Irrigation and Drainage
Prof. Damodhara Rao Mailapallli
Department of Agricultural and Food Engineering
Indian Institute of Technology, Kharagpur

Lecture - 01
Introduction

Hello friends welcome to the NPTEL course on Irrigation and Drainages. So, I am Damondhara Rao Mailapallli, I am an assistant professor in Agricultural and Food Engineering Department IIT Kharagpur.

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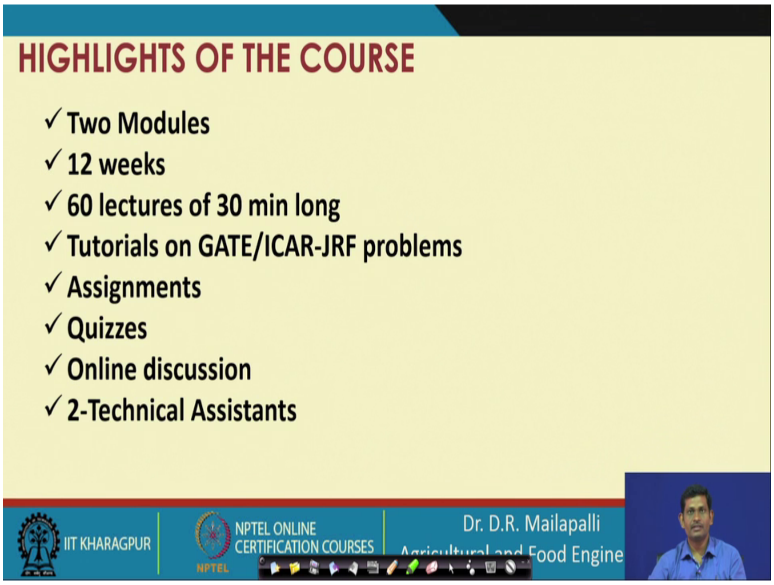

So, in this course the highlights of the course includes; so, we going to have two modules. So, one on irrigation, then the other one is on drainage. So, and then it is going to be 12 weeks course and each week we are going to cover 5, 30 minute lectures.

So, all together it will be like 60 lectures and also we going to have a tutorials on GATE ICAR JRF problems at the end of each week so; that means, the 5th lecture in a week will contain the tutorials. So, that will be talking about solving some GATE or ICAR JRF I mean problems. So, then it contains assignments to give hands on you know training to the students and also the quizzers

So, update the course or other to update the previous weeks, you know the syllabus of previous weeks course content. And then a online discussion, if you have any questions or any enquires. So, we can have like discussion online. So, then we going to have two technical assistants to support in this discussion so, they are my PhD students.

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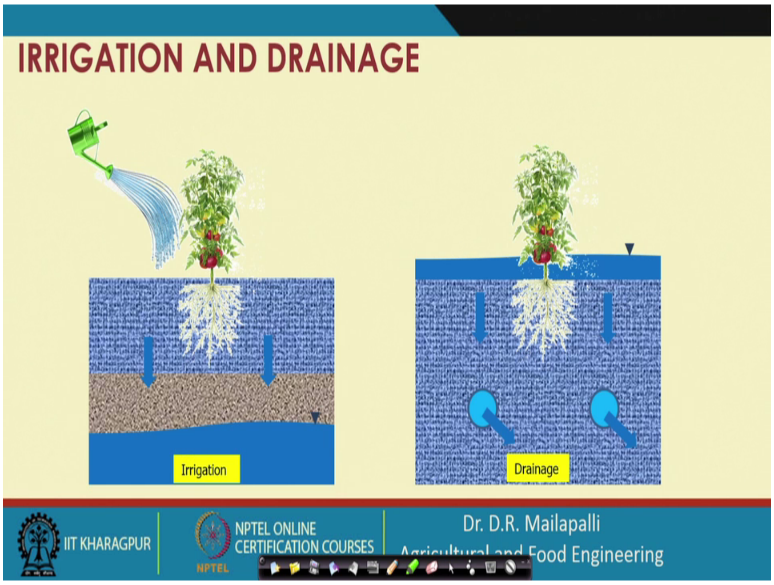

So, what exactly is the irrigation and drainage? So, if you see in the agriculture fields. So, the two cases you can really see in, the first case there is a dry field and the other case will be like a wet field contains some water pounded on surface.

So, in case of dry case; so, it does not means that the water is not there, in a in the surface or definitely there is a water within the soil profiles. So, that is called the groundwater. So, if the groundwater is needed to the surface and the plants are grown in the fields.

So, you need not give irrigation to the plants because, plants can extract water from the root zone, or from the water table ok. So, since the water table is you know deeper. So, we need to give water artificially on the surface. So, that the water will penetrate into this soil and available to the plant whereas, in other case.

So, that is and in drainage case what happens the fields are pounded with water always. So, in order to grow crops in that particular you now piece of land, you need to take up the water excess water from the surface. So, how do you do that, you can either you can provide the channel, or they cut the field on the surface or you can provide some you know the subsurface drainage pipes

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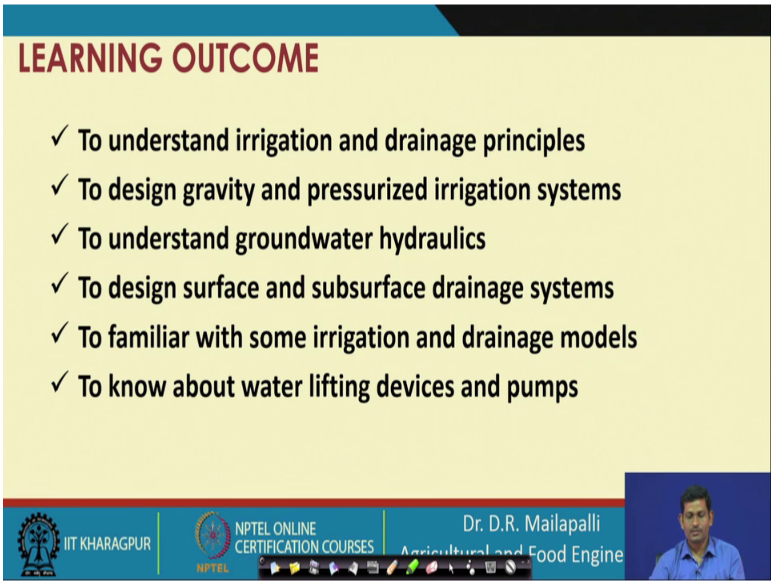

So, that the water will penetrate all the way though this and then so, that is the major difference between irrigation and drainage. So, the irrigation case you provide water artificial on this soil surface whereas, in the drainage case you take out the excess water, which is pounded on the surface by providing the detailed drainage in the surface I mean underground.

So, a in the both cases so, all object is to give suitable you know environment to the plants to grow. So, that is the major goal in both irrigation and drainage. So, the landing out come in this course includes, the to understand irrigation and drainage principles this is important to understand, or to design an irrigation or drainage system. And to design gravity and pressurized irrigation systems.

So, if you are talking about irrigation so, will be surface irrigation where you provide water on the surface by gravity force, you need not use any pump to pump the water, where as in pressurized irrigation system for example, in case of micro irrigation or drip irrigation you need to pressurized the irrigation.

So, that water can penetrated to the smaller forces which is in the dripper or you can say this sprinklers ok, you need pressure for that. And to understand the groundwater hydraulics.

So, this is important to understand how water flows from you know the surface to the drains in case of drainage. And to design surface in subsurface drainage systems so, once you understand the governing equations and the principles. So, you will able to design surface in subsurface drainage systems. And to familiar with some irrigation drainage models so, there are models available to simulate irrigation and the drainages cases.

So, we are doing to discuss about those and to know about water lifting devices and pumps. So, you have water undergrounds so, how to tab the water using and pumps. So, that we are going to (Refer Time: 06:20) in this.

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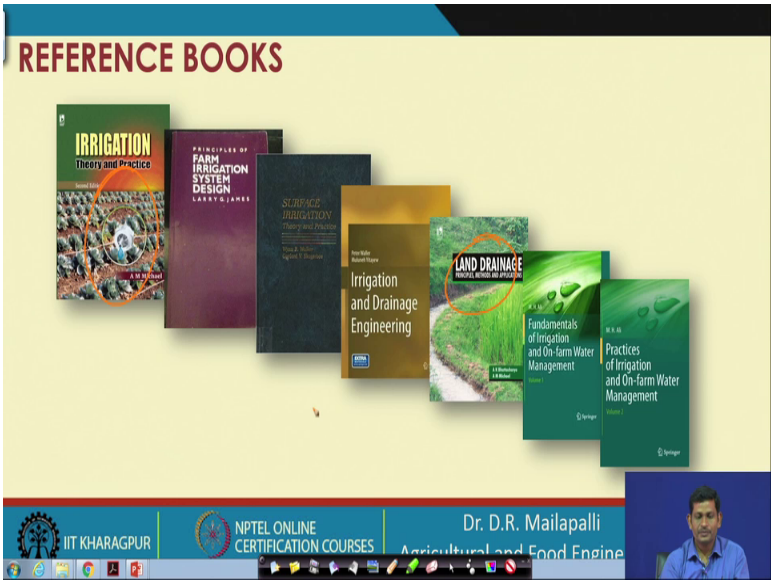

And the reference books there are seven reference books available, but mostly we will be focusing on I mean; So, this irrigation theory and practice by a Michael and, then land dryness which is by Bhattacharya and Michael. And there are other foreign additions you can go throw.

