**Irrigation and Drainage**
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**Lecture - 54**
**Economics of Drainage Project**

Friends this is lecture number 54 of Irrigation and Drainage course; in this course we are going to learn the Economics of Drainage Project. So, basically if you once we are looking for you know investing the money in drainage project. So, basically we would like to know how much whether it is beneficial if you put money on this drainage project like 5 years or 10 years or 30 years down the line. So, basically this is very important because, this involves lot of cost right like investment and constructing the drainage channels and laying out the tiles.

So, all those things there is a lot of investment involved. So, if you put investment ok so, whether this is worth to invest this particular money in drainage project. So, that you will attain the desired benefits in 20 years or 30 years down the line ok. So, here what we are going to see we are going to lend different terminologies initially then, followed by discounting cash flow method and then different financial or the economics indicators to understand whether the investment we are keeping or we are putting in drainage project is really beneficial or not ok.

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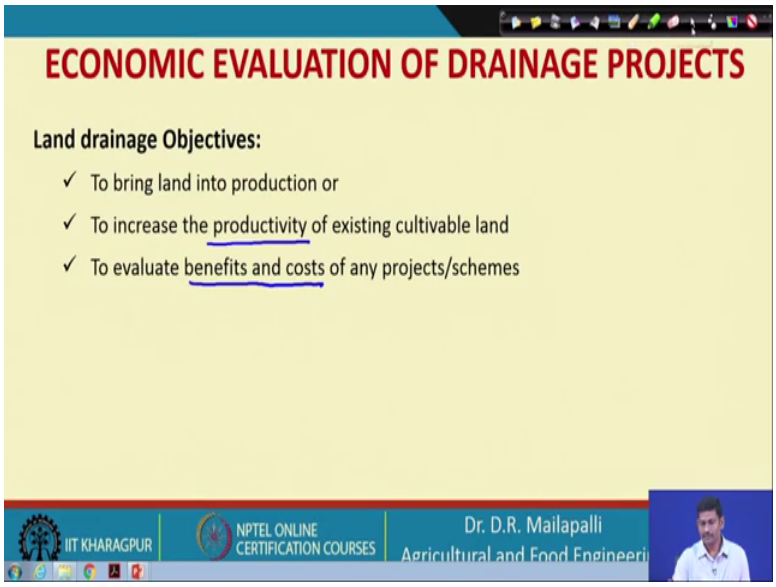

So, then here main the objective of the land drainage basically to bring land into production so, this is number 1. So, whatever the land which is under enunciated or the waterlogged condition; so, the number 1 objective is to bring that particular land into production and the second to, the second is to increase the productivity of existing cultivable land.

So, the productivity; that means, the yield divided by amount of water we are giving to the plant. So, that productivity needs to be increased and second is to evaluate the benefits and cost of any you know project scheme or in this here the drainage project. So, these three objectives are basically we look into in drainage projects ok. So, then next is sorry.

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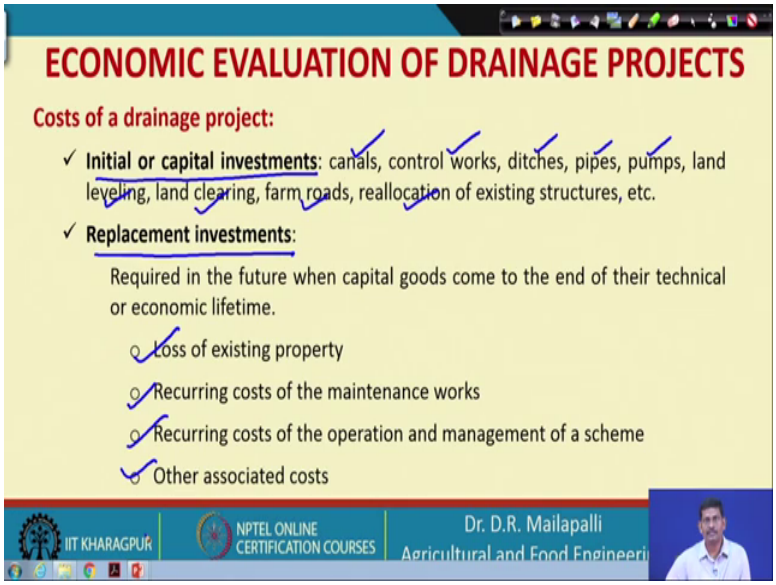


So, the cost of drainage project; so, cost involves for example, initial or capital investments. So, this is basically two canals right and control works, ditches, pipes, pumps you know land levelling, land clearing, farm roads, reallocation of existing structures so, etcetera. So, these things require initial investment. So, this is that we can categorize as a cost and then there are some replacement investments this is also you know has cost. For example, loss of existing properties, suppose your drainage project is going on and all of a sudden you know some you know natural calamity happened and you lost some of the properties and the other one is recurring cost of maintenance works.

So, every year you have to put some cost on maintenance and recurring cost of operation and management of the scheme and other associated costs such as some kind of you know remoulding all other things ok. So, this is basically so, the two categories of costs the first one is investment like the initial cost and second what is the maintenance cost ok; so, basically the two broad categories.

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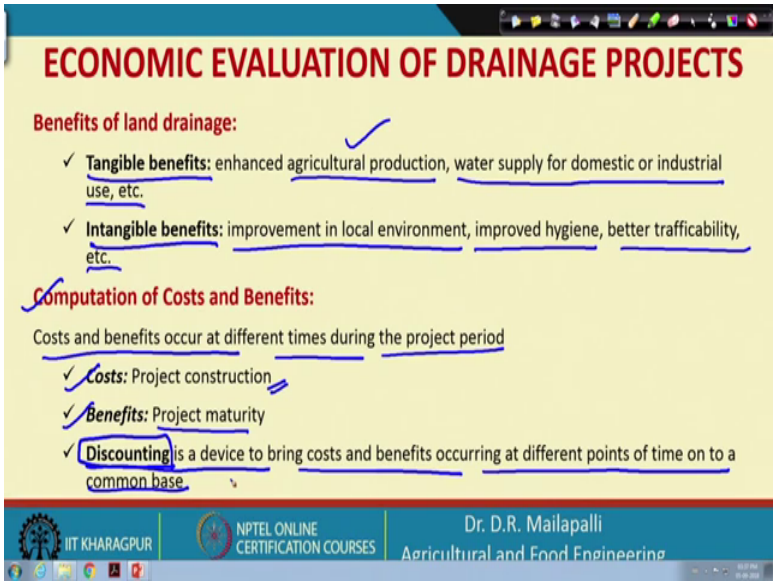


Then so, next is what are the benefits? So, the benefits here the classification so, it is like a tangible benefits. So, tangible benefits are or directly you can see the benefits like enhanced agricultural production like increasing the yield; that means, they right now the land is a arable. So, before it was a not good for agriculture production now because of the drainage you will be able to grow the crops. So, that is why the agricultural production is going to enhance and water supply for domestic and industrial use etcetera.

