Irrigation and Drainage

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Lecture - 56
Drainage Case Study

Welcome to 56 lecture number on Irrigation and Drainage, so in this we are going to see a Case Study on Drainage. So, mostly we have taken a problem, which is already you know available in land drainage textbook.

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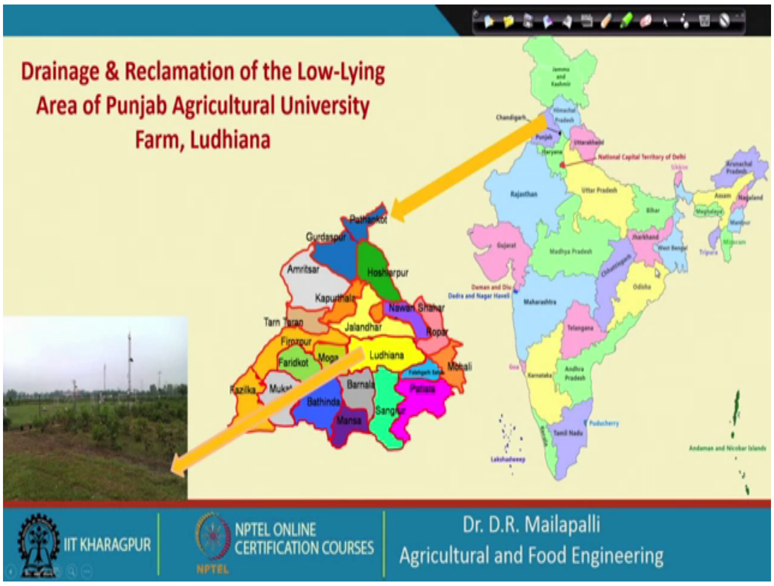

So, we are going to see how the drainage and reclamation of the low lying area of Punjab Agriculture University form in Ludhiana. So, in basically if you see in Punjab especially in the most of the areas are affected with salts. So, the main problem here is you see this the Ludhiana form sideways.

So, the main form is affected with salts because low lying area and so whatever the water which is you know coming from their high land areas are going to in India at the you know form area. And so that is carrying the salts and also it is causing you know lot of for water inundation and it is and the land is not used for farming. So, there this was started in 1966 but it is a you know good study to explain as a case study.

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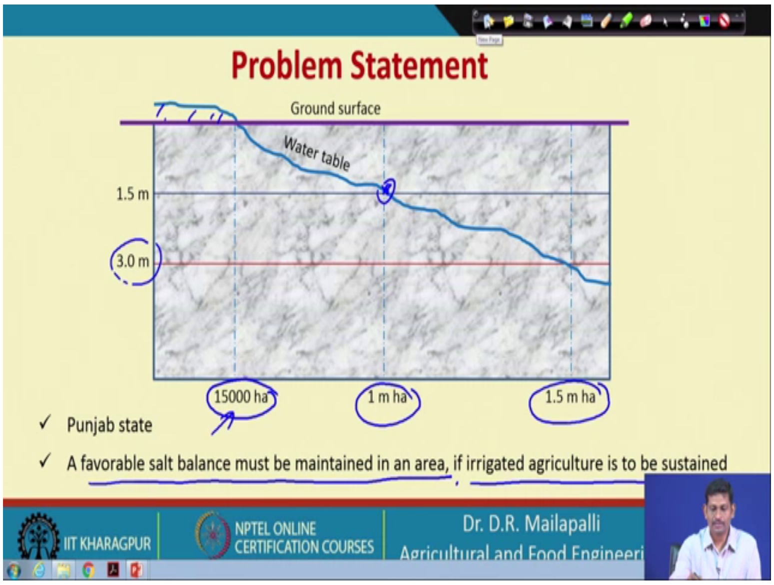

So, here basically in the in Punjab if you see the water tables, so around 15000 hectare land is I mean 0 to 15000 hectare land is you know the water table is above the surface and then 1 million hectare. So, water table is a below 1.5 meter and the next 1.5 million hectare land as the water table below 1.0 sorry 3 meter.

So, this way the 1 15 15000 hectare land has you know problem not only that and up to 1 million hectare up to 1 million hectare land agriculture land is you know under is under drainage requirement ok. So, if favorable salt balance must be maintained in the areas where the water table is high or the shallow if irrigated agriculture is to be sustained. So, if you want to irrigate the fields or the agriculture sustainable agriculture production, so the shallow water table needs to be maintain I mean needs to be controlled using this you know suitable drainage system.

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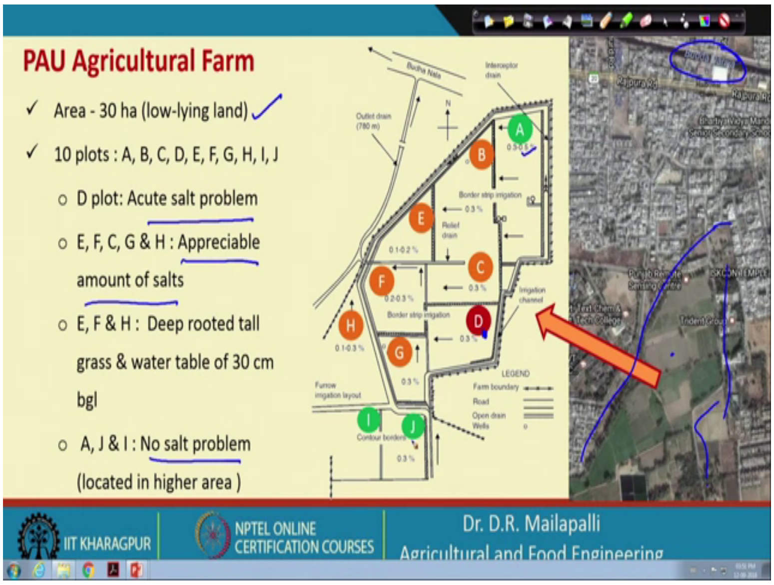

So, here if you see the Punjab agricultural form I mean university form, so the area is 30 hectares low lying area around 10 plots if you see A B C D E FG H I J so these are the plot numbers and the D plot has acute salt problem. So, this has acute salt problem and then E you know F B C G H have appreciable amount of salts and then A I J so these are located in higher areas and no salt problem ok.

