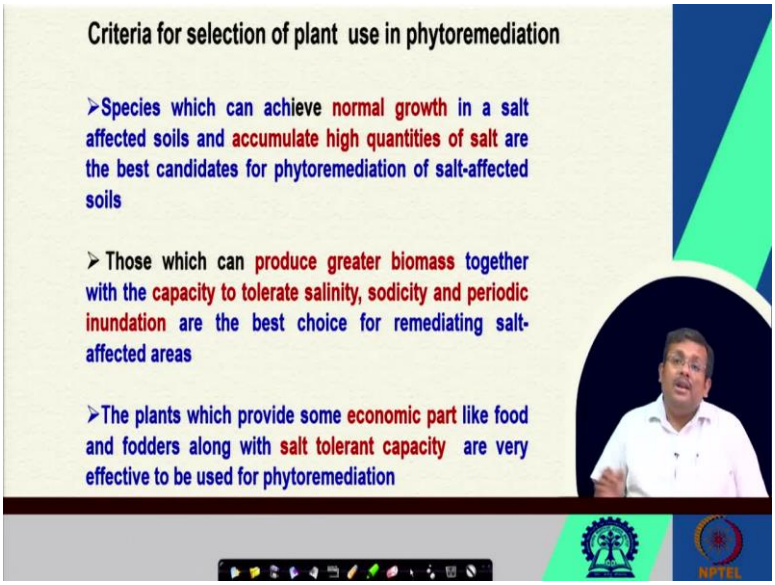


Now, what are the criteria for selecting plant use in phytoremediation? How we can select? This plant is good for salt phytoremediation. Now, species which can achieve normal growth in salt affected soils and accumulate high quantities of salt are the best candidates for phytoremediation of salt affected soils.

Those also those which can produce greater biomass, together with the capacity to tolerate salinity, sodicity and periodic inundation are the best choice for remediating salt affected areas. Finally, the plants which provides some economic part like food and fodders along with salt tolerant capacity are very effective to be used for phytoremediation. So, these are some of the criteria for selecting the plant for phytoremediation of salt affected soils.

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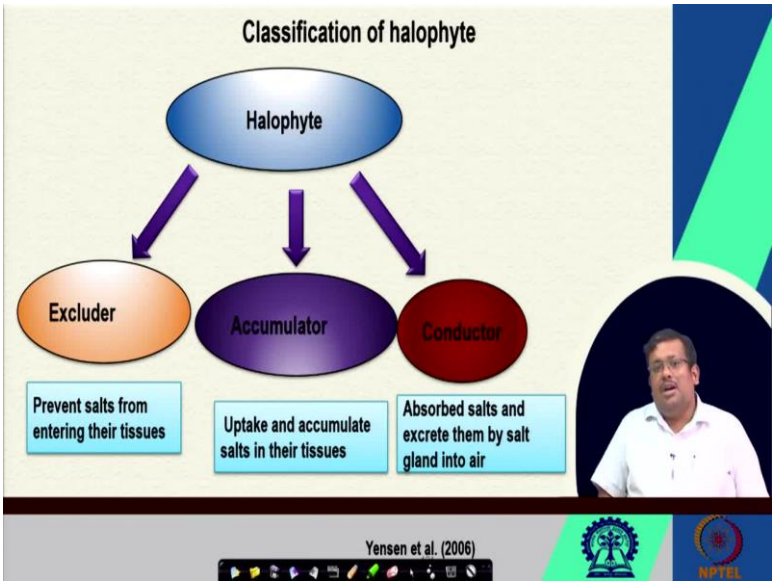

Now, the halophyte or salt reclaiming plants can be classified into 3 categories one is excluder, second is accumulator and third one is conductor. What are the excluder? Excluder are those plants which prevent salts from entering their tissues. Secondly, accumulators which uptake and accumulate salts in the tissues and third one is conductor which absorb salts and excrete them by salt gland into air.

So, the excluder can prevent the entry of the salt, accumulator can accumulate in the tissues and conductor can remove or excrete the salt by salt gland into air. So, these are some of the ways through which halophyte can operate.