So, whatever the outflow you are getting from the drainage. So, that can be treated and used as water supply for domestic and also for industries. So, this is a directly our direct benefits from agriculture, I mean drainage. So, then other one is a intangible benefits like the indirect benefits or you can see the improvement in local environment because, of you know the water the impound water or the pond water is been the (Refer Time: 05:37) water is being taken out.

So, the environment will be clean right. So, that really improves the local environment and improved hygiene and better traffic ability because now the soil is like a aerated and

it will be most suitable for trafficking and etcetera. So, these benefits are categorized in basically two classes: one is tangible benefits and intangible benefits and then the computation of a cost and benefits this is very important. So, once the project is done so, finally, we are going to see the cost benefit ratio.

So, that is if that is more than 1 then their investment here putting in the particular drainage project definitely will be a worth ok. So, here the computation of cost and benefits, the cost and benefits occur at different times during the project period. The whole project period are going to classified into three you know time periods.

So, one is a you know economic life, actual life you know terminal life. So, something like we are going to discuss those and the cause project construction ok. So, and then benefits are like a project maturity. So, generally the cost are happened during initial stages like project construction and benefits; once the project gets maturity then you get the benefits.

And then discounting is a device to bring cost and benefits occurring at different point of time on to a common base. So, since the cost and benefits are happening in two different you know time periods or different time periods. So, in order to understand the investment you put now whether reality it is useful, I mean reality it is worth to invest in the particular project or we will be able to get the benefits after 20 years.

So, what happened the benefits and costs they are the different time period. So, in cost benefit analysis what we do; so, benefits and the cost will bring the both you know on the same base and we will compare whether it is I mean whether we get profits or not. So, for that this discounting cash flow analysis is very important. So, discounting will be a device used to bring the cost and benefits on the or of that different time lines and to bring to the same time then compare those things ok.

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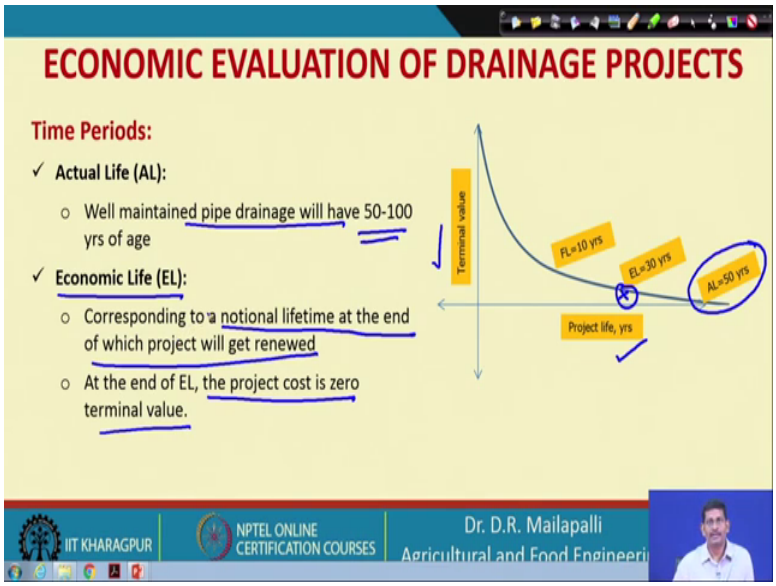


So, then next is the time periods of the drainage project, if you see the project life on you know x axis in years and terminal value on y axis. So, here the actual life so, actual life is generally you know 50 year 50 to 100 years for drainage project. So, well maintained pipe drainage will have you know up to 50 to 100 years of age so, that is actual life. So, generally at actual life you do not get any terminal value. So, terminal value will be zero the project terminal value is zero, but you can the project can continue.

So, then the next time line I mean that life is economic life so, this is a economic life. So, corresponding to a notional lifetime at the end of which project will get renewed. So, economic life what happened; so, the once you take the end of economic like the project cost is zero terminal value. If you see our minimum or zero terminal value can be achieved at the end of economic life. So, beyond that the value of the particular project will be zero for example, you buy a car right.

So, initially the life will be more in a operational first year, if you the resale value will be more then you know during the course of time or after usage like you know 5-10 years the resale value will be less. But, after sometime after you know 10-15 years if you see so, this will be you know still have a zero value, but you can still use it. So, that is economic life so, economically it is a zero value right. So, that is project then the next is a ok.

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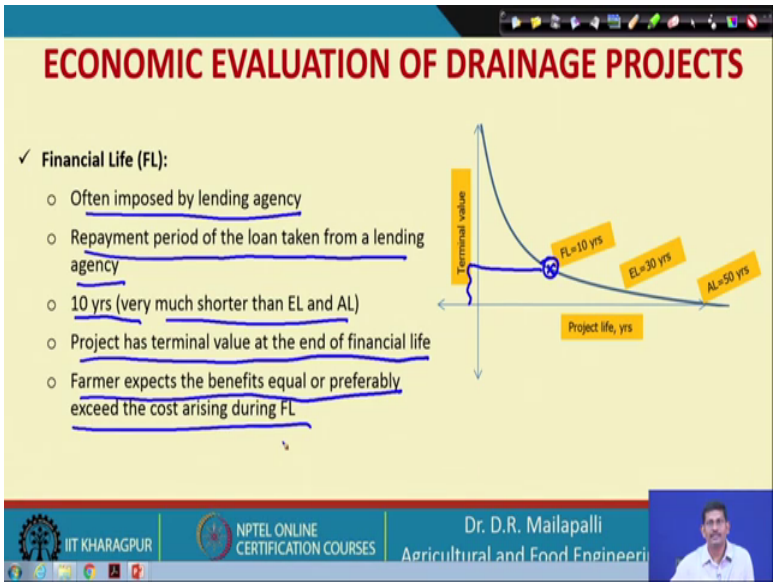


So, the next is financial a life. So, in the financial life generally they often imposed by lending agency. So, if you are taking you know loan from a financial company. So, they decide like 10 years or 15 years of time. So, that is the financial life and repayment period of the loan taken from a lending agency. So, this is basically the repayment period 10 years very much shorter than EL and AL like economic life and actual life so, this is 10 years basically. So, the project has terminal value at the end of the financial life. So, even at the end of the financial life it has some terminal value ok.