So, in order to you know understand the principles.

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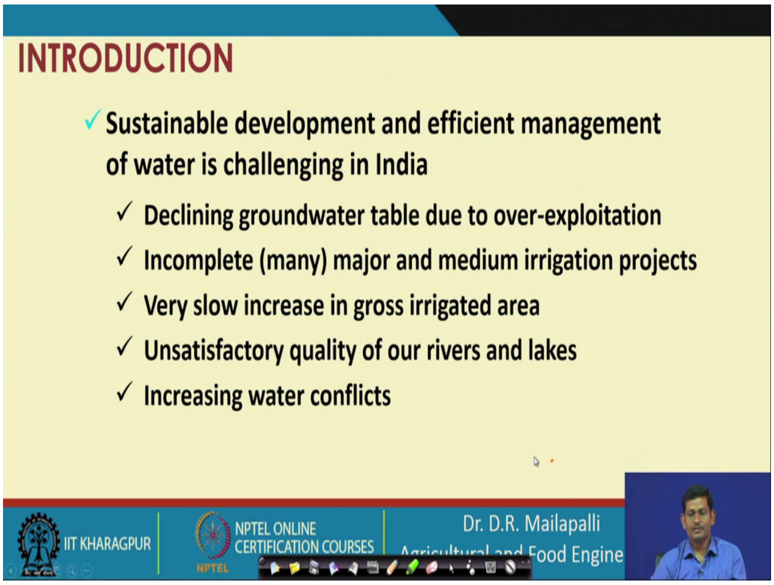

This a sustainable development so, if you coming into the introduction. So, are the efficient management of water is challenging in India because, the water tables is getting declining day by day due to the over exploitation of water for drinking and irrigation purpose. So, that really burden a farmer to tap water from the deeper, you know aquifers; So, and also incomplete or major and medium irrigation projects.

So, the many projects are you know under construction, or even in the pending projects so, because of in political or you know financial status. So, they are not able to you know finish in time. So, and very slow increase in gross irrigated area so, in every budget so, in the government budget you are providing lot of you know funds for irrigation, but the thing is the amount of funds you are pouring in irrigation, it is not helping in increasing the gross irrigated area. And then the quality of water in rivers and lakes are degrading day by day and increasing water conflicts.

So, it is not only within India and across the in the country, countries like neighboring countries for example, India and Pakistan, India and Nepal India and Bangladesh. So, you have lot of water conflicts and with in India for example, Tamil Nadu and Karnataka, Maharashtra and Andhra so, there now Telanganna. So, the conflicts are increasing so, because of this. So, the water management is really challenging in India.

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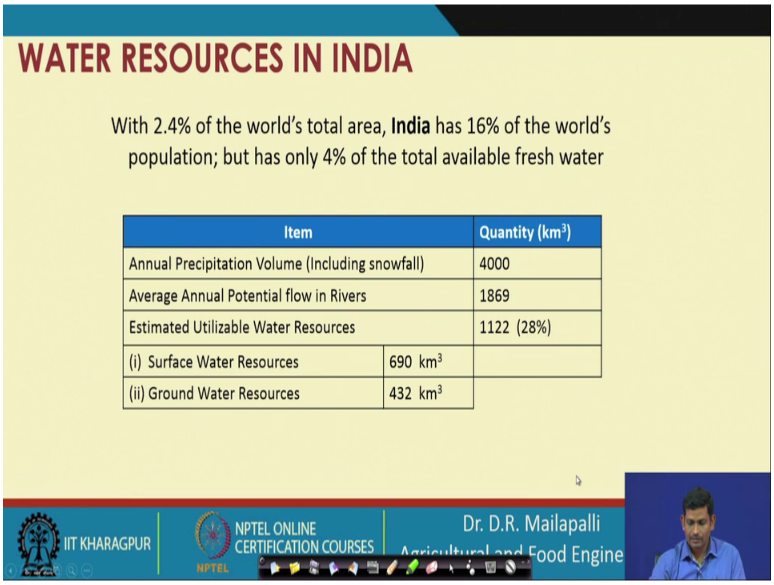

Then though India has 16 percentage of world's population, but as only four percentage of the total available fresh water if you see this table.

So, we have like the annual precipitation, we receive from rain fall including snow fall. So, around four thousand kilometer cube, but the average annual potential flow in rivers. So, this only 50 percent almost 50 percent is of that and utilizable water resource could be 28 percentage deserve annual precipitation and, surface and ground water is kind of you know like 70 percent.

You see the water availability or water resources in India so, we are receiving the annual precipitation about 400 kilometer cube, the average potential flow in rivers is almost a 50 percent whereas, the estimated you know utilizable water resources. So, that is about 28 percentage deserves annual precipitation volume and, the utilizable is classified as surface and ground water resources.

So, the surface water resources are around 60 percent and, where as ground water about 40 percent something like that and ok. So, the next is per capital water availability in India. So, this table shows per capital water availability which is declining but with increasing population.

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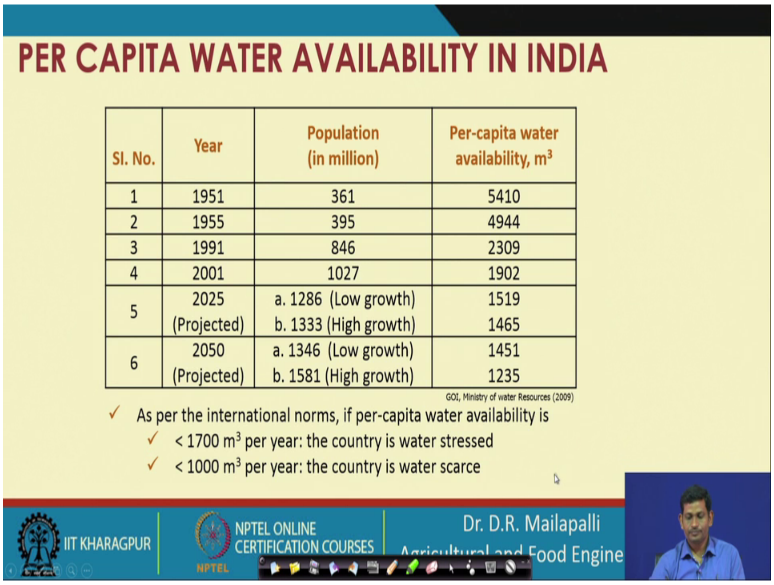

Sl. No.	Year	Population (in million)	Per-capita water availability, m^3
1	1951	361	5410
2	1955	395	4944
3	1991	846	2309
4	2001	1027	1902
5	2025 (Projected)	a. 1286 (Low growth) b. 1333 (High growth)	1519 1465
6	2050 (Projected)	a. 1346 (Low growth) b. 1581 (High growth)	1451 1235

But if you see this as per the international norms per capita water availability, if it is less than I mean if it less than 17000 metric cube per year per capita, the country is under water stressed. If it is less than 1000 metric cube per year the country is water scarce. So, if you see this numbers we are going to heat the water stressed condition and, in feature the water scares condition very soon.

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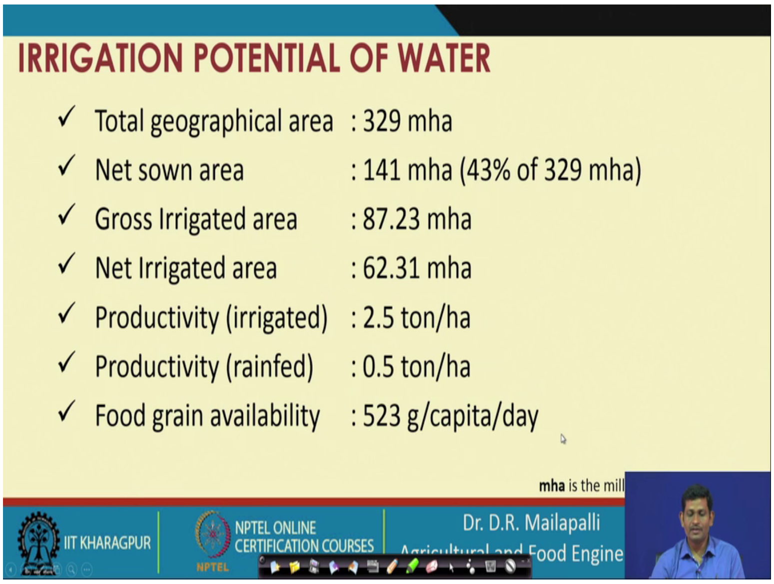

And the irrigation potential of water so, the total geographical area of India is 329 million hectares and, the net sown area 141 million hectares is 43 percentages of 329 million hectares. So, this is what the net sown area; So, and then the gross irrigation area. So, that is 87.23 million hectares and the net irrigated area 62.31 million hectares so, the so the gross irrigated areas.