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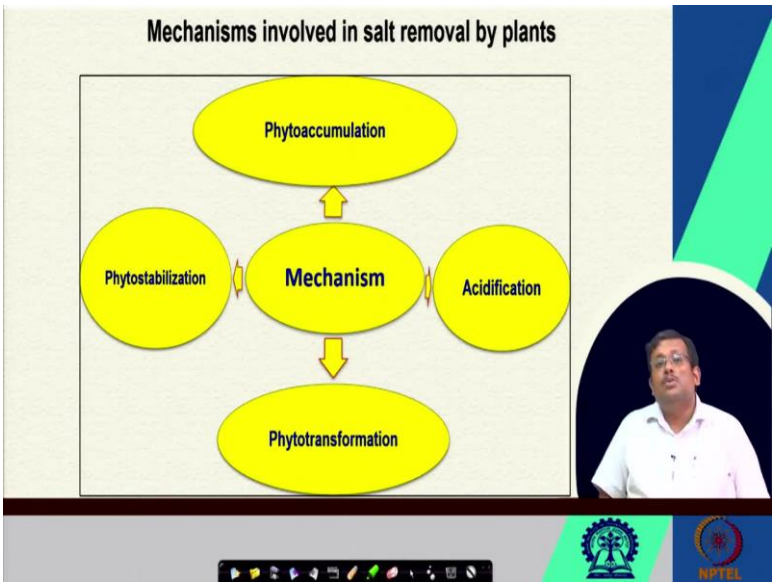


Now, what are the mechanisms which are involved in salt removal by plants? Phytoaccumulation, acidification, phytotransformation, and phytostabilization, these are the 4 methods through which the plants can reclaim the salt affected soil.

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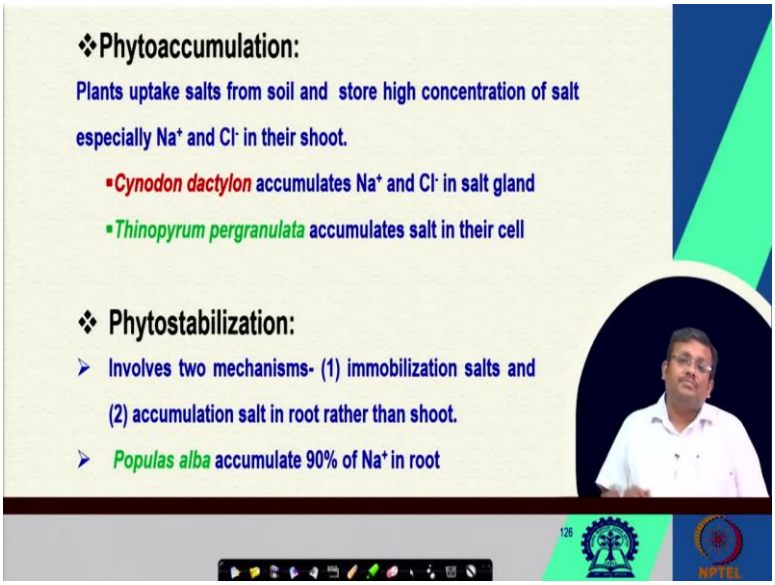


Now, let us discuss them one by one. Let us first discuss what is phytoaccumulation? Now plant uptake salts from soil and store high concentration of salt especially sodium and chlorine in their shoot in the ionic form. For example, cynodon dactylon accumulate sodium and chlorine ions in salt gland. Also, thinopyrum accumulates salt in their cell.

Phytostabilization, what is phytostabilization? So phytostabilization involves 2 mechanisms. First of all, immobilization of salts and accumulation of salts in root rather than in shoot. For example, populas alba is a plant which can accumulate 90 percent of the sodium in the root rather than in the shoot. So, this is an example of phytostabilization.

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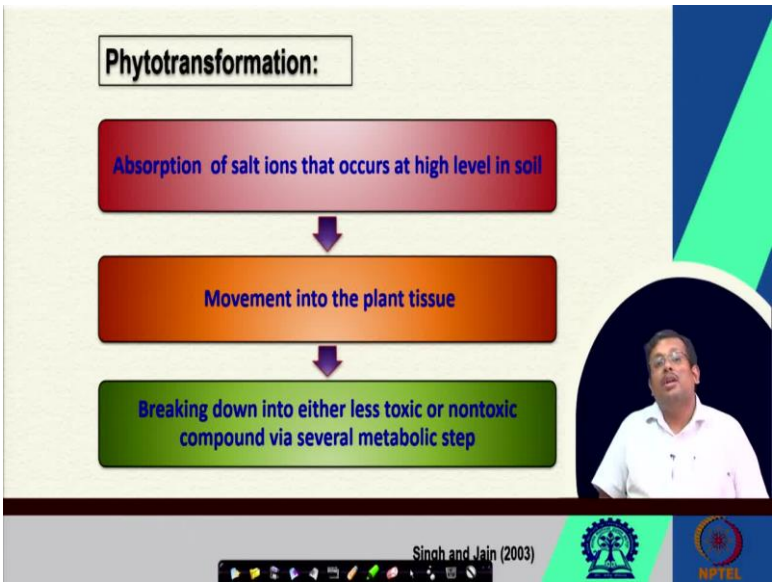

Phytotransformation is absorption of soil times that occurs at high levels in soil and then the salts move into the plant tissue and then finally breaks down into either less toxic or non-toxic compound via several metabolic steps. So, this is the way through which phytotransformation works.