So, farmer expects benefits equal or preferably exceed the costing arising during the financial life. So, still farmer expects the benefits equal or exceeding what he was you know planning during the financial life. So, these 3 life's are very important in design I mean during the economic analysis of a drainage project.

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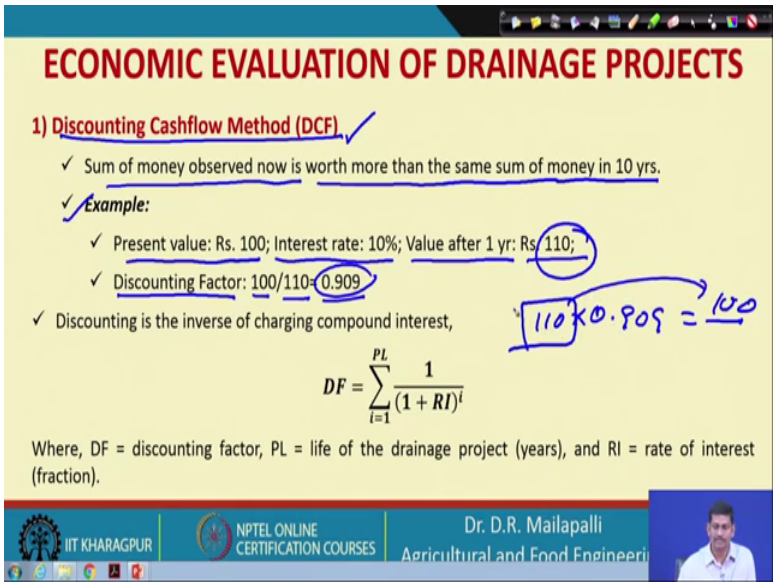


So, the next is as I said the Discounting Cashflow Method. So, this is very useful in order to understand the investment you know investment you made today definite whether it is really worth in 10 years or not. So, what happened the benefits will be bring back to the present value right; the benefits which is happening in 10 years so, that value will be you know taken back to the present value and compare the cost and benefits. So, that in discounting cash flow method we are going to see that. The sum of money observed now is worth more than the same some money in 10 years.

So, this is what we I mean test in case of discounting and cash flow method. For example, here the present value of an asset is 100 rupee right and interest rate is 10 percent and value after 1 year would be 110 rupee. So, this is simple math like PNR by 100 if you which you substitute you know 100 rupee and 10 percent interest rate and 1 year.

So, you after money you get 10 rupee extra so, 110 rupee. So, the discounting factor would be 100 divided by 110 that is a 0. 909 is the discounting factor. So; that means so, if you are expecting 110 rupee in next year I mean 1 year, if you are expecting 110 rupee in a year. So, how much you need to invest? So, that is the 110 multiplied by the discounting factor that is 0.909 so, that that will be 100 rupees. So, that means; so, the benefits 110 you bring to the you know original value 100 rupee ok.

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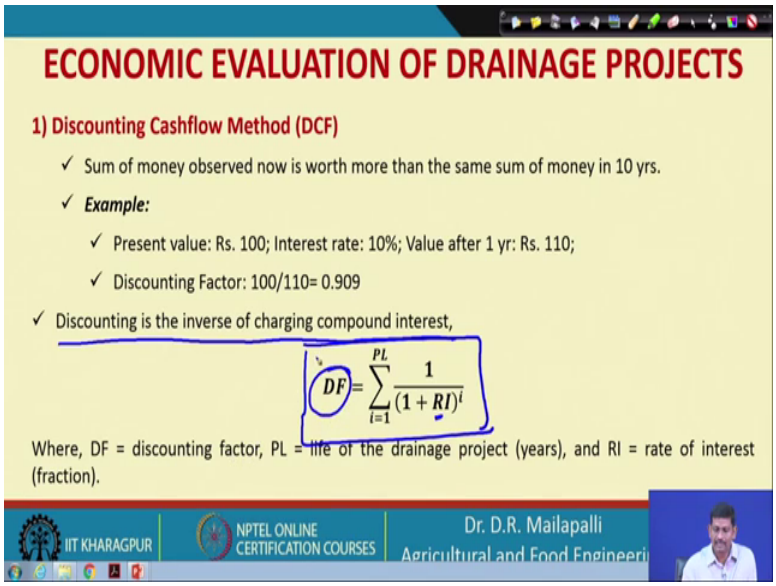


And the discounting is the inverse changing compound interest. So, this is the equation we will be using it for estimating the discounting factor. So, that is a you know every year this is yearly. So, i equal to 1 to PL, PL is a project life 1 by 1 plus rate of interest power i, i is the number of years ok. So, in this way this is the discounting factor and there is a table and there is a table available for this calculating the discounting factor.

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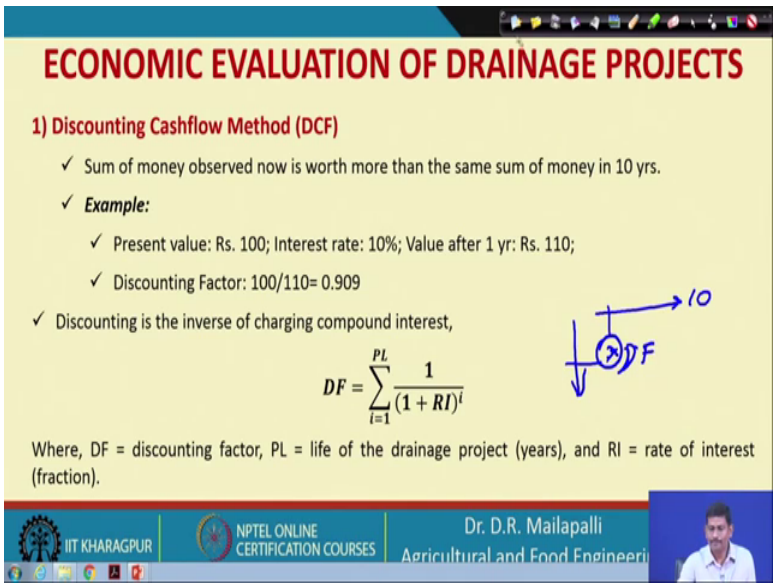

If you know the number of years and then number of years and then percentage I mean rate of interest on x and y axis then you get the particular you know the DF ok. So, here we are going on the see that oh here.