So, net irrigated area the difference is [vocalized-noise so, in case of gross irrigated area. So, you will be counting this crop which is grown in a repeatedly in a particular year. So, and the productivity which is under irrigated condition 2.5 ton per hectares and whereas, in rainfed condition 0.5 ton per hectares.

So, which is very low compare to the irrigated condition; So, you can understand the irrigation potential here. So, and the importance of irrigation is. And the food grain availability if you see around 523 gram per capita per day available these days.

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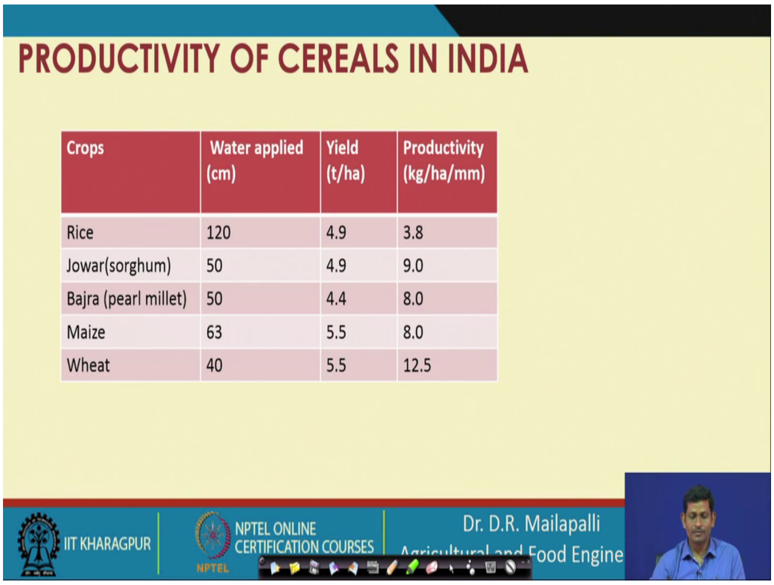

Crops	Water applied (cm)	Yield (t/ha)	Productivity (kg/ha/mm)
Rice	120	4.9	3.8
Jowar(sorghum)	50	4.9	9.0
Bajra (pearl millet)	50	4.4	8.0
Maize	63	5.5	8.0
Wheat	40	5.5	12.5

So, productivity of cereals in India, if you see this is rice is consuming you know almost double the water required for other crops, around 120 centimeter whereas, look at the yield. So, yields of pretty much same the water productivity definitely will be less in the case of rice because, it consuming lot of water.

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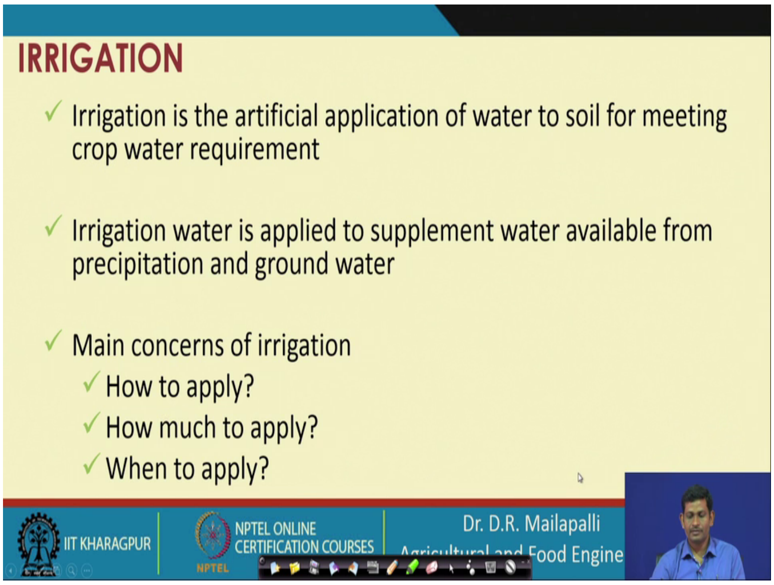

So, the irrigation here what is exactly the irrigation, irrigation is artificial application of water to the plant to the soil, in order to grow the crop profitively ok. So, and then irrigation water generally applied when there is no rainfall, or groundwater sources.

And the main concerns in irrigation is when to apply, how much to apply and how to apply; So, these three things are very important when you decide, or when you schedule an irrigation to a plant.

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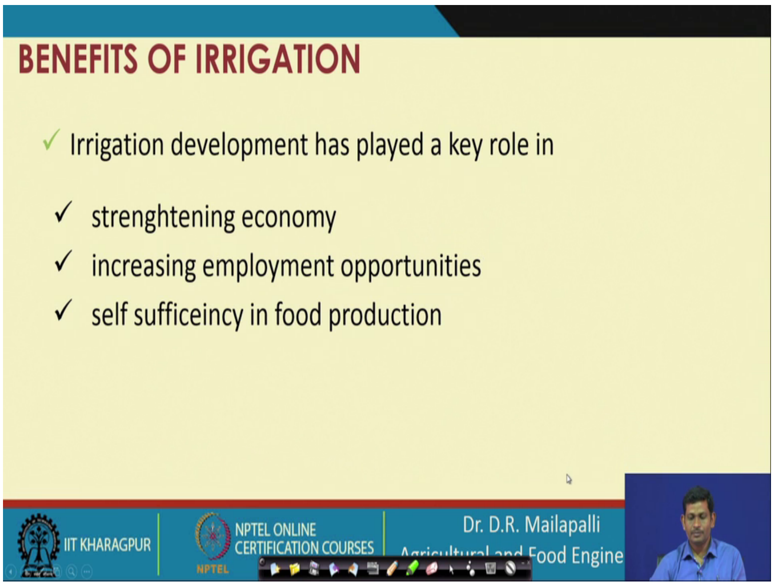

So, the benefits of irrigation that includes. So, irrigation developments has played a key role in fist of all in strengthening economy because, the irrigation means what I mean you are applying water for the benefit of the crop. So, indirectly you are I mean directly you are producing a crop. So, that will influence the economy.

So, if you have more gains produces having more profits and the it strengthen the economy and then increasing employment opportunity. So, when the crop production is more, it is definitely drives the you know rural youth in to the into the agro business and definitely the employment opportunity will increase.

And the self sufficiency in food production if you see, the food production you have lot of water and there will have food production so, that the sufficiency food will be attained.

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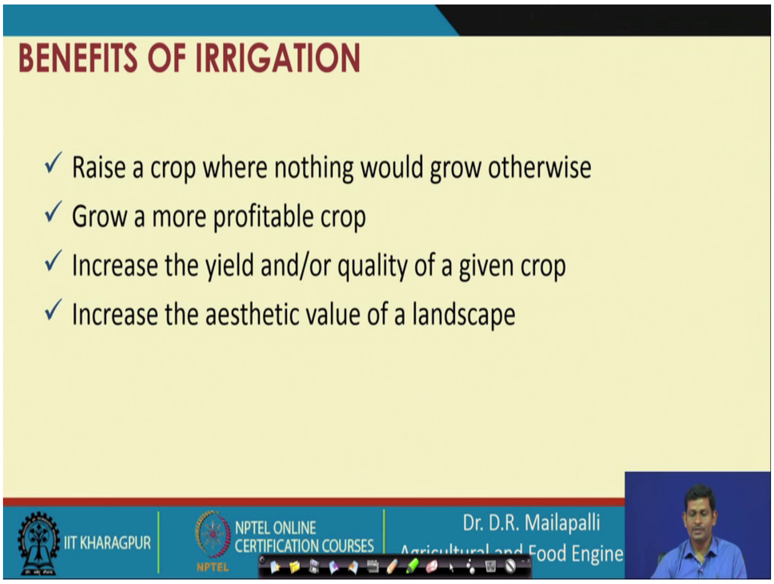

And the other benefits could be like rise of a crop where, nothing would grow otherwise. So, suppose if you have lot of water you can grow in diereses grow, grow crop in even diereses. So, and grow a more profitable crop suppose, if you are comparing alpha which is fodder crop you put lot of water for fodder crop.