So, this is the initially so there is a Budha Nala ok, so this is the Nala which is taking place you can also see there is a Budha Nala here right, this is a university form right the entire this strip is university forms. And now the problem is how to you know lower down the water table and the idea is to take out the water from the agricultural form and dispose it to the Budha Nala ok.

So, that is the idea here and then so what kind of you know drainage system we need to design for the situation, because the that the plots are not having the same kind of problem. So, some plots have severe salt problem and then some plots you know the appreciable amount of salts and some you know plots does not have any salt problems. So, how to design such kind of mixed salt affected conditions.

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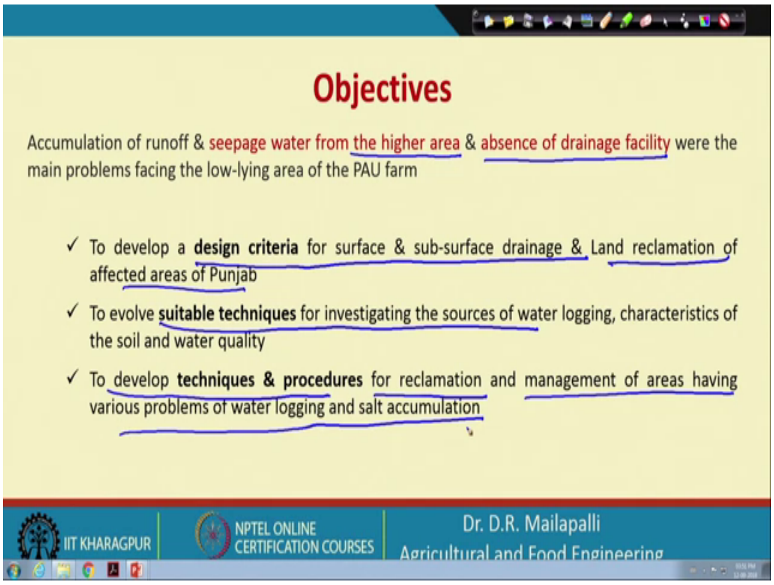

Now, the main objective here is amount of run off it is seepage, seepage water basically from the higher areas are coming in into the form and absence of drainage facilities. So, these two issues are causing the water in indention in the form. So, objectives are to develop a design a criteria for surface and sub surface drainage and land reclamation of the affected area of Punjab and to evolve at the suitable techniques for investigating source of water logging and to develop techniques and procedures for reclamation and management of area having various problems water logging and salt accumulation. So, this is a general objectives were framed for entire you know Punjab area, but a pilot project was started in the form taken the objectives.

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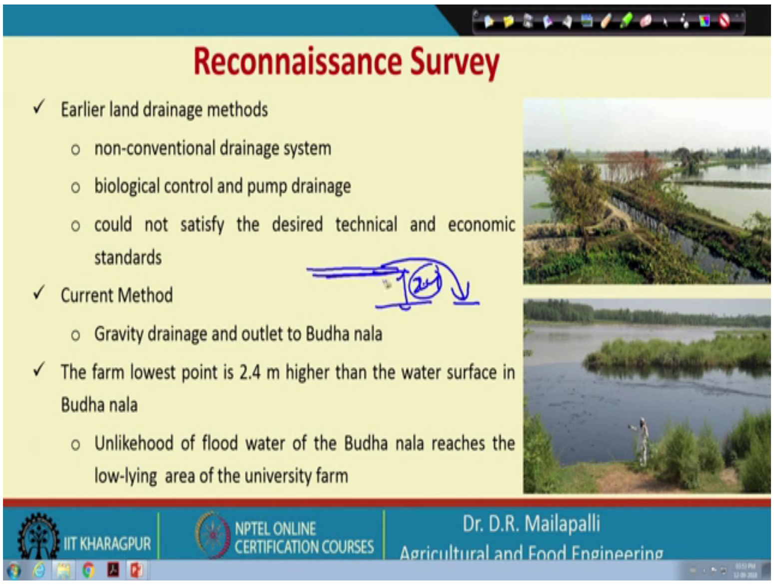

So, before I mean deciding drainage system or the main thing is reconnaissance survey, so we go there and see what where is the source of water and where exactly the excess water is taking place all those information and which due to survey. So, earlier land drainage methods used in that area were non conventional drainage systems like bio drainage and form drainage. So, these drainage systems were practiced before you know 1966 could not satisfy the desired technical and economic standards, so that is not real effective.

Then the current method so for example, gravity drainage and outlet to Budha Nala so this is what the plan is, so using gravity flow to the Budha Nala there is plan and the form lowest point is 2.4 meter higher than the water surface in the Budha Nala, this is the very good because so this is the form and this is the elevation. So, this is the form and this is the elevation of the Budha Nala, so this is around 2.4 meter above. So, easily the gravity I mean due to gravity flow the water from the you know water from the a form can be disposed into Budha Nala so and then next is a drainage.