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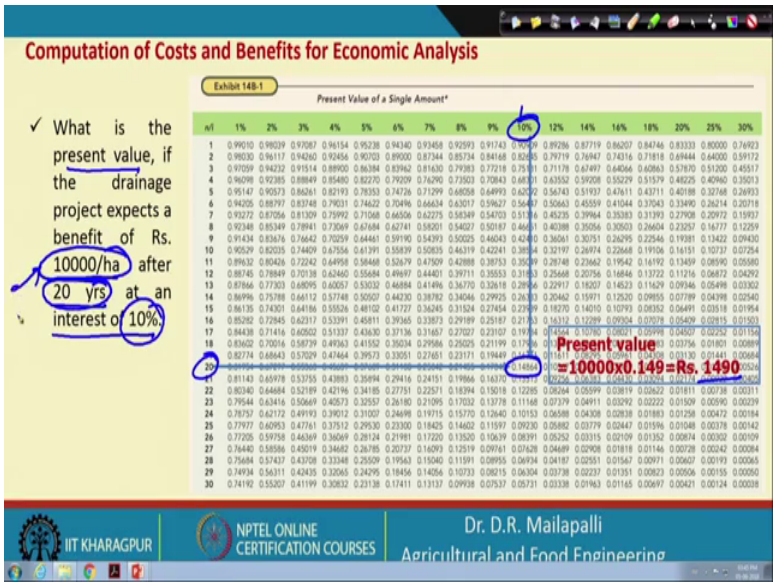


So, this is a table for example what is the present value right, what is the present value if the drainage project expects a benefit of 10000 rupees per hectare after 20 years at an interest of 10 percent ok. So, you are expecting 10000 rupees per hectare in 20 years and if you are investing in this particular project at a rate of 10 percent; so, what would be the present value of this? So, for that this is the discounting in our table.

So, this is a 10 percent and at 20 years 10 percent 20 years. So, you got like discounting factor there is a 0.14864 and if you can multiply with 10000 you get 1490. So, the present value of 10000 hectares is at 10000 rupees per hectare is 1490 rupees per hectare ok. So, if you can invest 14990 rupees per hectare now like at a 10 present interest rate for 20 years you may you expect 10000 rupees per hectare from the project ok.

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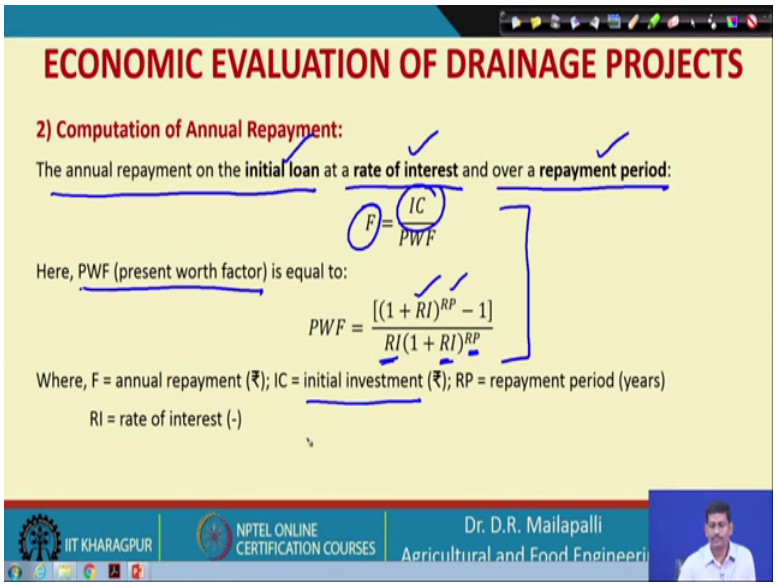


And then a computation of a annual repayment. So, once you decided so, this much you have to invest right. So, then you have to take loan sometimes you do not have money you might to take the loan. So, once you are taking loan so, how to estimate the annual repayment. So, here the annual repayment on initial loan at a rate of interest an over a repayment period so, here initial loan, loan amount, rate of interest and repayment period.

So, these three parameters are required. So, where so, F is the annual repayment is equal to. So, IC that is a IC is the initial investment. So, that is the initial loan and then PWF so, that is present worth factor. So, present worth factor again you know a calculated by 1 plus the rate of interest right and a repayment period minus 1 divided by rate of interest 1 plus rate of interest power repayment period ok. So, these two equations using these two equations you will be able to find out the what is the repayment you know annual repayment amount for a particular loan amount ok.

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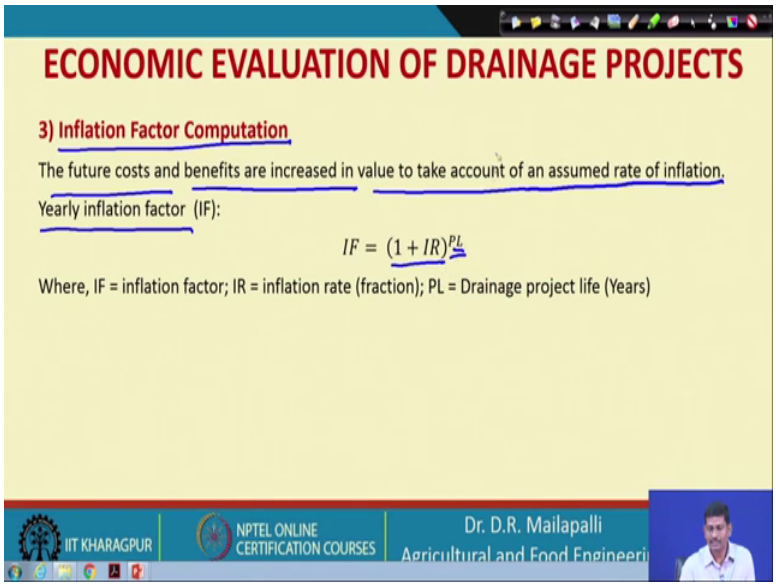


And then third is the inflation factor computation. So, inflation; that means, so, the amount of a particular you know object will definitely, will increase in you know in future years ok.

So, the how there is a particular factor. So, that is called inflation factor. So, the future cost and benefits are increased in value to take account of an assumed rate of inflation right. So, yearly inflation factor so, that is 1 plus you know interest rate power project life. So, this is a inflation factor which is computed with an equation 1 plus IR that is in interest rate and then project life and this is also I mean there is a table available for inflation factor.