So, instead of that the water the same water is use to grow a profitable crop like a wheat. And increase the yield and a quality of given crop. So, the definitely you are not making any water stress condition and the quality of the crop will improve and also the produce will improve. So, increase the aesthetic value of the landscape. So, you have lot of water, then you can use it for landscaping and also the greenery other greenery purpose so, that the landscape will be green and, definitely that improves the aesthetic value.

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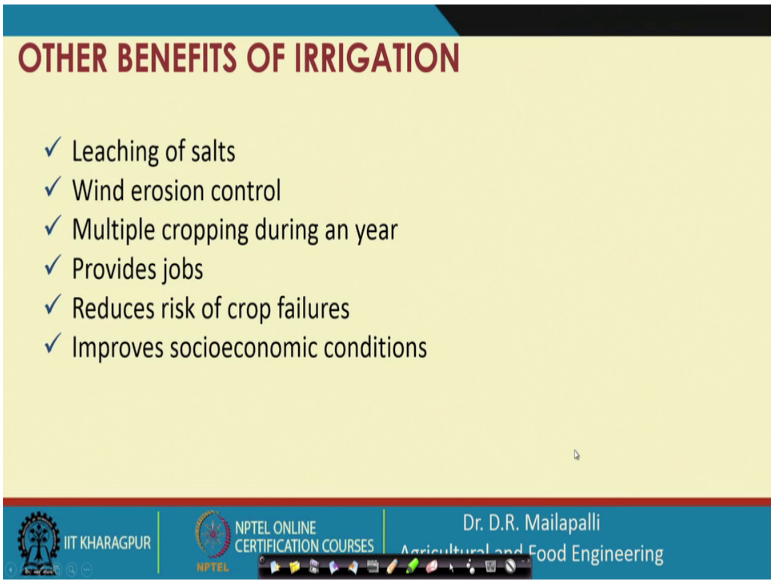

So, another other benefits will be the leaching of salts, if you have problems with salts in soil and you have lot of water, then you can you know use water to leach out the salts into the soil. And wind erosion can be controlled by applying you know water on tops. So, that that will make the ground wet and wind cannot blow this soil particulars.

And multiple cropping during an year so, and you can grow like a not single crop, you can grow like a 3 crops or 2 crops in a year. And provides jobs already discussed and reduces risk of crop failures.

So, because you are not you know making crops under water stress condition defiantly that will improve the crop condition and no risk of crop failures; Improves socioeconomic conditions. So, definitely that will help the rural population in income generation and increase this socioeconomic condition.

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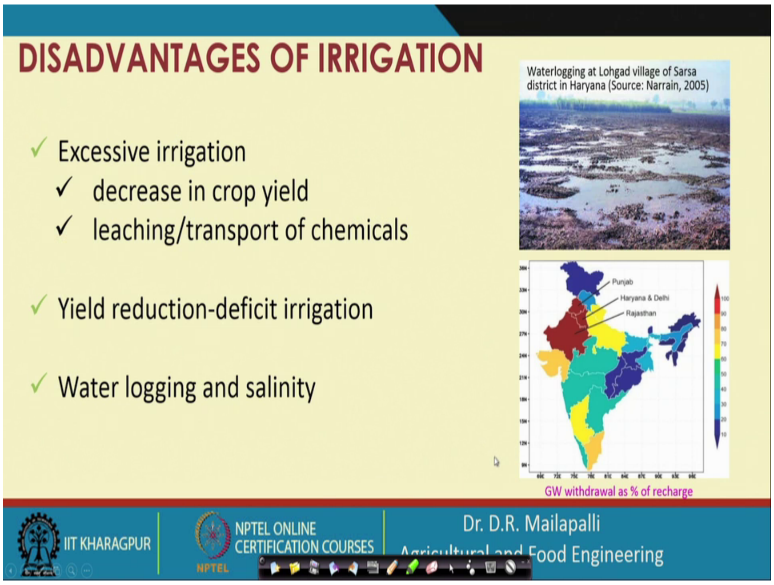

So, disadvantages of irrigation if you have you know lot of water and excess irrigations so, it going to decrease the crop yield because, so like if you put lot of water what happened the crop roots will be under wet condition always and the water, which is on standing on the surface will act has a barrier and it cannot you know help out any oxygen which is on this surface go into the soil.

And there by definitely the crop yield is going to reduce because, the roots require the oxygen. So, if you are not you know if you are making oxygen stress condition definitely the crop, yield is going to decrease and the leaching transport of chemicals. So, the salt are in any other chemicals can be leached into the groundwater or transport into the surface waters.

For example, you have sorry for example, you have pesticides or fertilizers. So, yield reduction can be happen if you have a deficit irrigations. So, not only excess irrigation, even if you reduces irrigation so, that is called deficit irrigation and yield definitely going to reduce.

And then water logging and salinity could be a problem say for example, here if you see the field so, the water is really pounding on the surface not allowing you know oxygen enter into the soil it is it is not a irritated condition. So, it is not favorable to the plants and if you see this image, Indian image so, the ground water with drool as percentage of recharge. So, the mostly the Punjab, Haryana, Delhi and Rajasthan, they withdraw ground water more than the recharge. So, it really it is alarming situation the groundwater table is really defeating deeper into the soil.

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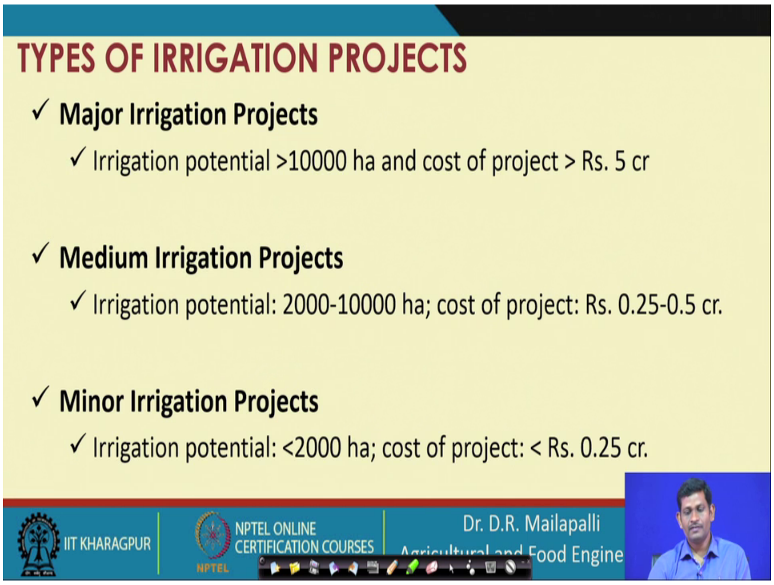

So, the types of irrigation projects if you see in India. So, they are classified into three major classes one is the major irrigation projects. So, if the irrigation potential is greater than 10000 hectares and, then cost of project is more than 5 [FL] so, then you can say that the project is like a major irrigation project. And the in the case of medium irrigation projects the irrigation potential is about 2000 to 10000 hectares.

So, that is irrigation potential and the cost of project will be like 258 to 50 lakhs. And the minor irrigation projects which will have a the irrigating potential less than 2000 hectares and, the cost of project which will be less than 25 lakhs.

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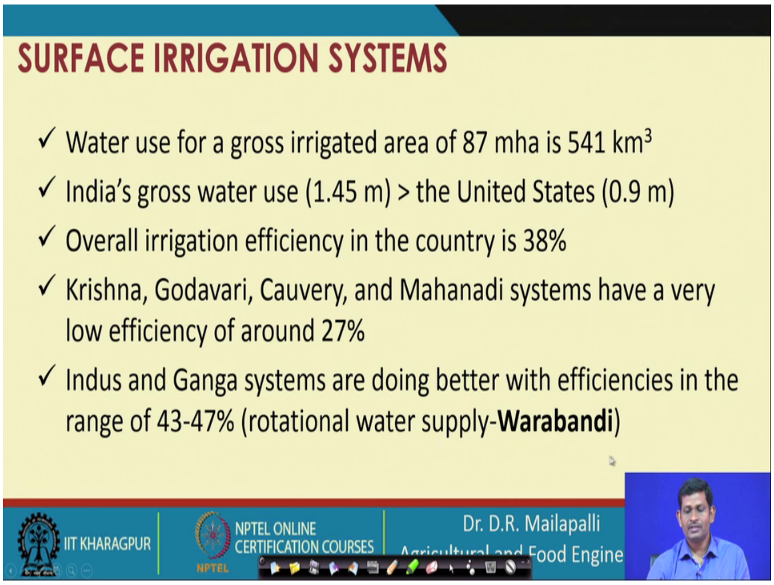

So, the surface irrigation system if you see for example, if you have you know forever irrigation, border irrigation, basin irrigation, all are called surface irrigation systems, if you see the status of surface irrigation systems in India.

