Advanced Aquaculture Technology
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Lecture: 04
Propagation Water Budget

Hello, everyone, welcome to the course Advanced Aquaculture Technology for the fourth lecture of Module 1, which is the propagation and water budget.

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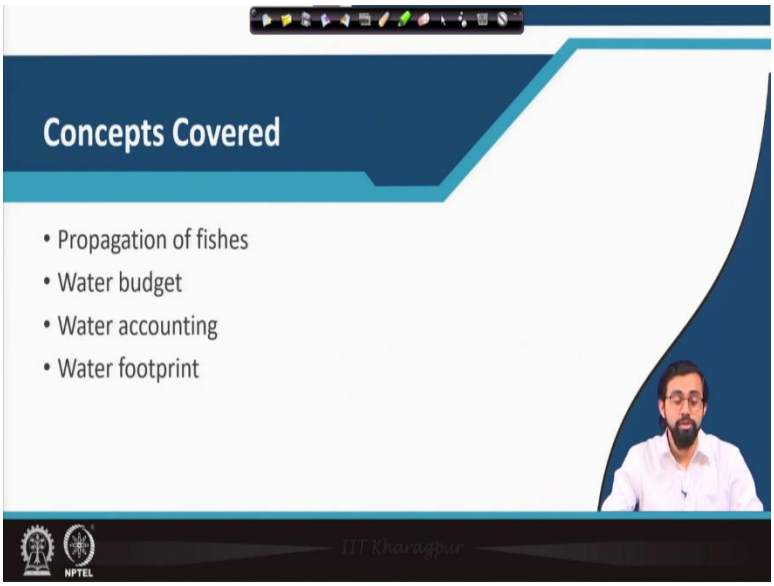

So, in this module, we have already learned about the basic aquaculture some basic aquaculture things. And now we will go ahead with the Propagation of fishes, Water budget, Water accounting, and the Water footprint of aquaculture systems and management's.

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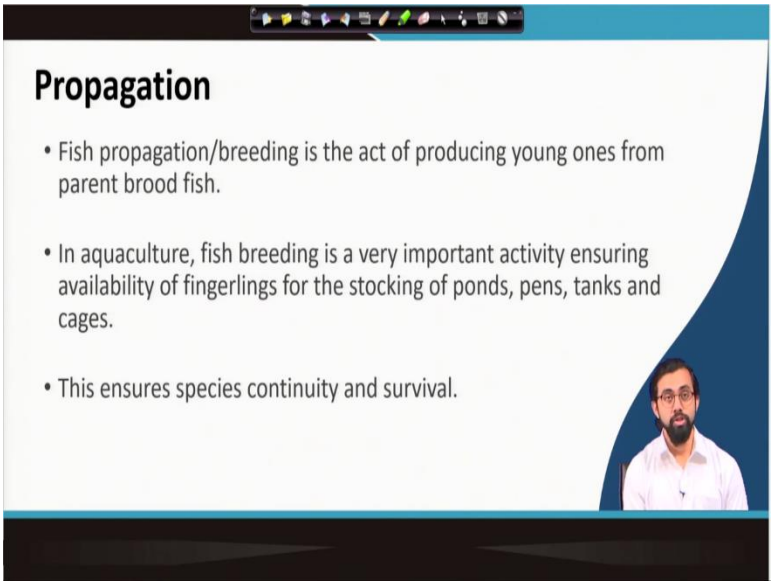

The first thing that we need to know about the propagation is that the breeding or the propagation it's only an act of producing the young ones from the parent brood fishes. So, in aquaculture the fish breeding, it is very important because in order to ensure that the availability of fingerlings are there for the stocking of ponds, pens, tanks, cages, or any aquaculture facilities that you are developing in your system or aquaculture farm that you are targeting.

It also ensures the species continuity and the survival and specifically like whatever the target culture species that you are, farming in your aquaculture farm. So, in order to have it in ample amount, and to go ahead with the year-long production and also the continuous production on the same, you need to have this propagation unit to develop the propagation methods, or you need to go ahead with the natural artificial, I will go I will discuss about it in details in the later slides.