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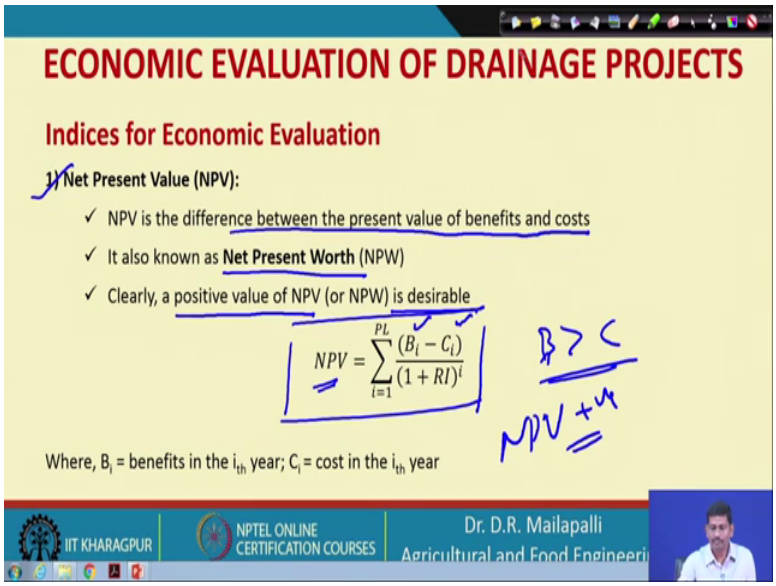


You can find out the inflation factor from that table. So, then there are financial economic indicators. So, through which we can decide whether the investment is really beneficial or not. So, one is the Net Present Value NPV we called. So, NPV is the difference between the present value of benefit and cost ok. The present value of the difference between the benefit and cost and it is also known as net present worth NPW and clearly a positive value of net positive worth or net present worth or net positive value.

So, which is described within equation which is equal to benefit minus cost divided by 1 plus R I that is rate of interest power i ok, this is so, every year we are going to find out what is a cost benefit difference right and then the corresponding 1 plus RI power i. So, then that will be the net present value ok. So, the net present value generally it needs to be a positive value because the benefits should be more than the cost and the indicator here is the NPV should be. So, NPV should be positive that is one thing. .

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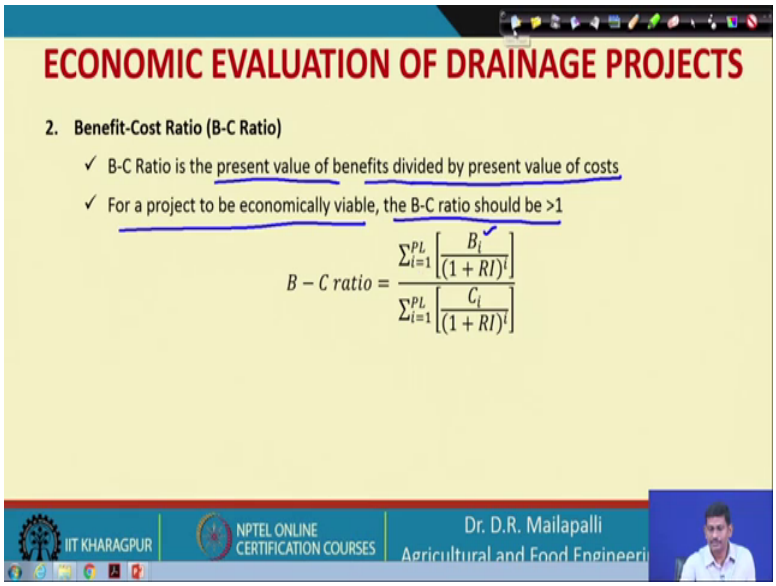


And then so, the next is benefit and cost ratio. So, benefit and cost ratio is the present value of benefits divided by the present value of the cost right that is the ratio. So, for a project to be economically viable the benefit cost ratio should be more than 1 ok. So, because benefit is always more than cost in case of profits; so, B C ratio is estimated by the every year anyway. So, this is benefit divided by 1 plus RI power i and cost divided by 1 plus RI power i this is BC ratio.

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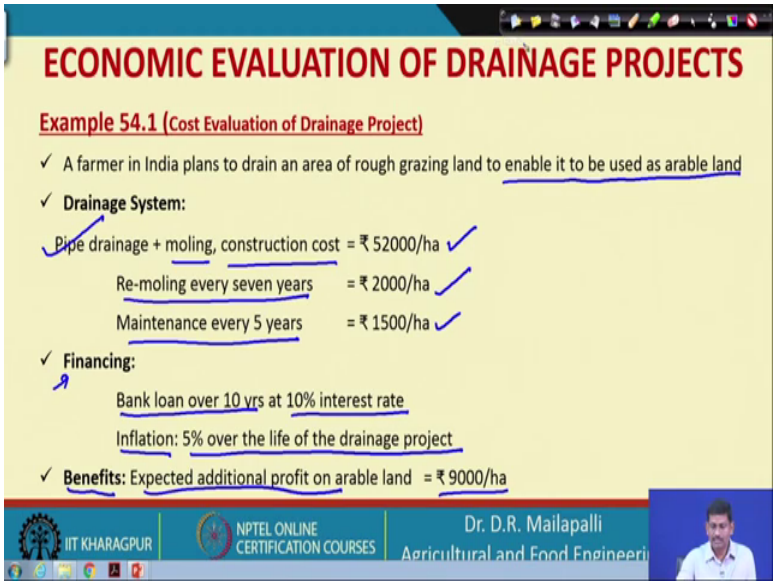

So, now let us see an example here the cost evolution of a drainage projects. So, a farmer in India plans to drain an area rough grazing land to enable it to be used as a arable land. So, there is a waste land. So, I mean grazing land basically the grassland. So, he wants to turn that into a agricultural land.

So, drainage system here he planned for a pipe drainage with moling construction cost that is a 52000 per hectare and re moling every 7 years right. So, that is 2000 per hectare in which and maintenance every 5 years 15000 per hectare. So, these are the in other costs and he went for financing right. So, the bank loan or 10 years at 10 percent interest rate and inflation 5 percent over the life of the drainage project ok.

So, the benefits what he is expecting is the expected additional profit on arable land is 9000 rupee per hectare. So, he that us what he was expecting 9000 per hectare. So, let us see let us evaluate the cost and benefits of this particular project and whether he is investment is beneficial or not ok.