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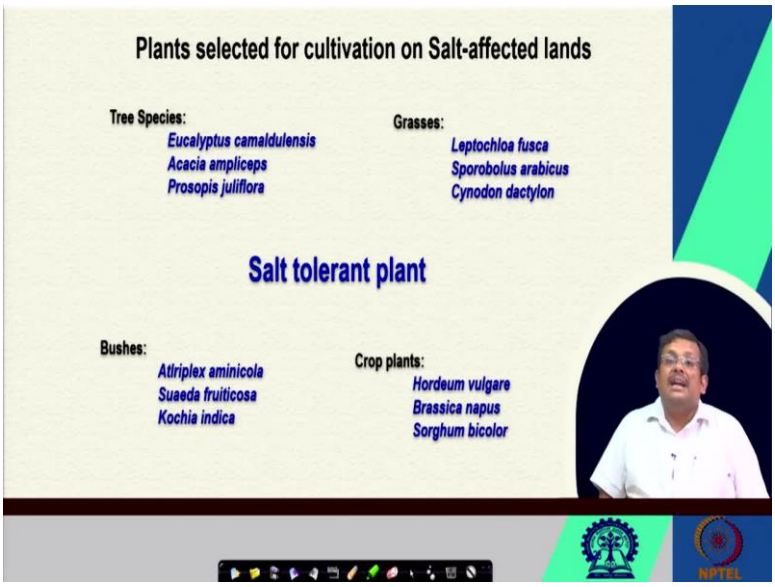


Now, let us see some examples of the plants which are selected for cultivation on salt affected lands. If we consider the tree species eucalyptus, acacia, prosopis these are some of the examples of tree species or trees which can grow in salt effective soils in case of grasses leptochloa and then sporobolus, cynodon these are some of the grasses which can grow in the salt affected soil.

In case of bushes, you can see atlriplex, then suaeda and kochia these are some of the bushy plants which are known for their salt tolerance. And in case of crop plants, we can see hordeum vulgare then brassica and sorghum these are some of the crop plants by the way, I must also tell you that rice is a salt tolerant plant some of their varieties of rice can tolerate high salt concentration in the soil. So these are some of the plants these plants which are selected for cultivating in the salt affected lands.

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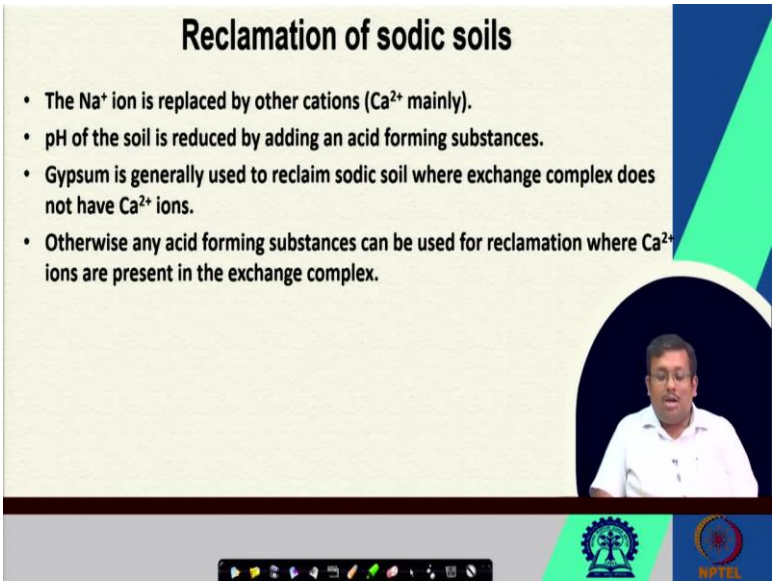


So, far we have seen different reclamation measures for saline soil. Now, let us also discuss the how to reclaim the sodic soils? Now, the major principle of reclaiming the sodic soil is replacing the sodium ion with calcium ion. Now, the pH of the soil is can be reduced by adding an acid forming substance. So, Gypsum is generally used to reclaim sodic soil where exchange complex does not have calcium ions.

So, when we apply gypsum that can help in replacing the sodium by calcium in the exchange complex. Otherwise, any acid forming substance can be used to reclaim where calcium ions are present in the exchange complex. So, there are different types of acid forming substances which you can also apply to reclaim the sodic soil where calcium ions are present in the exchange complex. So, there are different ways through which we can reclaim the sodic soil.