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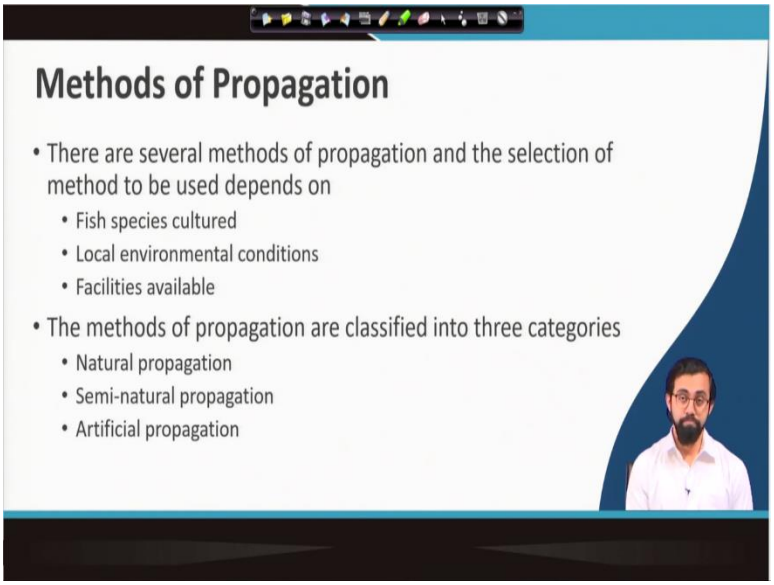

In general, the methods of propagation it depends on different factors. So, there are different methods of propagation but the selection of method it entirely depends on the fish species that you are culturing or the targets of culture species, it can be fish, it can many other aquaculture species, local environmental conditions.

The facilities that are available in the local vicinity, and if the methods of this propagation according based on this different criteria's it can be divided into three categories, the first one is the Natural propagation, second one is the Semi-natural propagation and the third one is the Artificial propagation.

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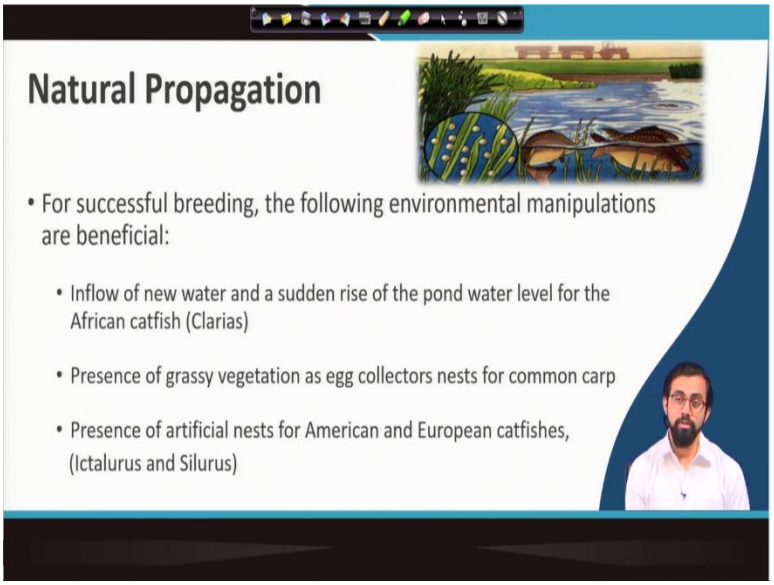

What is natural propagation actually, in natural propagation, you know, like we try to manipulate the natural conditions? And in the natural conditions, we try to go ahead with the propagation of the breeding of the culture species or the culture, whatever the target species that we are targeting in our farm.

So, in general, say I am giving you some examples in case of African catfish or the Clarias, what we do we try to increase the inflow of new water or the freshwater availability in the pond or in your tank, and sudden rise in that this pond water level, it helps the African catfish, to go for breeding it is in a particular breeding season.

In case of common carp, what we do we try to incorporate more amount of grassy vegetations in the pond bottom or the slope. So, that it will act as an egg collecting nest for the common carp, we can go ahead with the artificial nest we can inculcate or incorporate the artificial nest in case of American and European catfishes like the Ictalurus or the Silurus. So, in these kinds of fishes in these kinds of species, this presence of this artificial nest actually very much helpful so that they can go or the brooder fish they can go for the propagation procedure there in the nest itself.

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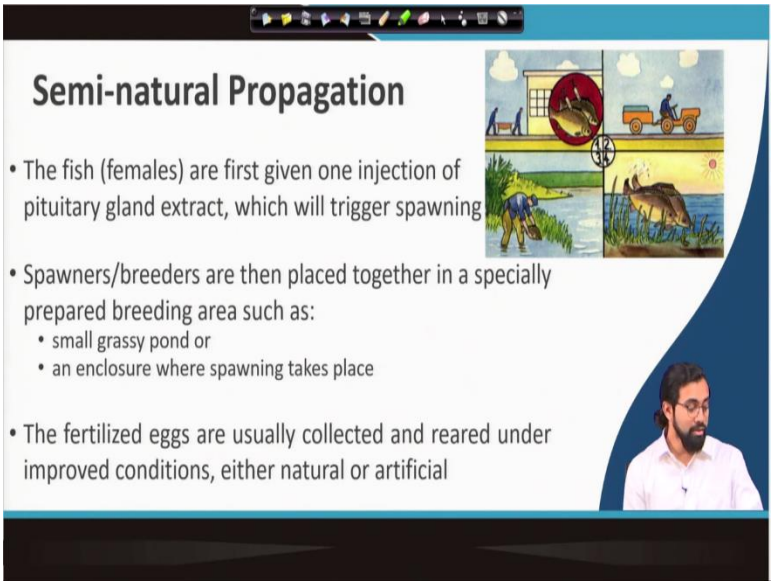

The second type which is a Semi-natural one, the semi natural one is the one where it is not we are not completely depending upon the natural procedures rather we try to incorporate some additional artificial methods. So, not entirely the artificial propagation ones but it is like semi one. So, in these particular cases, what we do we try to first inject the female fish with a pituitary gland extract.