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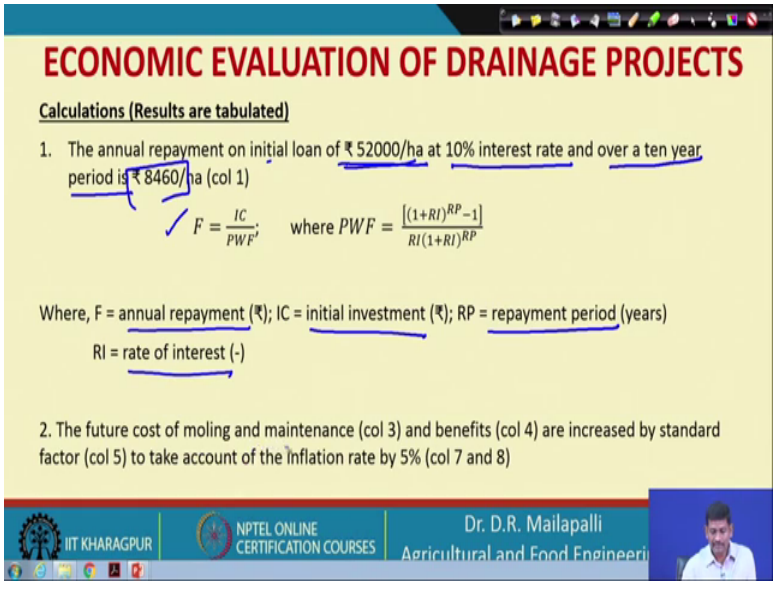


Calculations here if you see so, the annual repayment period on initial loan. So, this is what he got a loan from a bank or financial company at 10 percent interest rate and over 10 years 10 years period. So, this is around 8460 per hectare ok. So, this is from the formula capital F is equal to IC by PWF present worth factor.

So, the present worth factor has a formula. So, knowing the values now annual repayment so, and this initial investment repayment period and rate of interest. So, putting those values you get the annual repayment will be 8460 per hectare every year ok. So, the future cost of moling and maintenance. So, I am going to show you the table because the all analysis was done in an excel file. So, let us see the column by column. So, here the first column will be like if you see here.

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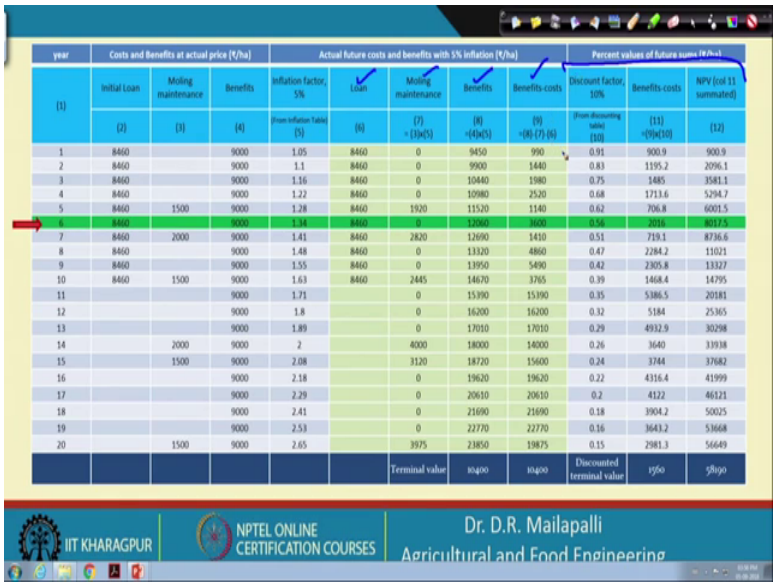


This is the first column sorry so, the first column initial loan amount every 8460. So, that is what here 8460 per hectare column number one that is the annual repayment ok. So, he has to repay all these things and then this third columns you see the maintenance sorry this is the second column the loan amount is this is a column number 2 ok. So, this is the column number 2 and then next is the column number.

Here if you see the second you know point. So, that is the future cost of moling and maintenance that is a column number sorry. So, the column number 3. So, every 5 years right every 7 years remoling every 5 years you know the maintenance right a maintenance 1500 rupees. So, like that. So, again after 10 years it is a maintenance 15 years maintenance 20 years maintenance.

So, remoling 7 years 14 year and 20 year ok; so, that is the thing so, that is the column number 3 and then column number 4 that is the benefits. So, column number 4 and benefits are increased by standard factor to make account inflation rate by 5 percent. So,

he will we are going to so, column number 4 sorry yeah column number 4 there is a benefits. So, that is what he initially he is expecting these benefits right. So, this is the benefits. So, that is in sorry ok, that is in column number 4 benefits. So, maintenance more make column number 3 benefits column number 4 and inflation factor that is a 5 percent.

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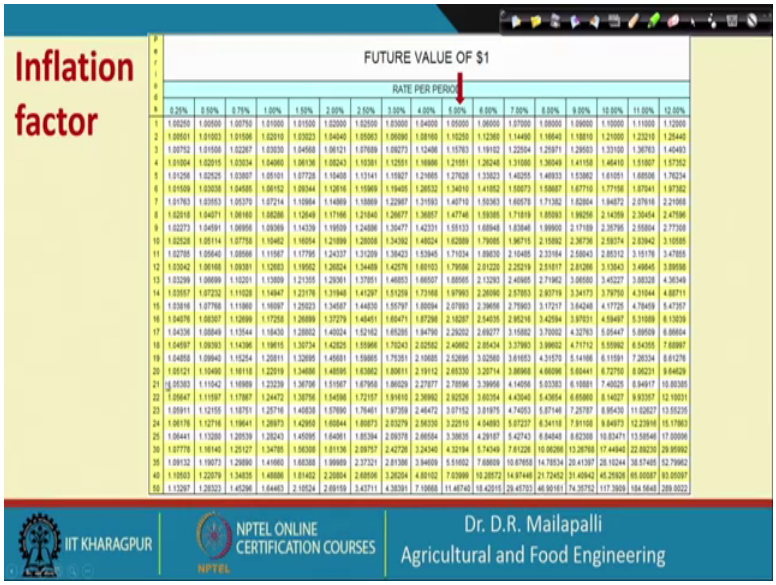


So, for 5 percent there is a table this is the inflation factor table. So, if you see the 5 percent right it is the mark c 5 percent mark and then up to 20 50 years it is given we will take up to 20 years. So, this whole column will be taken out from here and inserted in here this is our 1.04 1.1 this is from 5 percent and up to 20 years ok. So, that is column number 5 and now this is actual future cost and benefits the 5 percent business. So, we are going to with this inflation rate you are going to translate all these values right except you know the initial loan amount. So, loan amount will be same that is in column number 6 and moling and maintenance.