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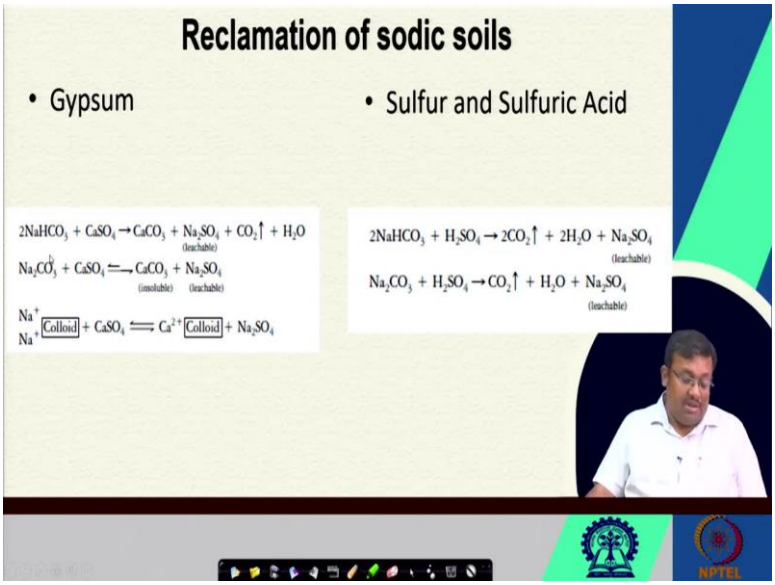


Here you can see the examples of reclamation of sodic soil by gypsum. So, here sodium bicarbonate when it reacts with calcium sulfate or gypsum, it produces calcium carbonate sodium sulfate carbon dioxide, which escapes into the atmosphere and water and this calcium sulfate reacts with sodium carbonate to produce calcium carbonate and sodium sulfate.

So, these calcium sulfate reacts with these colloidal surface removing the sodium to produce these… and then replacement of the sodium can be done by this calcium ion and thereby stabilizing the soil and thereby reclaiming this sodic soil.

Also addition of H2SO4 can react with sodium bicarbonate to produce this sodium sulfate and also sodium carbonate can react with H2SO4 to produce the sodium sulfate. So, ultimately that impact in the reclamation of sodic soil.

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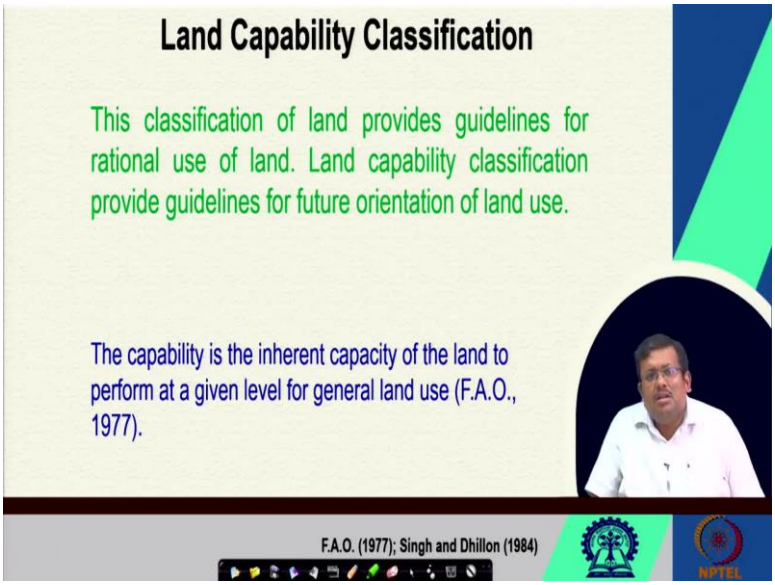


Now, let us discuss the last concept of this week 7 that is land capability classification. Now, this classification of land provides guidelines for rational use of land. So, land capability classification provide guidelines for future orientation of land use. So, the capability is the inherent capacity of the land to perform at a given level for general land use.