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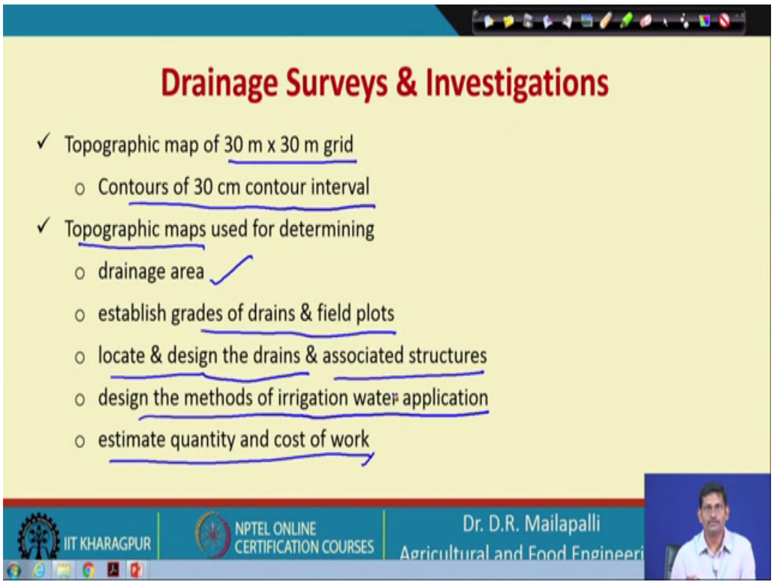

And survey investigations if you see, the topographic map of 30 meter by 30 meter grid was prepared and contours of 30 centimeter contour interval, so that that is prepared based on the elevations of the entire form. So, this the topographic maps our used to determine the drainage areas and establishing grades of drains and field plots and locate and design the drains associated structures and design the methods of irrigation water application. So, I mean what kind of irrigation we need to maintain for the particular plot and estimate the quantity of cost of you know work this is very important to estimate the cost and to decide what kind of irrigation, for example contour farming versus for irrigation all those things.

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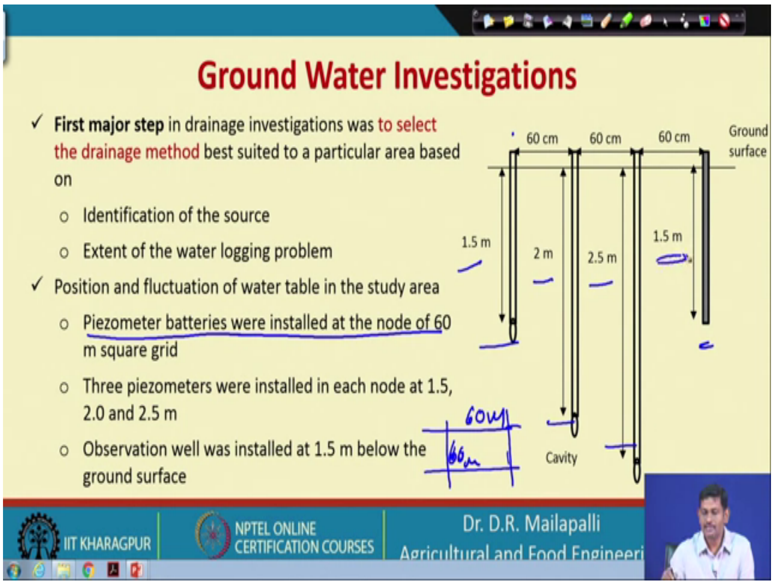

So, now even before that there is a groundwater investigations for taking place this is very important to understand you know you know how the water table is wearing seasonally in that area particular area. So, for that what happened the entire area the first major step in the ground water investigation was to select drainage method, so the identification of the source and extent of water logging problem.

So, this with this ground water investigation will be identifying this the source of the ground water and I mean groundwater fluctuations other thing and extent of water logging problem. So, how much or how much area is been affected with this water logging ok. So, position and fluctuation of water table in the study was estimated by piezometer batteries.

So, they were installed at 60 meter square grid so the entire you know the area is been divided into you know grid in the 6 60 meter by 60 meter. So, within this grids so there are 3 piezometers so that is installed at 1.5 meter 2 meter and 2.5 meter at a distance of 60 centimeter and there is a observation evolve 1.5 meter depth. So, with this setup so will be understanding the in the pressure at 1.5 2 meter and 2.5 and similarly had 1.5 meter what is the water table level.

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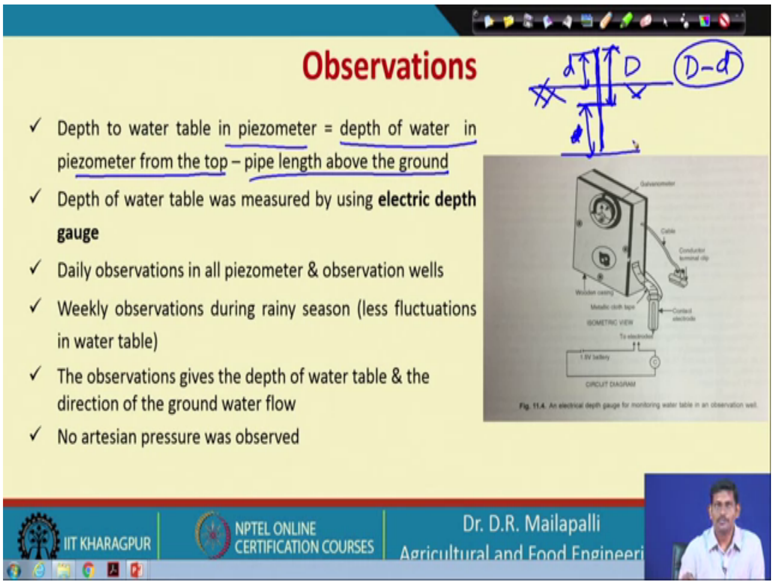