So, the water is used for a gross irrigated area of 87 million hectares is 541 kilometer cube under surface irrigation systems. So, and the gross water used if you see the water would the water which is applying on top of the surface. So, that is 1.45 meter in case of surface irrigation which is greater than the united states, I mean where the united states practice on the surface irrigation which is point nine meter.

So, we are putting lot of water on top of the surface, compare to the United States, in case of surface irrigation systems. So, the overall irrigation if you since in the country is 38 percent so; that means, 100 mm you are supplying to the field only 38 mm of water is being taken into the by the plant, or by the form.

And if you see the I mean other river basics like Krishna, Godavari, Cauvery and Mahanadi systems have very low efficiency of around 27 percent whereas, Indus ganga systems are doing better than the Krishna, Godavari, Cauvery and the efficiency is improved like 43 to 47 percent because, they have well structured water release systems called Warabandi for example.

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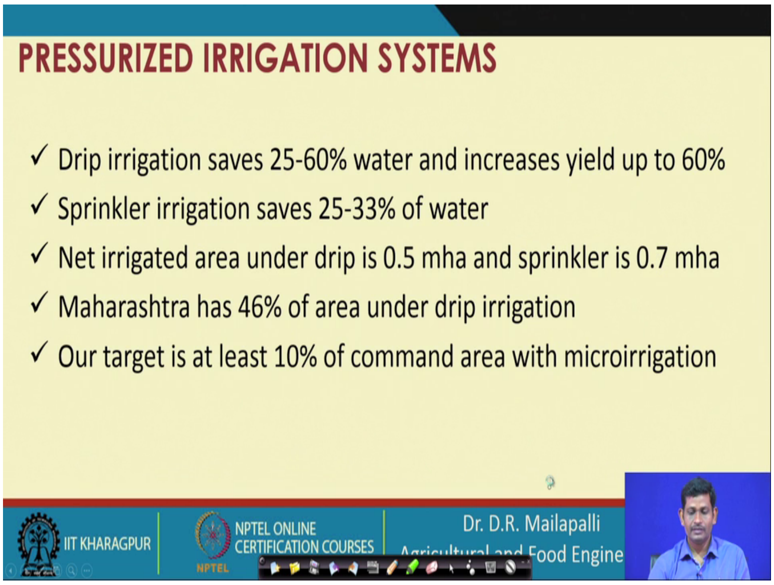

So, the pressurized in case of pressurized irrigation systems like drip irrigation sprinkler irrigation systems; So, drip irrigation saves 25 to 60 percentage of water and increase yield up to 60 percentage. Have a sprinkler irrigation saves 25 to 33 percentage of water.

So, the net irrigation under drip irrigation is 0.5 million hectares and the sprinkler is 0.7 million hectares, though we have a target of about 10 percentage of you know gross irrigated area needs to be under brought under you know micro irrigation or pesticide irrigates systems.

So, the Maharashtra is being the largest, I mean micro irrigation micro irrigation system practice state; So, this and then and then reasons for low irrigation efficiency.

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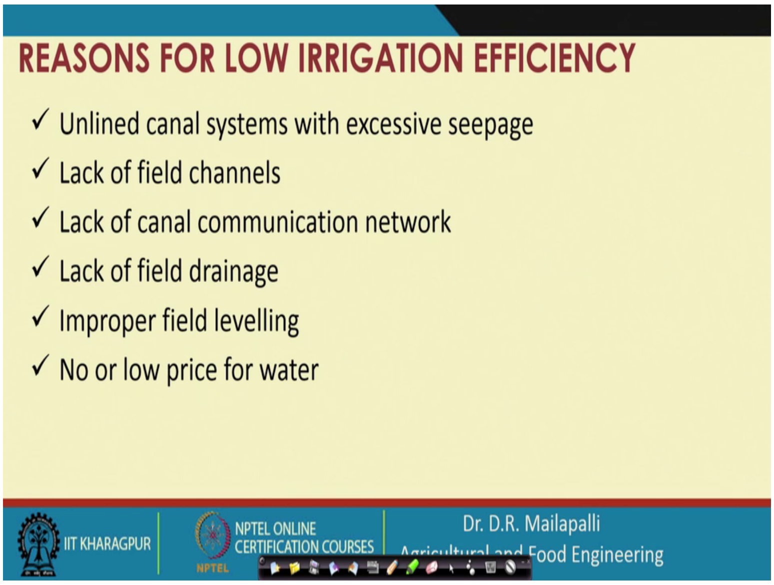

So, if you see this irrigation efficiency surface irrigation is about you know 30 to 40 percent, but what is really causing the a low irrigation efficiency if you see. So, the mostly the unlined canal systems with excessive seepage so, cannot system we have is mostly unlined. So, the water which is being delivered from the canal to field level, is been last through seepages or vaporization mostly.

So, then lack of field channels the channels so, you have very you know properly designed field channels required, for a delivering water efficiency to the fields. And then lack of canal communication network, you do not have canal communication network and you do not know when to you know release water for a particular, you know the area or command area.

So, if you do not know power communication definitely the scheduling will be you know faster or lower, or one day early or one day you know delay can be happened. So, that really causing the low irrigation efficiency. And the lack of field drainage this another important thing is so, the excess water you are taking out, or the excess water which is accumulating on the surface needs to be you know taken out from the fields for that the field drain drainage is requires. So, that is really lack.

And improper field leveling this is also very important in order to you know increase the uniformity of in founded distribution of the water. And the price of water right know it is no, or in a very less. So, this needs to be improved in this case.

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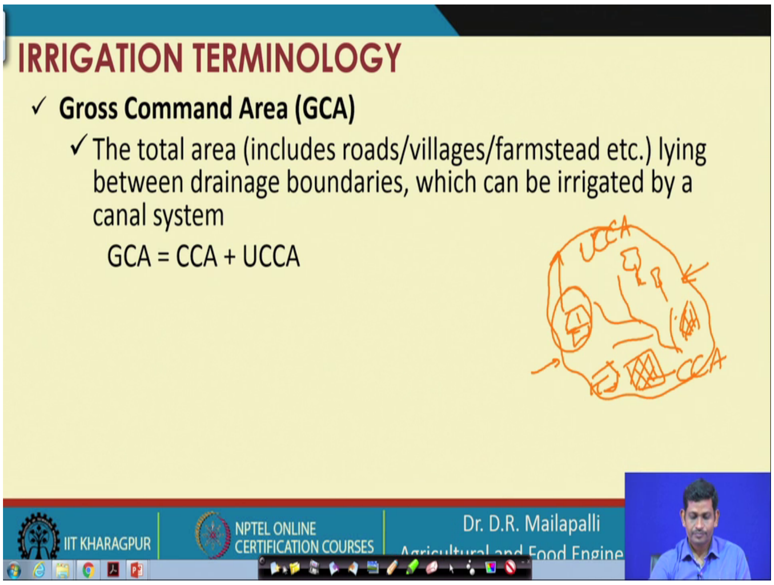

So, irrigation some of the irrigation terminology if you see the gross command area so, that is a total area that includes roads farmstead, the line between drainage boundaries which can be irrigated by a canal system. So, you have like a like a boundary suppose you so, you have the water spread like this is the drainage boundaries for example, these are the two drainage boundaries.

And you can have this area, you know is something roads, or you have some trees so, everything. So, you have some farmsteads ok. So, this is called gross command area, but if you are only I mean counting you were only a counting so, the farm lands. So, that is culturable command area.

So, this what culturable command area so, the gross command area. So, contains both so this is culturable command area and the other area which is not culturable so, it is called unculturable command area. So, this some of these two will be 2 gross command area.

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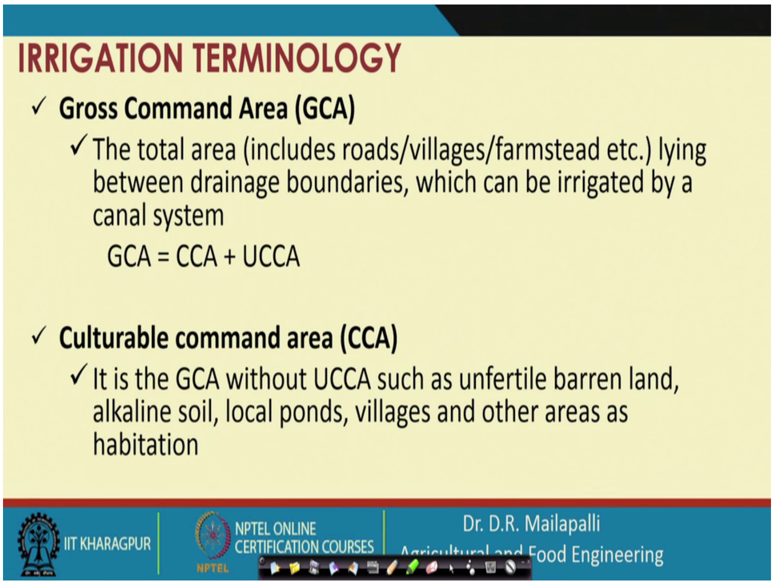

So, has they said the culturable command area this includes, I mean gross command area, without unculturable command area such as unfertile barren land, alkaline soil, local ponds, villages other area such as habitations ok.