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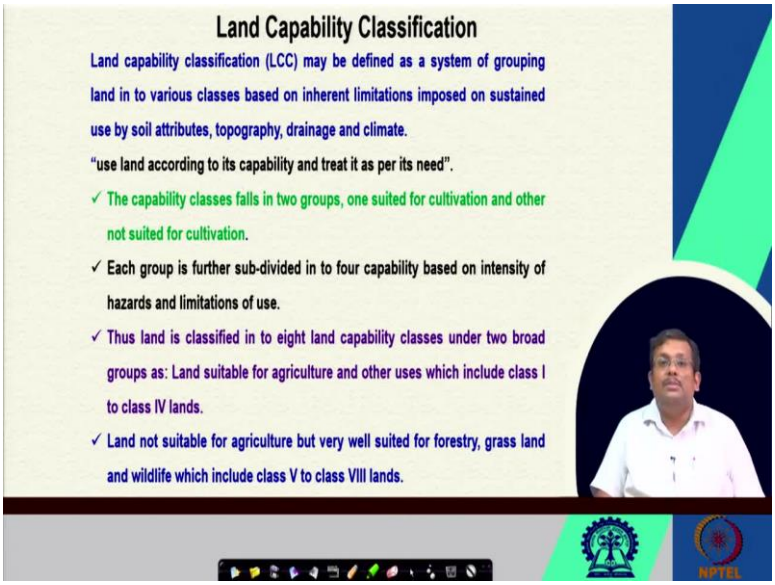


So, let us see what is land capability classification? So, land capability classification is defined as a system of grouping land in to various classes based on inherent limitations imposed on sustained use by soil attributes, topography drainage and climate. So, the motto of these or the objective of this land capability classification is used land according to his capacity and treat it as per its need.

So, the capability classes falls into groups one suited for cultivation and other is not suited for cultivation. Each group is further subdivided into 4 capability based on intensity of hazards and limitation of use. Thus, land is classified into 8 land capability classes under 2 broad groups as land suitable for agriculture and other uses which include class 1 to class 4 lands.

And then the other category that is land not suitable for agriculture but very well suited for forestry, grassland and wildlife which include from class 5 to class 8 lands.

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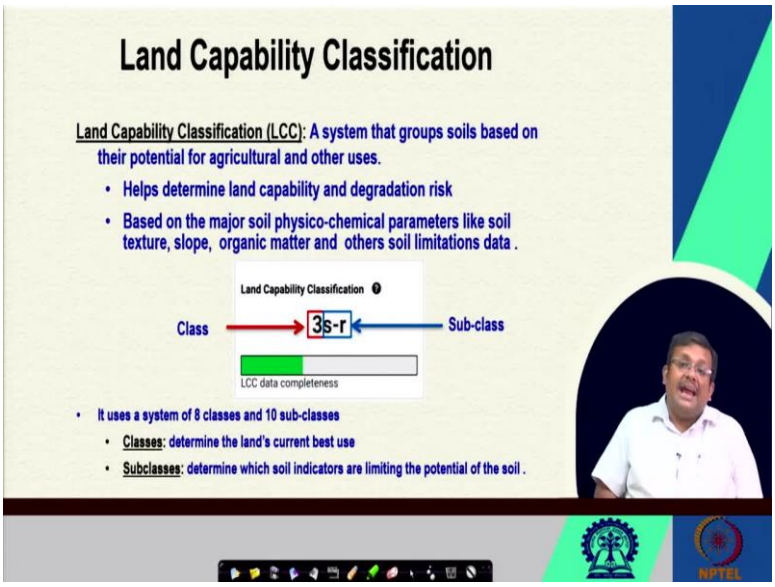


So, this land capability classification is basically system that groups soils based on their potential for agriculture and other users. What are the other benefits? Because it helps determine land capability and degradation risk. It is based on the major soil physio chemical parameters like soil texture, slope, organic matter and other soil limitations data and it uses a system of 8 classes and 10 sub classes.

Classes basically determine the land current best use and subclasses determine which soil indicators are limiting the potential of the soil. So, if you see here, this land capability classification can be divided into 2 part one is class, which shows the lands current best use, whereas subclass which shows which soil indicators are limiting the potential of the soil.

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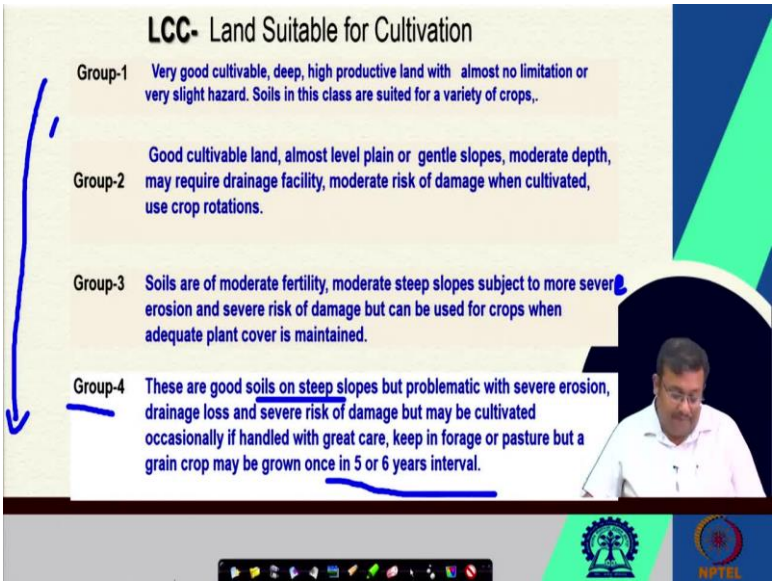


So, let us see some examples. So, the first group is land suitable for cultivation, here you can see from group 1 to group 4. So, group 1 says it is a very good cultivable deep highly productive soil land with almost low limitation or very slight hazards. Soil in this class are suited for a variety of the crops.