So, that is called number 7 which will be equal to the column number three mole maintenance and the inflation multiplied by inflation factor. So, that is column number 7 and benefits. So, the benefits also needs to be inflated so, that again 4 multiplied by the inflation factor. So, that is benefits column number eight ok. So, now and now benefits minus cost so, you know the benefits here. So, you know the benefits here and you know the cost.

So, cost in the sense the loan amount and moling and maintenance ok. So, these so, benefits minus cost is sum of 6 plus 7 and benefits. So, this is a cost minus benefits minus cost so, this column ok. Now so, this is actual future cost so, what we what we have to do in discounting cash flow analysis. Now we have to bring this future benefits into the present value. So, that I mean if you see from here to here. So, we are going to see we are going to bring the future value to the present value ok. So, let us see the discount for this ward we need a discounting factor.

So, discounting factor there is a table for 10 percent. So, for 10 percent interest rate for 20 years you will have the table values like this let me see whether I have the table or no not here, but previously I was showing you like here so, this is this 1. So, this table so, from this table 10 percent and 20 percent. So, the whole you know column will be taken and incorporated in column number 10 ok. So, with the discounting factor now we can bring back to the present value here benefits minus cost; that means, the column number 11 column. Number 11 will be equal to discounting factor multiplied by benefits minus cost ok so, this one.

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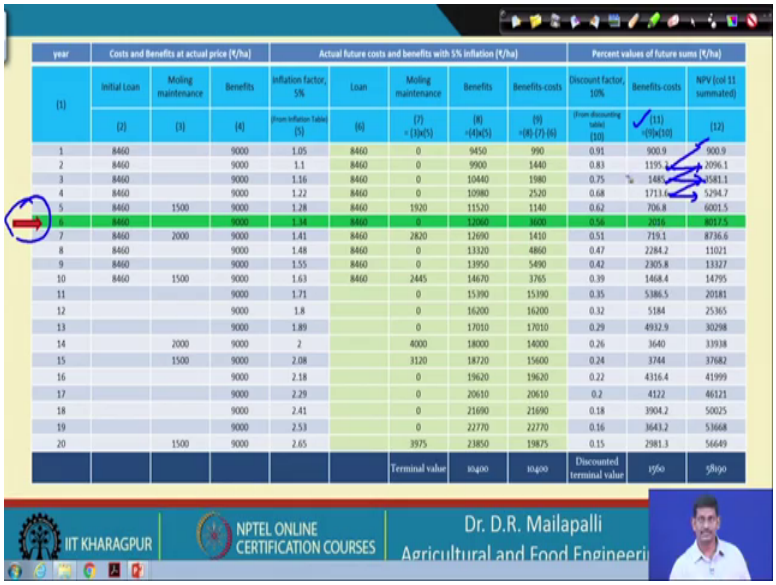


So, this is the present value now NPV net present value. So, this will be a actually every year you need to. So, this is a sigma so; that means, every year you need to accumulate I mean sum up. So, this is initial right 900 now 900 plus this one will give this and 2096 plus 1485 you get this right and this plus this you get this ok. So, like that this will be

summed up ok. So, now, the NPV is the present value of the future benefits or cost minus benefits ok. Now if you observe this all are positive the first thing. So, NPV is a positive so; that means, it is worth to invest and then let us focus on you know year number 6 and let us discuss the results here.

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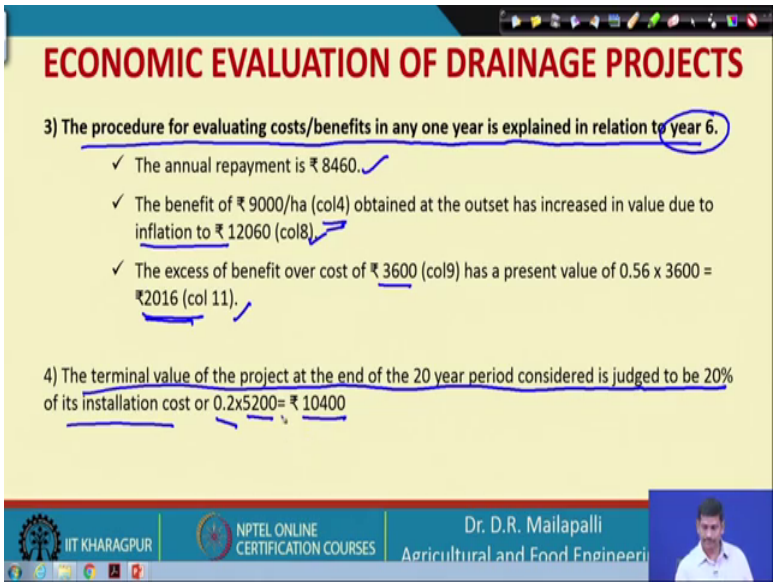


Let us go to the next this inflation factor and economic evolution if you see the third point, the second point there is a present values we know future values ok. So, the third point whatever we discussed over there like the procedure to evaluate cost benefits to any 1 year is explained in the year number 6. For example, the annual repayment is 8460 the benefit of 9000 per hectare is a column number 4 obtained at the outset has increased in value due to inflation ok. So, that is column number 8.

So, and then excess of benefit over cost that is the 3600 column number 9 has present value. So, that is this is the present value ok. So, the so, if you observe this. So, the present value here right so, the same thing if you see the column number 9 which is cost minus benefit minus cost. So, that is the present value. So, the terminal value of the project at the end of 20 years period considered to judge this 20 percent of its initial cost that is 0.2 times 5200 that is a 10400, if you see let us see in the table. So, the terminal value here.