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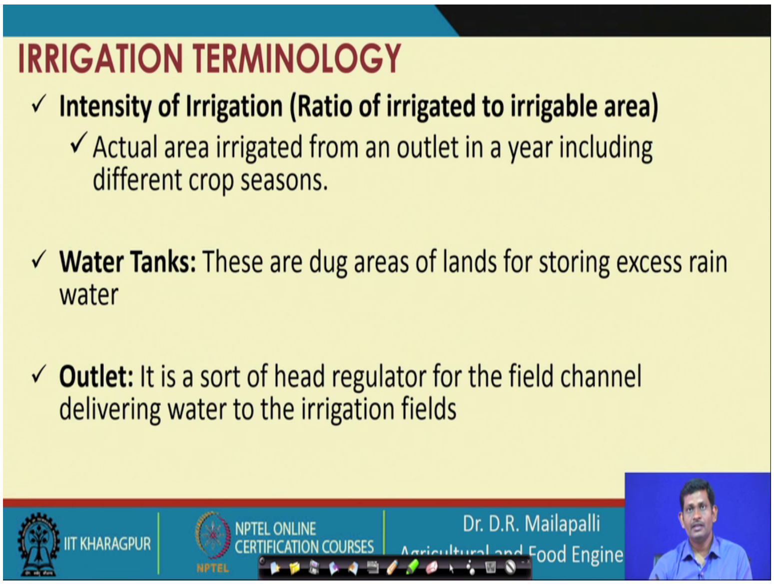

So, then the intensity of irrigation so, this the ratio of irrigated to irrigable, or irrigable area. You have some area available for irrigation, but based on your water availability water resources so, you decided to irrigate part of that land and so, that ratio of irrigated land to irrigable land will give the intense of irrigation.

And water tanks are really dug areas which can be useful to store the excess rain water. And outlets or kind of you know head regulator of the field level, to deliver water to the you know fields real fields. And water logged areas this is an agricultural land it said to be water logged.

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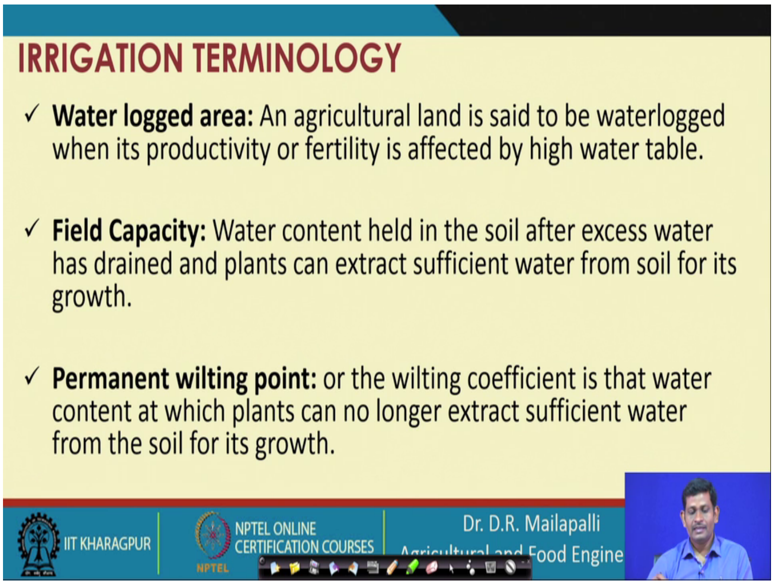

When productivity of fertile or fertilities affected by high water table. So, in this case what happens water table rises up. So, always you can see the water on the surface and, the field capacity it is the water contain held in the soil after excess water as drained and plants can extract sufficient water from the soil for it is plant growth.

So, if you see when there is a rainfall heavy rainfall, there will be lot of water which is standing on the surface and, but if you go next day morning the water will be receding slowly and you may not be seen water on the on the surface. So, where the water as gone somewhat the water as gone escape through you know over land flow, or through deflagration so, the water but still the soil contains some water.

So, the amount of water which is available during the time or after 1 or 2 days of heavy rainfall is called the field capacity. So, and then the permanent wilting point the wilting coefficient or permanent wilting point

So, the water contained at which plants can no longer extract sufficient water from the soil for it is plant growth. So, here so, at this the water which is available in the in the soil particulars, soil which is not extracted by this plants. So, when the plant show wilting nature ok. And this we will discuss more on these the upcoming lectures.

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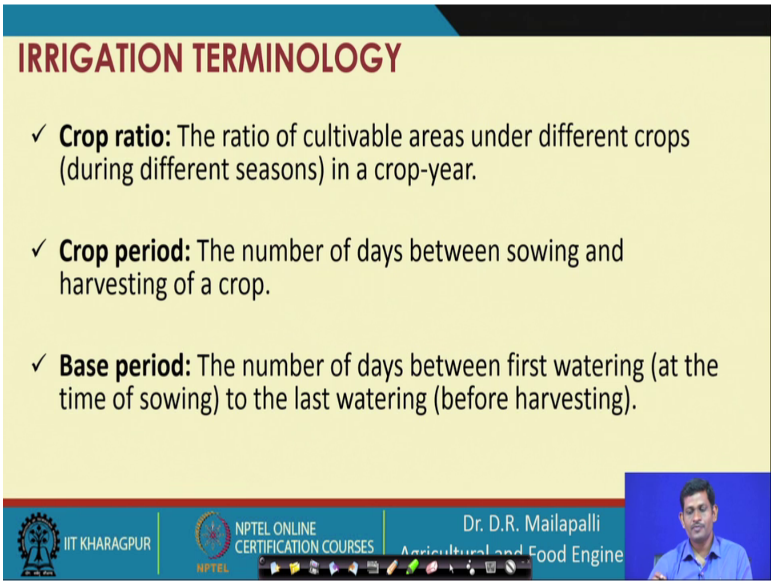

And the crop ratio the crop ratio generally so, we have two crops seasons here Kharif and Rabi season. So, the crop ratio could be so, we are I mean tracking the whole year. So, the cultivable area under different crops during different seasons in a crop year is called the crop ratio for example, you are cultivating rice in Kharif and Rabis. So, the ratio of cultivable area during Rabi and Kharif will give the crop ratio.

And the crop period so, the number of days between sowing to the harvesting of crop is crop period. And base period is a period of I mean water application, or the first watering to the last watering or before harvesting.

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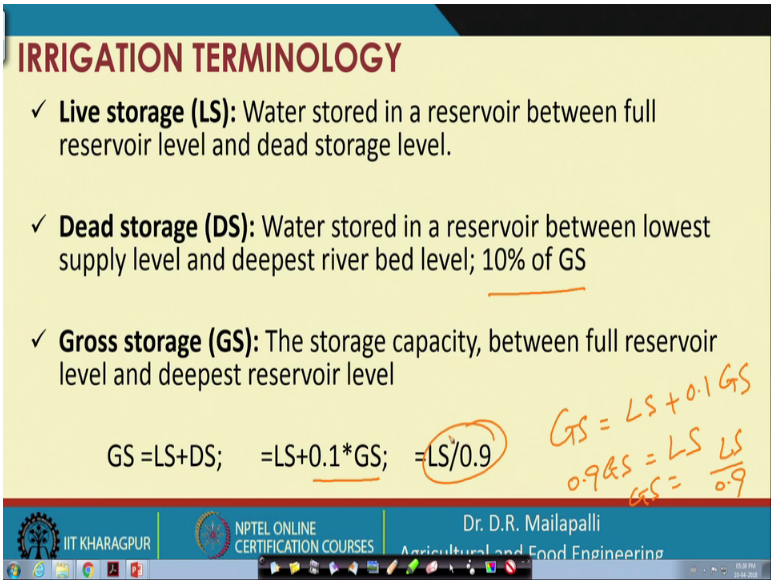

And the live storage dead storage and then gross storage. So, these three terminology belong to the you know you have a reservoirs ok.

So, live storage is complete is water complete water stored in the reservoirs between full reservoir level and at storage level. So, this water is really available for you know usage and the dead storage whereas, the stored reservoir between the lowest supply level to the deep deepest river bed level, which is 10 percentage reserve for GS or a gross storage whereas, gross storage is the storage capacity between full water reservoir level and the deepest reservoir level.