Group 2 shows good cultivable land almost level plain or gentle slope, moderate depth, may require drainage facility, moderate risk of damage when cultivated a use crop rotation. So, in this in this group 2, it is recommended to use the crop rotation. It is these are generally good cultivable land, almost level plains to gentle slopes, they have moderate depth, may require some damage facility, moderate risk of damage when cultivated.

Now, group 3 shows, soils are moderate fertility, moderate steep slopes, subjected to more severe erosion, severe erosion and severe risk of damage, but can be used for crops when adequate plant cover is maintained. So, we can see that these group 3 shows moderate fertility, moderate steep slopes, subject to more severe erosion and severe risk of damage, but also can be used for crops when adequate plant cover is maintained.

Group 4 land is basically showing these are good soils on steep slopes, but problematic with severe erosion then, drainage loss can also add severe risk of damage, but may be cultivated occasionally handled with great care, keep in forage or pasture, but a grain crop may be grown or once in 5 to 6 years interval.

So, one thing is that as we are going from group 1 to group 4, the number of limitations are growing from group 1 to group 4. So, if we compare these 4 groups of course, these group 1 is the ideal group of soils as per this land capability classification.

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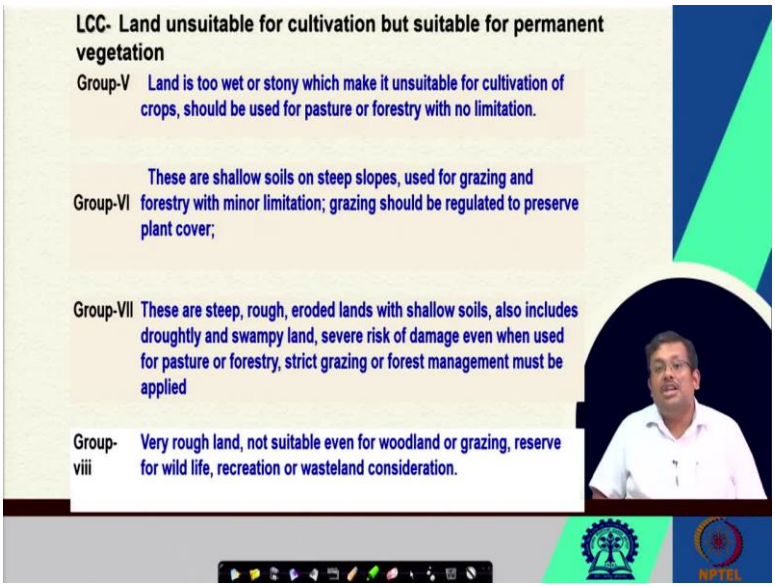


Now, let us see the land which are unsuitable for cultivation but suitable for permanent vegetation. Now, group 5 is basically land which is too wet or stony, which makes it unsuitable for crop cultivation and also should be used for pasture or forestry with no limitation. Group 6 shows these are shallow soils on steep slopes. These are used for grazing and forestry with minor limitation and grazing should be regulated to preserve plant cover.

Group 7 shows these are steep, rough, eroded lands with shallow soils also includes droughtly and swampy lands, severe risk of damage even when use for pasture on forestry, strict grazing or forest management must be applied and last group is, group 8 which indicates very rough land, not suitable even for woodland or grazing, reserves for wildlife and recreational or wasteland consideration can be done in this type of soil.

Again we can see that, among these 5, 4 groups of lands also we can see that as we are moving from group 5 to group 8, their limitations are also increasing.