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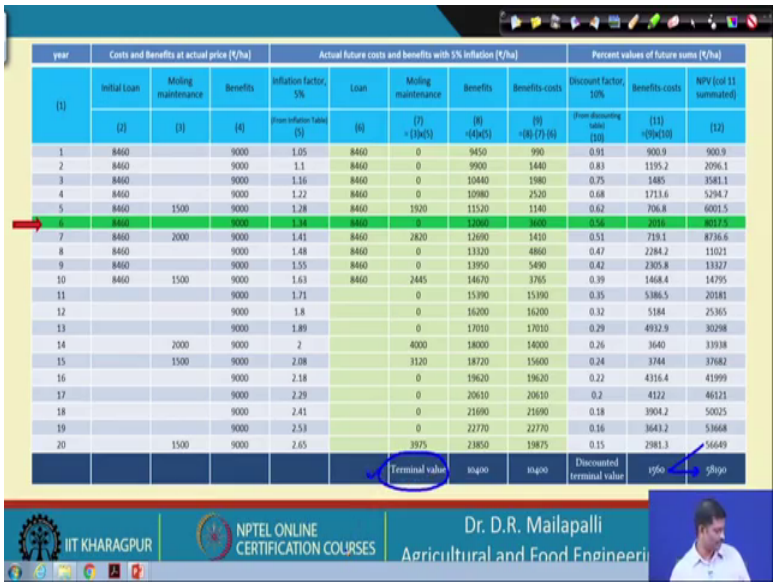


So, this is the terminal values, so, at the end of you know 20 years and benefits. So, benefits will be 20 percent dissolve you know the investment the 20 percent it is of investment and then benefits minus cost because, you only expect benefits and no cost that will be 0 cost. So, still benefits minus cost will be same. Now discontinued terminal value so, use a 0.15 you look at 1560 for this amount right benefits minus cost I mean this is a present value now.

So, now this plus this will be this 58190. So, that way you can also have terminal values ok. Now, go let us go back to the calculations. So, the term here this is the computation of you know for 6 years or 10 percent. And, if you can this is what 0.56 something like that that is what if you see here 0.56 multiplied by 0.56 we did 0.56 into 3600 the corresponding I mean 6 years benefits sorry ok.

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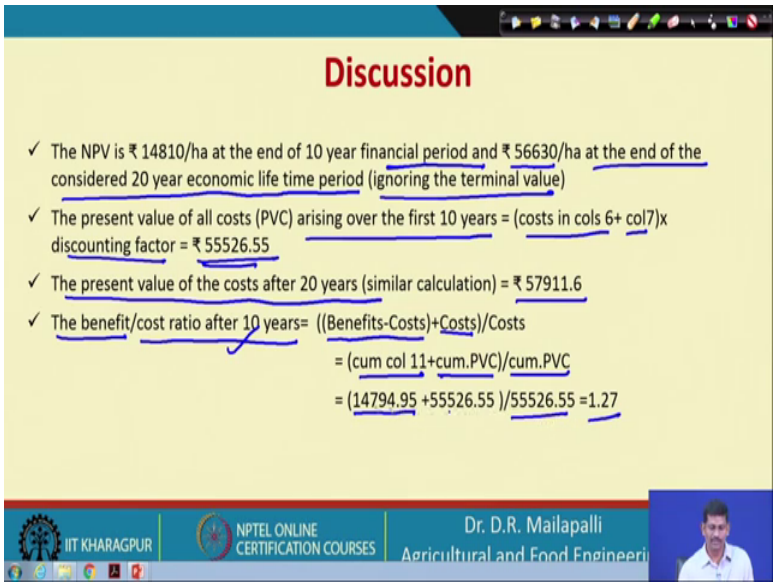


So, now discussion so, NPV is a 14810 per hectare at the end of 10 years, 10 years financial period and 56630 per hectare at the end of the considered 20 years economic life time period. So, you can if you can ignore the term terminal the present value for all cost PVC arising over the first 10 years. So, that is cost in column number 6 plus column number 7 into discounting factor.

So, that will be so, this much. So, this is what the present value of the cost and similarly the present value of the cost after 20 years you get 57911.6 and the benefits by cost ratio after 10 years so, right. So, benefits minus cost this is we have column number 11 and cost that is the column number we have cumulative PVC right the last column divided by cumulative PVC. So, from the table you get column number 11 for 10 years period that is a 14794.95 plus cumulative PVC. So, that is 55526.55 divided by the same you get 1.27 for 10 years the cost benefit ratio will be 1.27 for 10 years period.

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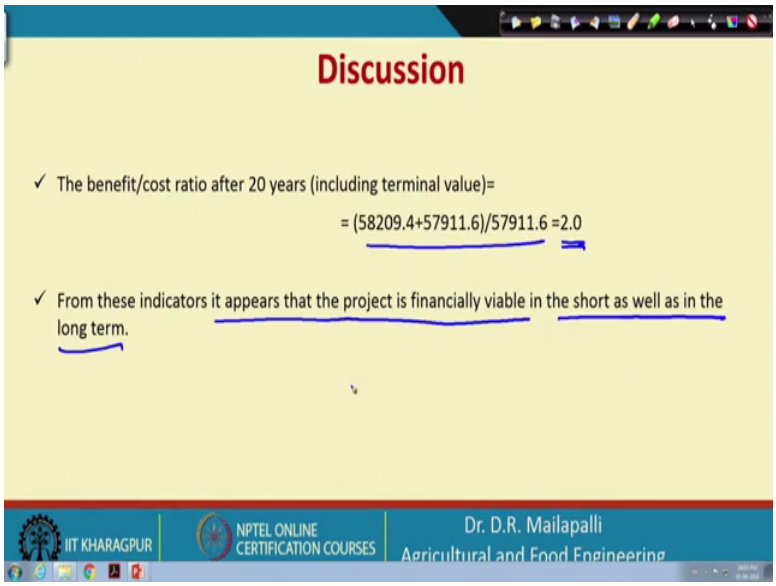


Similarly, for 20 years period we can also estimate cost benefit ratio. So, that will be like 2.0. So, from these indicators it appears that the project is financially viable in the short as well as in the long term ok. So, because the NPV that is net positive value is positive as well as the benefit cost ratio also the positive. So, that is why this is I mean worth to keep I mean worth to put amount or invest in this particular project; so, that you will achieve the desired benefits ok.

So, there is a thumb rule that if you are estimated like even 1 dollar like 1 dollar benefit right over a period of time definitely you need to invest in the particular project ok. So, this is all about the economic in the evolution of a drainage project. So, basically there are few terminologies we you know observed in this, what is a like project period.

So, the basically it has a financial life, economical life and then actual life. So, all these I mean the project has these three life's and the next is the discounting and also discounting cash flow analysis will be done to bring the you know benefits which are in the long run. So, that to be bring into the present value and compare with the cost and will be see whether we will be seeing whether there is a benefit or not right. So, that is the one thing it can be solved a problem on a cash flow discounting analysis ok. So, then is for this problem so, and thank you so much.

In the next class next lecture we are going to talk about some you know problems that is a tutorial right.

Thank you.