So, if you see this the gross storage which is equal to you know live storage plus dead storage whereas, he if you considering the 10 percent 10 percentage of GS. So, you have 0.1 GS so, which is equal to so, GS which is equal to LS plus 0.1; GS, if you take GS out where you had 0.9 GS equal to LS and GS is equal to LS by 0.9. So, this is the way we got this equation ok.

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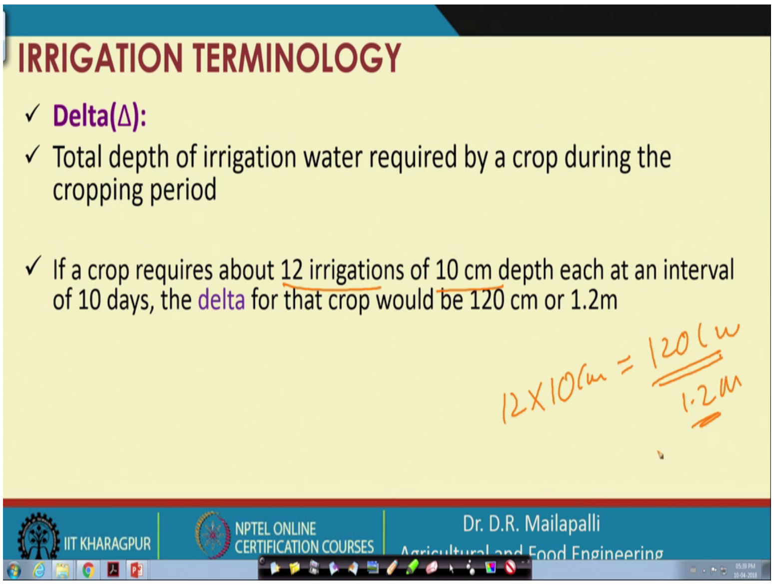

So, next is delta. So, what is delta? Delta is a total depth of irrigation water required by a crop during the cropping period here, we are talking about the base period ok. So, so, that is first water application to the last water application before harvesting so, this is total depth of water you have providing to the crop during the base period. So, suppose if a crop required about 12 irrigation of 10 centimeter depth.

So, then so, 12 irrigations 10 centimeter depth so, that gives you 12 multiplied by 10 centimeter so, that will give 120 centimeter of depth of water you provided during the base period. So, this is called delta. So, 120 centimeter, or 1.2 is a delta ok.

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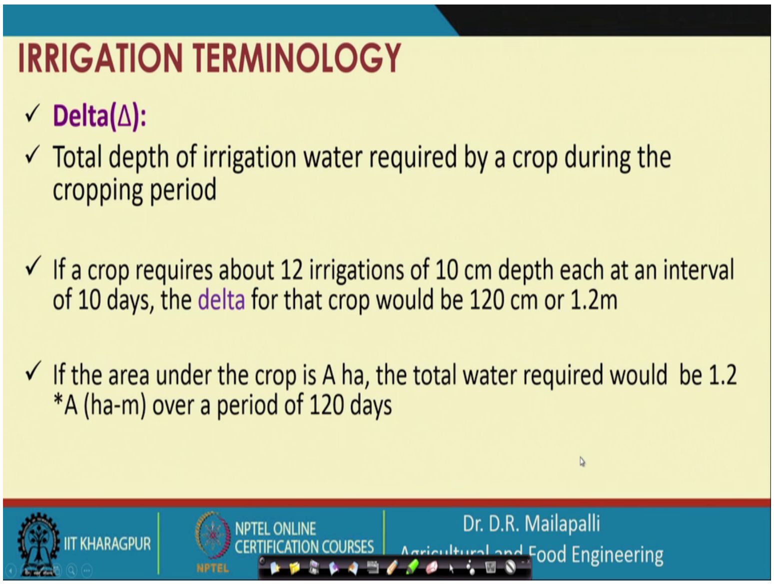

So, and then suppose if the area under the crop is a hectare the total water require would be 1.2 multiplied by area over the period of 120 days. So, this is the simple calculation receive.

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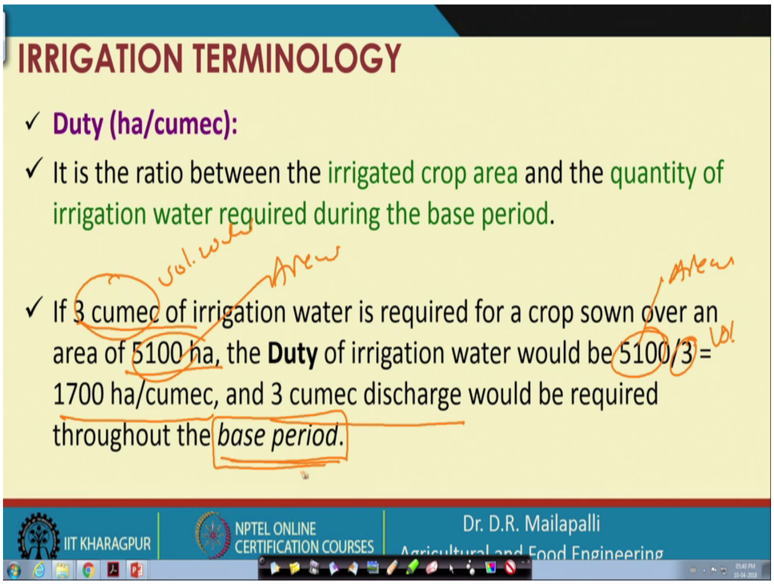

And the other terminology is called duty, so, which is hectare per cumic cumec. So, cubic meter per second so, the amount of the volume of water you are utilizing, or the area you irrigated for unit volume of water. So, that is that is called duty. So, it is the ratio between the irrigated crop area and the quantity of irrigation water required during the base period.

So, the definition is clear, suppose if you have suppose if you have 3 cumec of irrigation of water, which is required for crop sown over an area of 5100 hectares. So, the so, this is this is what this is the volume of water so, you are using right. So, and then this is the area and the duty will be the area divided by the volume you are using. So, that will be 1700 hectares cumec and 3 cumec discharge would be required throughout the base period.

So, do not forget this. So, we are targeting the base period, whatever you are using so, this 3 cumec per. So, you are continuously supplying during the base period.

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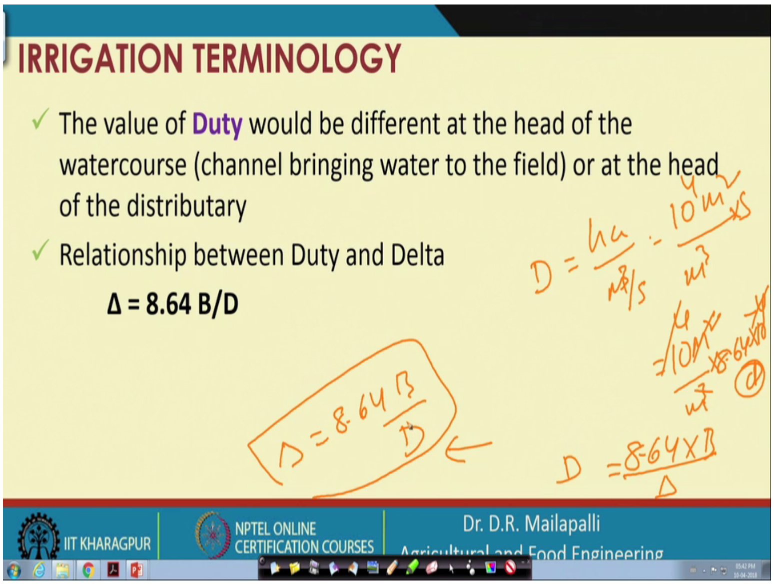

So, the value of duty be different at the head of the watercourse, or at the head of the distributors. So, that this is because they will lot of losses, if you constrain. So, relationship between duty and delta if you see so, the delta is equal to 8.64 B divided by D.

So, how do you get that so, duty generally duty is equal to hectare divided by cumec it is a cube cubic meter per second. So, hectares is a 10 power 4 meter square and cubic meter, suppose this is cubic meter into second ok. So, the 10 power 4 meter square for meter cube multiplied by you can convert that in days.

So, that will be 8.64 into 10 power minus four less days. So, you get like you know this is 10 power 10 power gets cancels out and meter square meter square this is meters so, 8.64 into base period lecture and this base period and meters this is delta so, that is D. So, you finally, you get delta is equal to 8.64 B by D. So, this is this is D yeah. So, it is these are the units you get.