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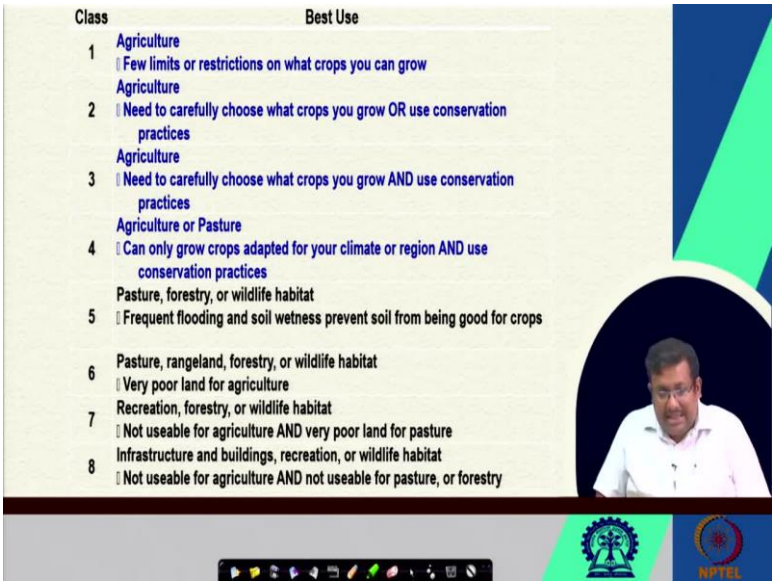


So these are some of the ways through which I mean these are the bases using what using, using these bases we have classified the soils into 2 major categories of suitability for crops and also suitability for permanent vegetation and then we are also subdividing them into other categories. So, category 1 to category 4 are useful for crop cultivation.

However, category 5 to category 8 are useful for permanent vegetation. Now, if we see the class 1 to 8 of course, we can see the best use, so, class 1 shows the best use is agriculture class 2 also so, class 1 to class 3, the best use is agriculture. For class 4 best use is agricultural pasture for group 5, class 5 pasture forestry or wildlife habitat, group 6 pasture rangeland, forestry or wildlife habitat.

Group 7 recreation, forestry or wild life habitat and group 8 infrastructure and building, recreation or wildlife habitat. So, see you can see that depending on the class variation, how the suitability of the soil for agriculture and other practices are vary. So, these group 8 or class 8 basically do not it is not usable for agriculture and not usable for pasture or forestry also.

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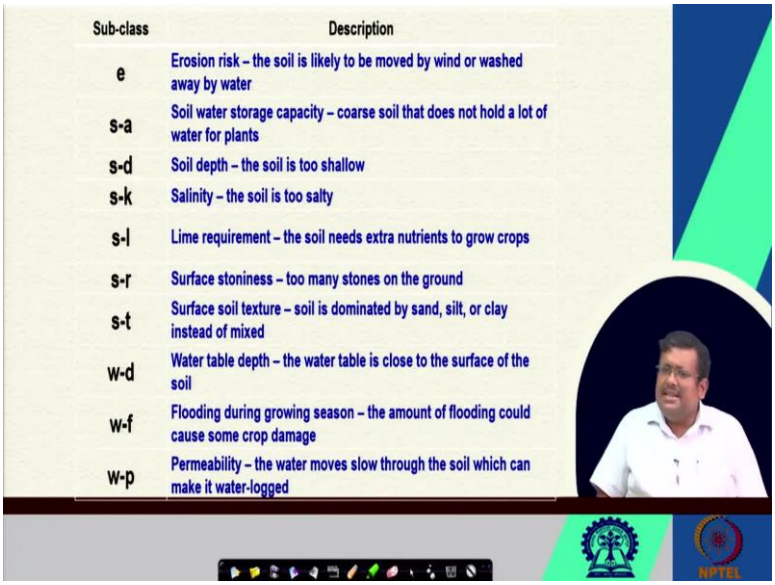


Now, we have also discussed about subclasses. So, let us see some examples of subclasses. Whenever we talk about e that shows the erosion risk that is the soil is likely to be moved by wind or washed away by water and then s-a, this stands for soil water storage capacity and s stands for the soil water storage capacity and this is coarse soil that does not hold a lot of water for plants.

Soil s-d is basically limiting factor the soil depths so the soil is too shallow, s-k is basically a limiting factor salinity so, the soil is too salty, s-l is basically lime requirement so, the soil needs extra nutrients to grow crops, s-r surface stoniness, too many stones on the grounds, s-t surface soils textured soil is dominated by sand silt or clay instead of mixed, w-d water table depth is the major constraint so, the water table is close to the surface of the soil, w-f is flooding during growing season the amount is a major constraint. So the amount of flooding could cause some crop damage and w-p is the permeability is the major limiting factors the water moves slow through the soil which can make it waterlogged.

So, these are the description of different subclasses under the land capability classification.