So, with these observations so will be understanding the groundwater fluctuations and whether the acute for system ok. So, in the piezometric levels will be understanding, if you supposed the observation well and piezometer you know surface if they are same; that means, there is a water table acute for. So, otherwise in piezometric case if this is you know under pressure the artesian pressure then this is artesian acute for. So, let us see if suppose observations are like depth of water table in piezometer, so that gives the depth of water in the piezometer from the top and pipe length above the ground.

Suppose so here is a ground level and this is the piezometer. So, suppose the water level is observed at this point right, so this is a d and suppose and you know this is a pipe length. So, anyway you will be estimating depth from here to here, so knowing this depth suppose this is a capital D and this is a small d ok. So, there in D minus small d will give the water surface from the ground surface. So, that is the one and depth of water table was measured by electric depth gauge, so electric depth gauge was used on top of the piezometer and find out the depth from the top of the piezometer to the water level.

So, daily observations were or piezometer and observation wells were made and weekly observation during rainy season because in during rainy season the water table would not fluctuate much. So, that is why, so less fluctuations are seen in water table that is why weekly grading were taken. So, the observations give the depth of water table and the direction of groundwater flow, so because you are getting you know these readings at every grid like there are several grids right.

So, this grid this grids so all the grid points and you will be knowing the direction of flow by using the piezometer readings so and during after observing the piezometer readings, so no artesian pressure was observed in the piezometer readings and water table maps are very important.

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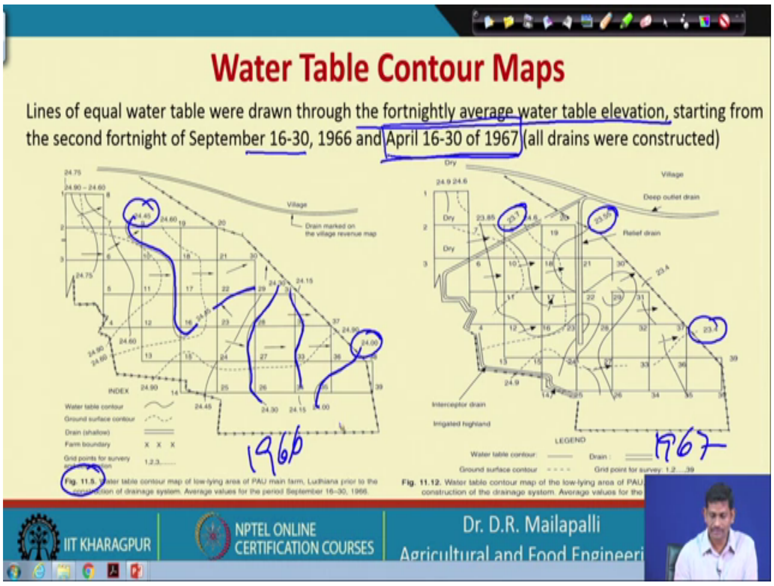

So, after getting the observation of this water table, so the maps for generated this a water table maps. So, this is through fortnightly average water table elevation, fortnightly means every 15 days and starting from the second fortnight of September 16 to 30 to April 16 to 30 of for 1967 all drains were constructed at this point. I mean after 1 year almost you know close to 1 year this is September and April so 9 months about 9 months so the drains for constructed during that time.

So, then so if you see this figure in this figure right, so I mean the contours if you see these are all water table contours so that means equal water table levels. So, the contours are showing equal water table levels and then here if you see like 24.3 right this is 24.3 and then this is 31 and then 24 sorry this is 24 and then like that. So, all these you know this is 24.45 so these or I mean the this contours are you know representing the equal elevation of or equal water table depths. And then this is you know 1966 and this is 1967 so, after 9 months if you see clearly the water table levels or gone you even deeper.

For example here is a 24 but here if you see I mean the similar similarly so 23.4 is not much and this is for 24.45 right. So, here 23.45 or 23.55 so little even there is a variation you can clearly see ok, so this is after 9 months and then water table this is called isobaths.

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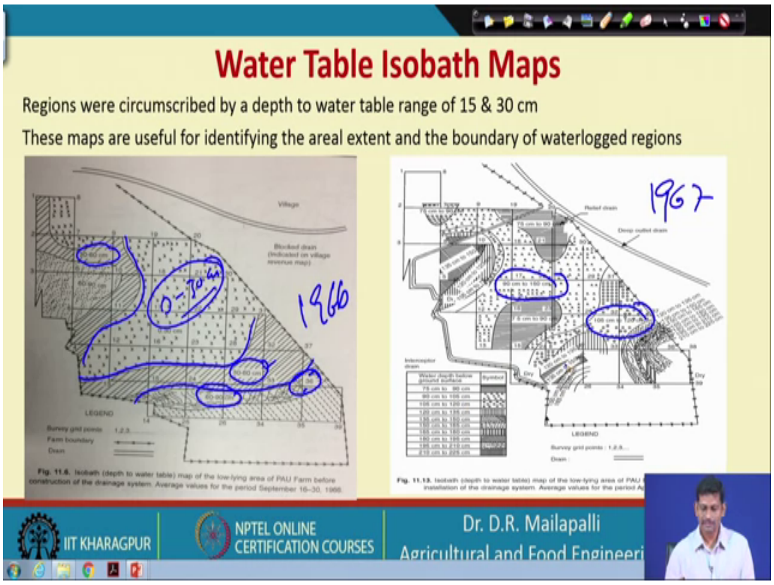