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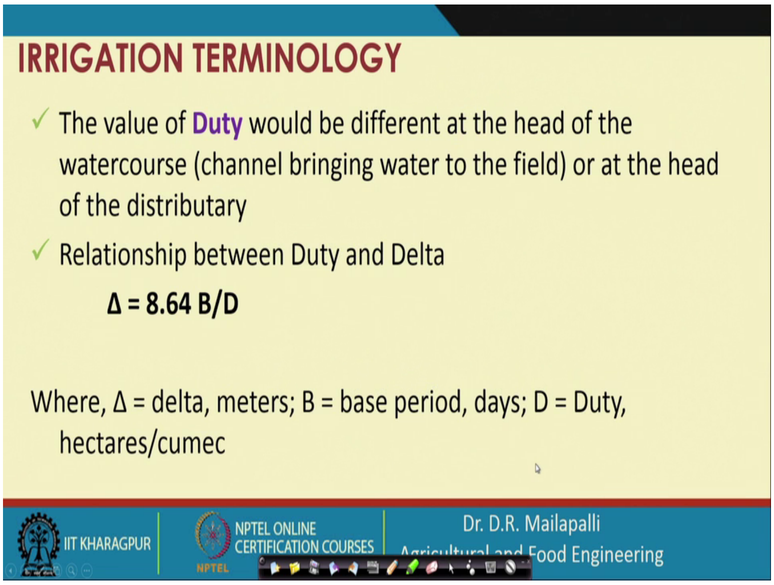

So, example if you see here.

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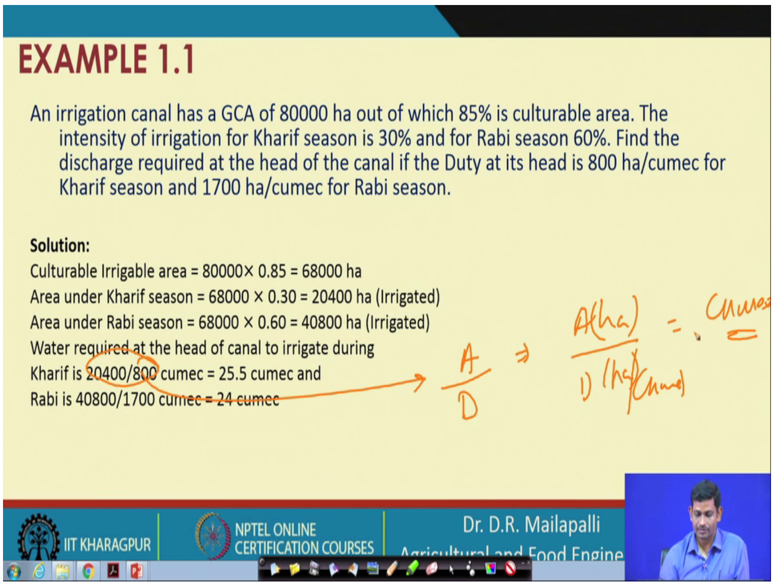

Suppose if you have an if you have an irrigation canal, which has GCA which is gross command area that is 80000 hectares out of which 85 percent is culturable area so; that means, you have total area, but only 85 percent is culturable area the intensity of irrigation for Kharif season is 30 percent out of this culturable area, only 30 percent for Rabi season a sorry Kharif season for Rabi season is 60 percent ok. And find the discharge required at the head of the canal, if the duty is given for the Kharif season and for Rabi season ok.

So, this is the problem. So, since the GCA is given so, how do you solve this basically? So, in order to solve that sorry solution here; So, the culturable command area if you see 80000 multiplied by 0.85 because 85 percent is the culturable area you got culturable area 68000 hectares and then area under Kharif season out of this culturable area only 30 percent is Kharif season.

So, multiplied by 0.3 you get 20400 hectares this is irrigated, This is during Kharif season similarly for Rabi season you get 40800 hectares. So, water required at the head of the canal to irrigate during Kharif season is so, area divided by I mean the cumec. So, area divided by cumec you get 25.5 cumecs ok. And then Rabi season you get 40800 divided by 1700 cumec. So, that will be 24 into cumec so, if you see this so this one so this number so, how you get this.

So, this is area divided by so, duty is given. So, area divided by duty so, duty. So, that will give area and hectares divided by duty. So, that will be in hectares divided by cumec right. So, then you get cumecs this is what you got fine.

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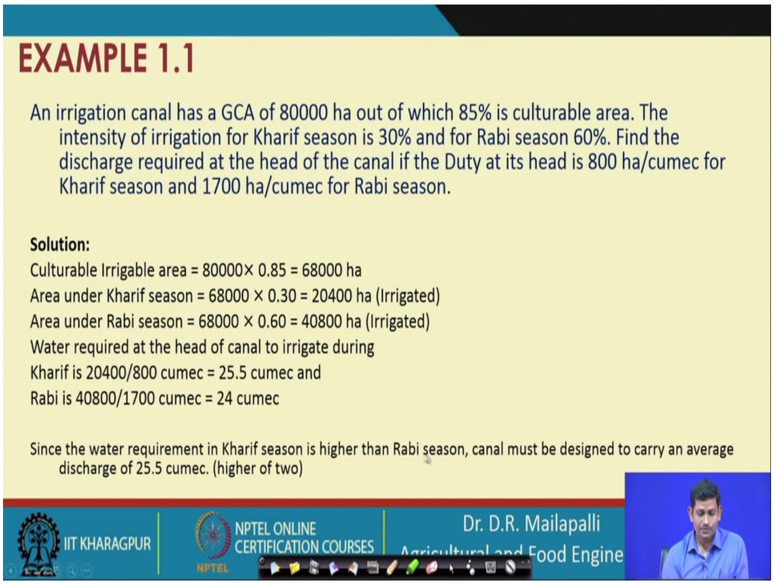

So, how to decide which one you really want to go with like 25.5 cumecs or 24 cumec; So, general thumb rule is you always go with higher you know the discharge. So, that it can serve both Rabi and Kharif season.

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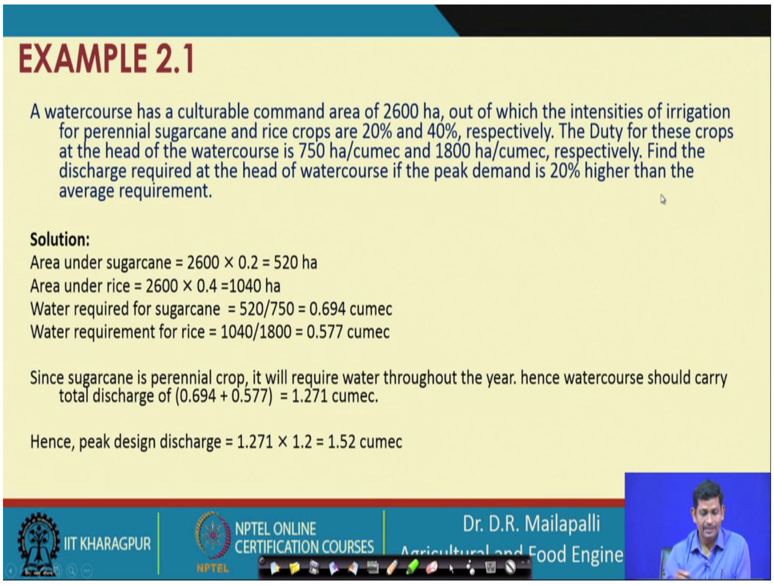

Whereas, example to the watercourse has a culturable command area 2600 hectares out of which the intensities of irrigation for perennial sugarcane and rice crops of 20 percent 40 percent respectively ok. So, here the intensity of irrigation is given. So, intensity of irrigation so; that means so, you have a irrigable area, but only part of that is irrigated for example, here 20 percent for a sugarcane and 40 percent for rice crop respectively ok. The duty of these crops at the head of the watercourse 750 hectares per cumec this is duty is given for both cases and, the discharge required the head watercourse, if the peak demand is 20 percent higher than the average water requirement.

So, it is similar to the previous example, if you see this the solution here if you see area under sugarcane. So, let us say so, you have 2600 hectares, but 20 percent is you know irrigable land sorry irrigated land. So, that is 550 hectares under sugarcane.

And similarly under rice 40 percent So, that is 10, 50 hectares and water required for sugarcane will be so, 500 hectares divided by duty you get you know 0.694 cumec. And similarly for rice 0.577 cumec and so, if you see this since sugarcane is perennial crop so; that means, you need to supply water throughout the year and rice requires you know one season.

So, here I mean what is the decision like I mean what water needed to provide. So, since sugarcane is perennial crop so, you need to some of these like sugarcane as well as I mean rice crop the water required for sugarcane and rice can be combined and, you will have the maximum water which is required that the total discharge during the year is 1.271 comecs ok.

Hence, the peak design is charged if you see this 20 percent higher than. So, you can put like 20 percent 120 percent now. So, here you have 1.2 so, that will be 1.52 ok. So, thank you for this lecture this is the first lecture and we are doing to cover more on the following lectures so;

Thank you.