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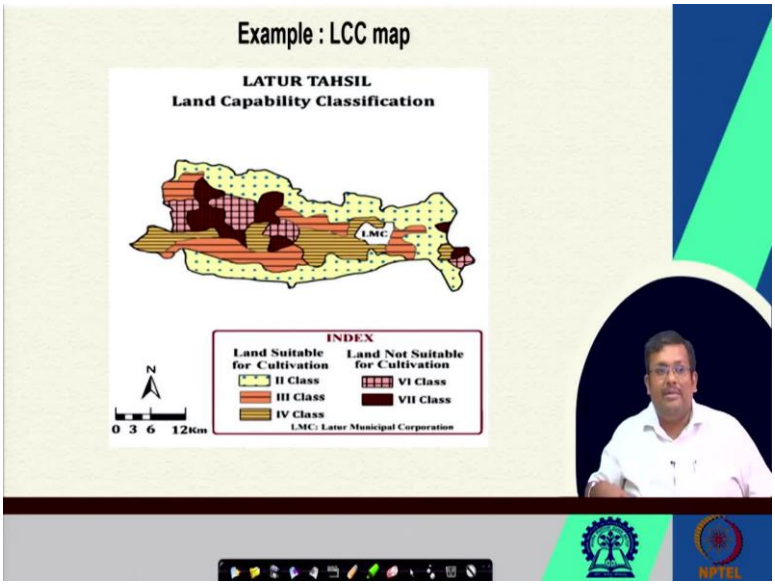


So, guys, it is now clear for to us that based on the land capability classification, how we can justify and also map the suitability of the land for a particular purpose. As you can see here, this is the Latur Tehsil of India. And you can see that land capability classification based map of this Latur Tehsil is there.

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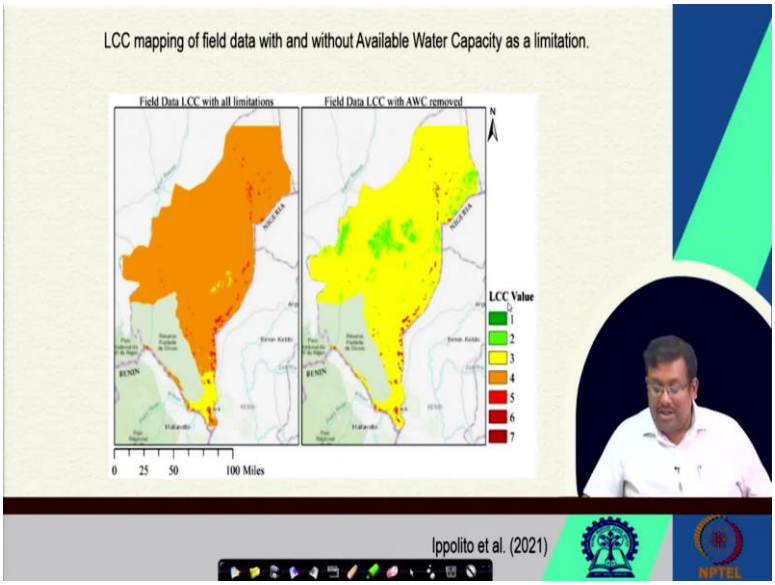


Also you can see these land capability classification mapping of the field data with or without available water capacity as a limitation. So according to these land capability classification, we can see from class 1, to class 7.

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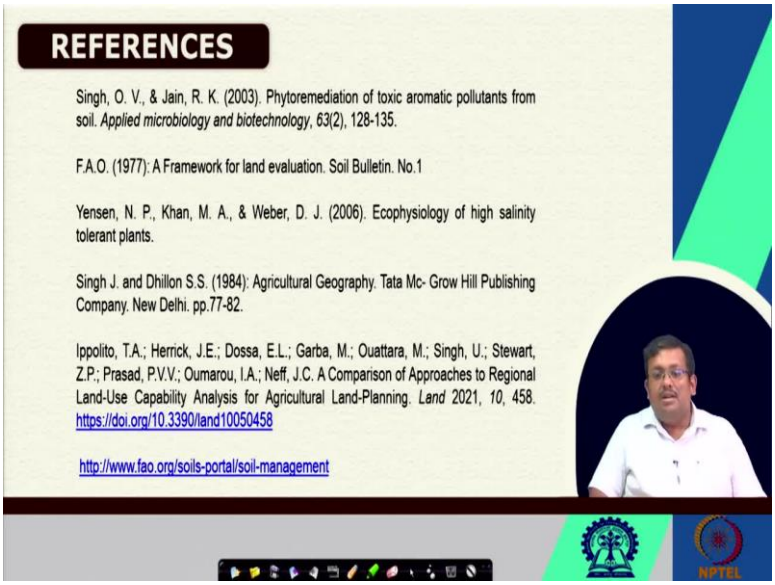


So this gives you an idea about land capability classification add its major impact, I hope that you have gathered some good knowledge from this good knowledge from this lecture. And now what is land capability classification is clear to all of you. And let us wrap up this week 7. And if you have any question, please feel free to let me know or let or post it in the forum so that we can answer your queries. Thank you very much.