So, isobaths means so after getting the contours will be identifying you know some area some patch of area giving the equal water table levels. So for example, in this from here to here; from here to here, so this will give like 0 to 30 centimeter you know water table and this is 30 to 60 centimeter from here to here right and similarly 30 to 60 centimeter this side ok. So, like that the elevation of water so he this is a shallow water table little deeper and the next level you know next we will go like 60 to 90 centimeter here right.

So, this is again 1966 and this is after installing the drains, so 1967 if you see this within this. So, water table went to 90centimeter to 150 centimeter it was point 0 to 30 centimeter, so now it went to 90 to 150 centimeter and similarly this sides here 30 to 60 and you can see 105 to 120 centimeter here ok. So, that means, there is a I mean the drainage system which is installed after you know 9 months during 9 months definitely helped in reducing the lowering the water table you know below the surface. And then so the next is so sorry so next is a observation well hydrograph.

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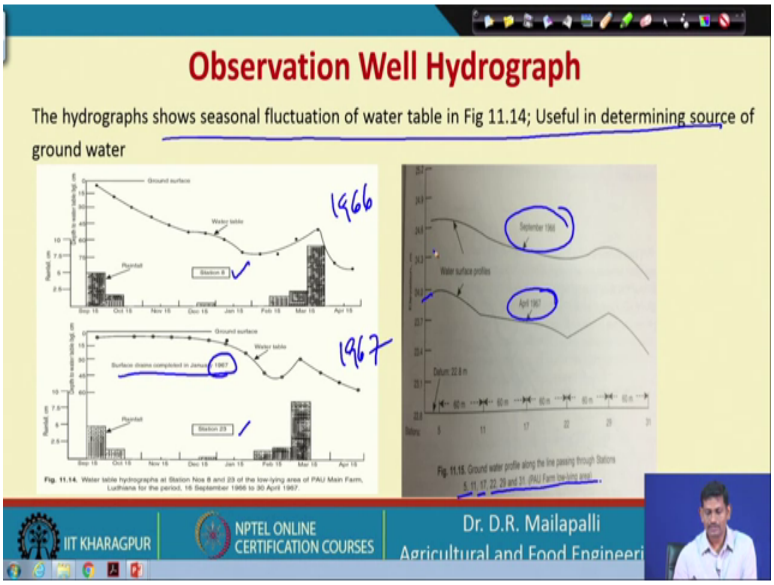

So, they used you know the nearest wells to collect the water table, so hydrograph shows the seasonal fluctuation water table. So, here if you see this is again 1966 and this in 1967 1966 this is before the drainage system was installed and this is after drainage system was installed.

So, this is a rainfall if you see this is the rainfall and there are some station number 8 and station number 23. So, if you see the ground from ground water surface this is water table in 1967 groundwater table from the surface drains completed in 1967, so this is a water table and here clearly see September 66 and April 1967.

So, the water table was initially 24.6 something like that, then is reduced to 24 in you know this is a datum. So, ground water profile along the line passing through the stations this is 5 11 17 all the stations. So, this clearly shows the water table has been you know gone down right, if you are 24.6 that is the from the bottom I mean the datum is in the bottom. So, then definitely there is a change in water table from 1966 to before drainage and after drainage.

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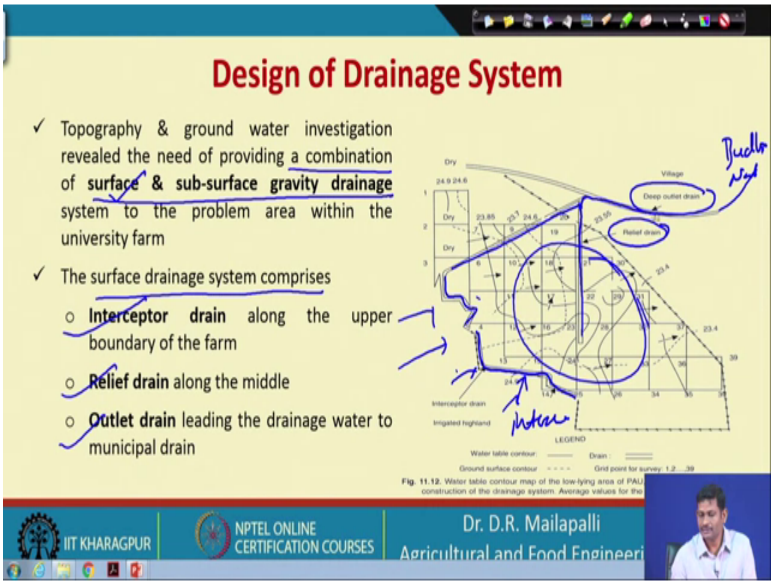

So, this is the design of drainage system if you see so the topography and groundwater investigation revealed the need of providing the combination of surface and subsurface gravity drainage systems, because in some places the water table is shallow and other places the water table is deep. So, in order to compensate in order to get water from the excess water from the both situations, so we plan for I mean the plan for surface as well as subsurface gravity drainage in the university form.

So, the surface drainage system so which is comprised of intercepted drain and relief drain in outlet drain. So, these 3 drains if you see here so this is the outlet drain, so this will connect to the what you call Budha Nala this is a Budha Nala and then here. So, this is a relief drain this is a relief drain and the drain which is taking water just from the upland areas, so that is intercepted drain so this is called intercepted drain.

So, this collects basically water from the I mean upland area, so whatever water which is taking place so, that will be taken. And this relief drain will be taken care of getting water or extracting water from the entire you know the low land areas and then so this water will be carried and then relief drain water will be carried and then finally it pass through the deep water ditch.

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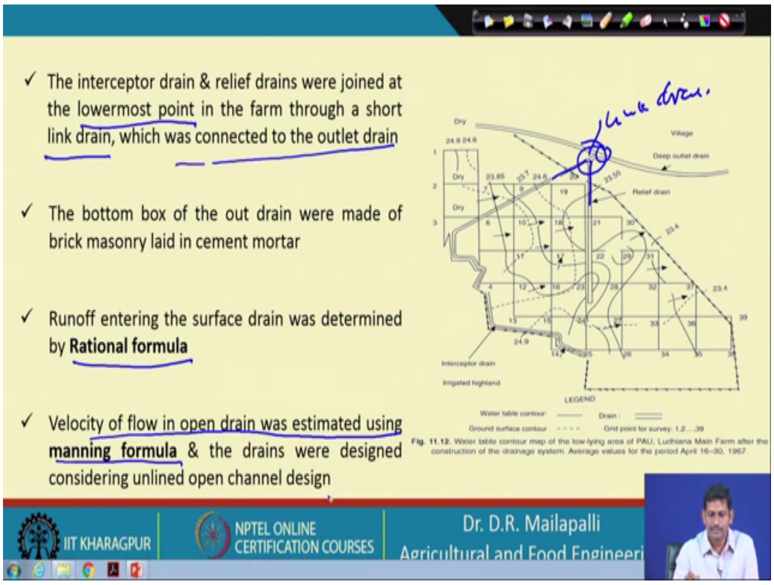

So, this is the plan for the university form, so intercepted drain and relief drains were joint at lowest points so here, so these 2 will join at lowest point in this point the form through a short link drain. So, this is called a link drain link drain which was connected to the outlet drain and the bottom box of the out drain were made of brick masonry. So, here the outlet drain has brick masonry outlet and runoff entering the surface drain was determined rational formula.

So, basically the drainage I mean design procedure surface and subsurface procedure was used to find out the peak flow using rational formula in the particular area and based on that they channel design was made. The velocity of flow open drain was estimated using Manning's formula, so the channel designed which is explained in week number 11 is used to find out the dimensions of the channel.

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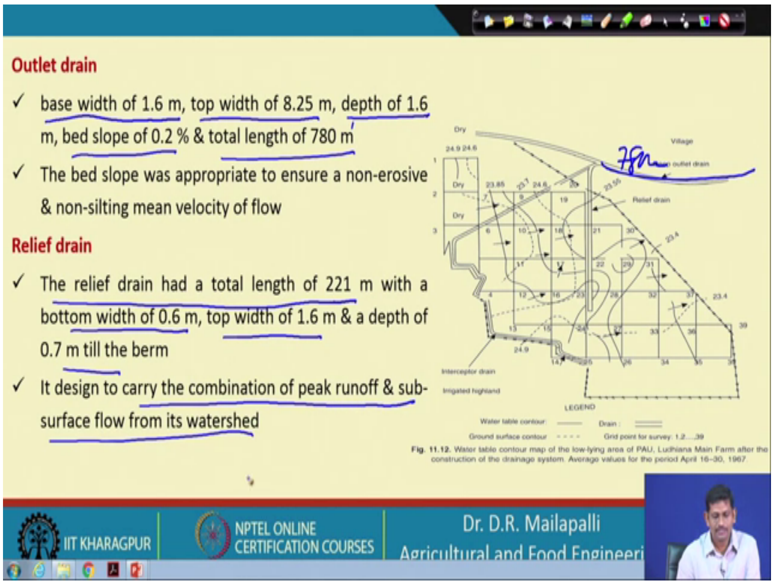

So, then there is a outlet drain so it was decided after calculations 1.6 meter is a base width and top width is 8.25 meter and depth is 1.6 meter and the bed slope is 0.2 percent total length is 780 meter outlet drains ok. So, this is 780 meter outlet drain to the Budha Nala and there is a relief drain the relief drain had a total length 221 meter with a bottom width of 0.6 meter and top width 1.6 meter and depth 0.7 meter till the berm and it design to carry the combination of peak runoff and subsurface flow from it is watershed ok. So, this relief drain we used to get both surface as well as subsurface drains drainage from the area.

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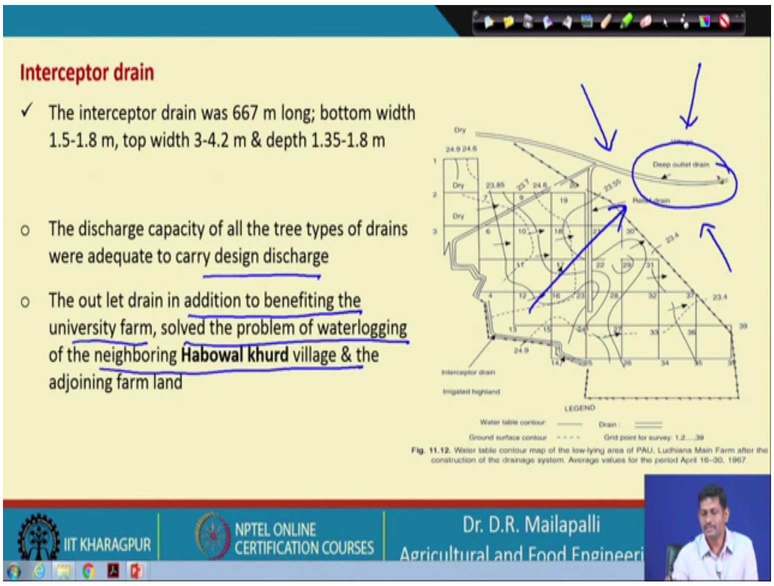

So, next intercepted drains has 667 meter long and bottom width 1.52 1.8 meter top width 3 to 4.2 meter depth is 1.35 to 1.8 meter. So, the ranges are because for different you know areas for from here to here and from here to here. So, they are several channels so the values of different based on the amount of runoff which is taking place or amount of flow which is taking from the upstream side and the discharge capacity of all 3 types of drains for adequate to carry design discharge.

So, that is that was I mean observed and the outlet drain in addition to the benefiting the university form. So, this whatever the outlet drain it solved the problem water logging of the neighboring villages to the adjoining form, so whatever say not only from the I mean water taking water is I mean extracting from the form. But, there are some areas the neighboring areas, so water also from other areas also going to the outlet drain. So, water logging for the neighboring villages also will be controlled using this.

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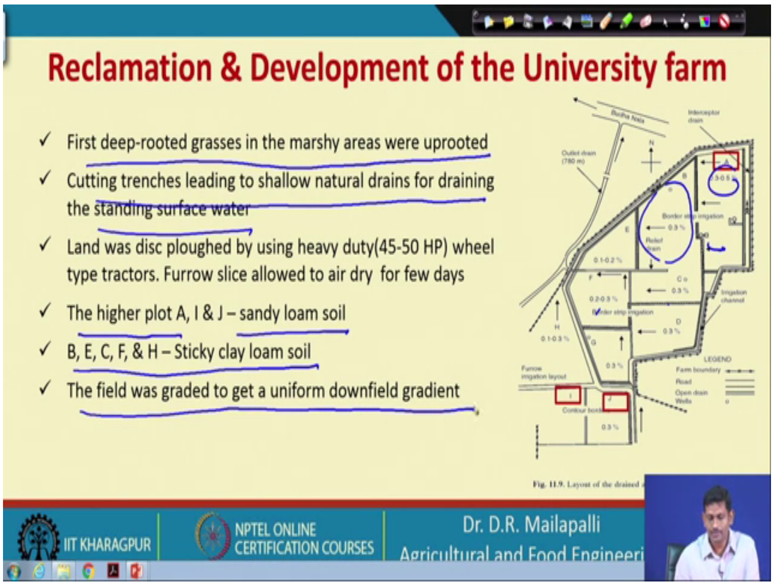

So, now next is once the drainage is designed to reclamation so that is development uniforms. So, first deep rooted grass in the marshy areas were uprooted because initially it was used as a by drainage so that is removed and then cutting trenches leading to shallow natural drains of drain standing. So, depressions connecting the depressions whatever the small depressions so that thing. And land was disc ploughed the entire area was you know whatever the area which is taken place here so, land was disc ploughed and maintained you know different grades.

So, the higher plot A J I that mean, so I suppose I J and A these are higher plots which does not have any solved problem. So, which has a sandy loam soil and B E C F sticky clay loam soils so and the field was graded to get uniform down for gradient so that is that is the.

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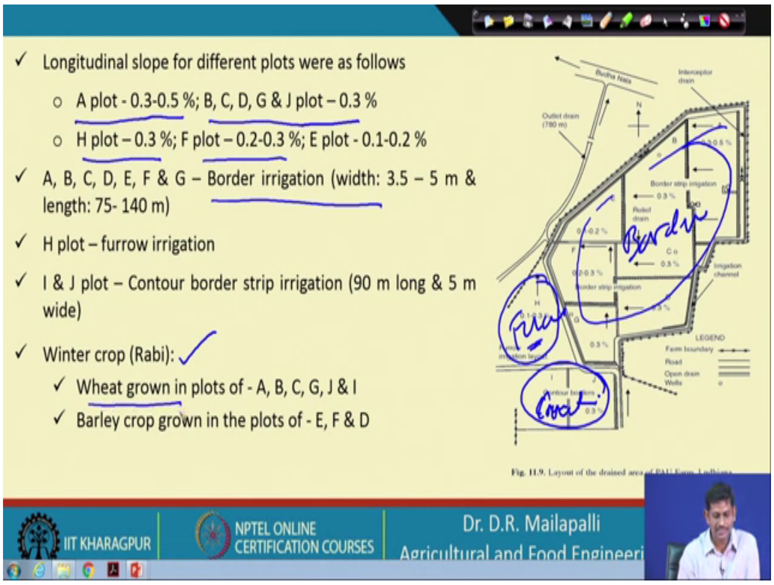

So, the grades here maintained were the for plot a point 3 to point 5 B C D plot 0.3 percent H plot 0.3, so like that the so based on I mean assuming the minimum at work moment as well as the cost of you know construction cost of leveling into consideration. So, the grades were decided and A B C D E F so border irrigation so all these things.

So, so H plot is a furrow irrigation right I J plots contour irrigation this is for contour this is for furrow irrigation and the next all other plot this is a border irrigation this is a border irrigation this is the furrow irrigation and this is a contour forming. So, and then water winter crop in the Rabi season, so that is wheat is grown plots of A B C G. So, A B C G all this plots except in E F D so E F and D, so these 3 plots so barley was grown except that all other I mean areas the wheat was grown. And then there is a water samples collected from the drainage water.

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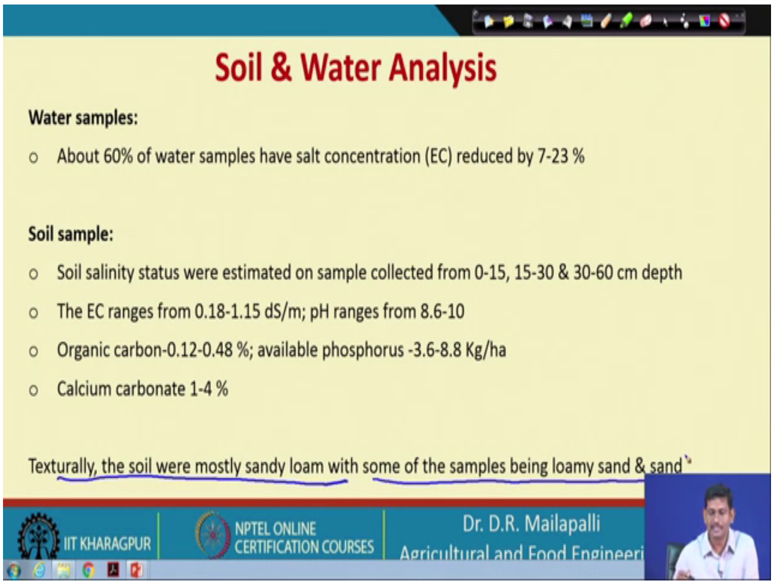

So, it was observed that 60 percent of water samples have salt concentration reduced by about 23 percent ok, at most 23 percent of salt concentration was reduced compared to you know 1967 and 1967. And soil samples were taken from different depths in the area. So, the EC was observed from 0.18 to 1.15 decisiemens per meter pH also range for 8.6 to10. Organic carbon varies from 0.1 2.48 available phosphorus 3.6 to 8.8 in calcium carbonate 1 to 4 percent.

So, these chemical properties clearly shows that the land is or the soil is reclaimed, I mean after I mean the drainage after installing the drainage system. Texturally the soils were mostly sandy loam with some of the samples being loamy sand and sand so this is also I mean the after textural analysis it was observed.

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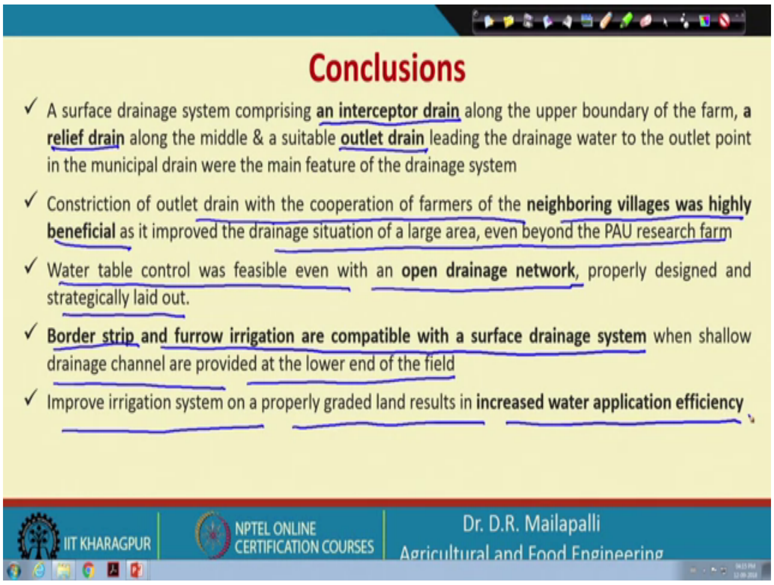

The conclusions from the case study include the surface drainage system basically comprise of interceptor drain ok, so then relief drain and outlet drain. So, interceptor drain used to extract water from the upland area relief drain is to you know extract water from the surface and subsurface of the problematic area and outlet drain to you know carry the both water from intercepted drain and relief drain to the Budha Nala ok.

So, then construction of outlet drain with the cooperation of farmers in the neighborhood villages was highly beneficial because, I mean not only the form is benefiting this is definitely getting you know the water from other neighboring villages and their fields also really I mean they can be used to you know grow more crops without any salt problems reduce salt problems.

So, water table control was feasible even with an open drainage network properly designed and strategically laid out. So, in this if you see the drains are open drains or drains so this is clearly shows that even with open drain system you can you know maintain the water table in the particular area.

Border strip and furrow irrigation are compatible with a surface drainage system when shallow drainage channels are provided the lower end of the field. So, border and furrow irrigation or compatible with the drainage system and improve the irrigation system on properly graded land results in increasing water application efficiency.

So, the finally so irrigation system definitely improved with the you know laying of the drainage system plan drainage system and that definitely increased with the application water application efficiency ok. So, this I mean this particular case study gives an you know very good example of using you know drainage system in a problematic area and how it is been used to reduce the salt content or salt affected areas are lower down the I mean ground water table in the problematic or drainage problematic areas like you know agricultural fields ok.

Thank you so much.