So, which definitely triggers the spawning activity in them and then what happens this spawners or this breeders then after this gland injection after the injection of this pituitary gland extract, we take it out of the school and we put it in the small grassy pond or say like an enclosure where the spawning text place as we call this spawning tank as well.

So, we try to prepare it prepare the land or the breeding area before head, it can be based on your construction based on the space availability based on the type of species the breeding specie, the type of the brooder fish that you are culturing, that you will be culturing there. So, based on that, you have to design it accordingly.

And all this discussion about the design and consideration like engineering consideration, we will be discussing even maybe in the later lectures. So, at this stage, you just need to know that enclosure has to be sufficient enough for the breeders or the spawners to survive in a very optimum environmental condition for them to go for a the proper spawning so this fertilized eggs, which after the spawning is taking place.

So, those are collected and they are reared under the improved conditions either naturally or artificially. So, this kind of propagation techniques, we call it semi-natural techniques. So, it is very much famous a and even in nowadays all over the world, but in order to go for the more intensive aquaculture system sometimes and also based on some the demand of the species, we have to go for the third and the last propagation method that we are going to discuss is the artificial propagation systems.

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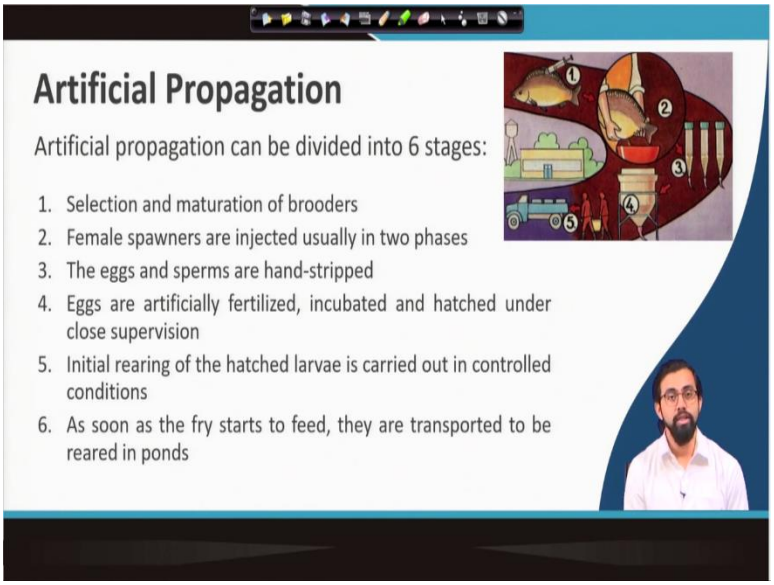

In case of Artificial Propagation, it can be divided or it can be like divided in like 6 stages, 6 different stages, first, you have to go for the selection of the brooder fish. So, you have to go to the school and you have to go to the school of fishes and you just try to find out the fish, the female fish with its optimum conditions.

There are different criterias depending on the species that we need to think upon like the before while choosing the brooder fish, so that the best you know quality is kind of transferred to the offspring to their offspring. So, that is why we try to have the best quality brooder fish and we select them there are selection criteria spawners and the maturation of the brooders is the first stage.

Then this female spawners are injected usually in two phases, then the eggs and the sperms are hand stripped from this in during these particular methods, and these eggs are then artificially

fertilized and incubated in incubation, incubators and also the so, to have a proper, how to say like optimum condition for them to grow.

And so that they will hatched in the close supervision methods. So, these eggs are like placed in a incubator as I already told and so, that this kinds of incubators are actually not so costly, but you can have it in your farm and you can even develop it like you know from the local using the local technology also.

So, these incubators are used to maintain the proper temperature, that is the first and foremost thing that temperature has to be maintained and also there are other incubation criterias as well which have to maintain. So, in order to have these eggs properly hatched in these incubators in proper condition.

Initial rearing of the, these hatched larvae is carried out in a controlled condition in a rearing tank in a but then the soon after the fry starts, they start to feed they are transported to the proper rearing ponds. So, there are initial rearing ponds and the final stage of rearing ponds, the initial reading ponds on the like pre-straining rearing ponds those where we go for this initial rearing of these hatched larvae and then we go ahead with the further procedure in the final the larger size rearing ponds.

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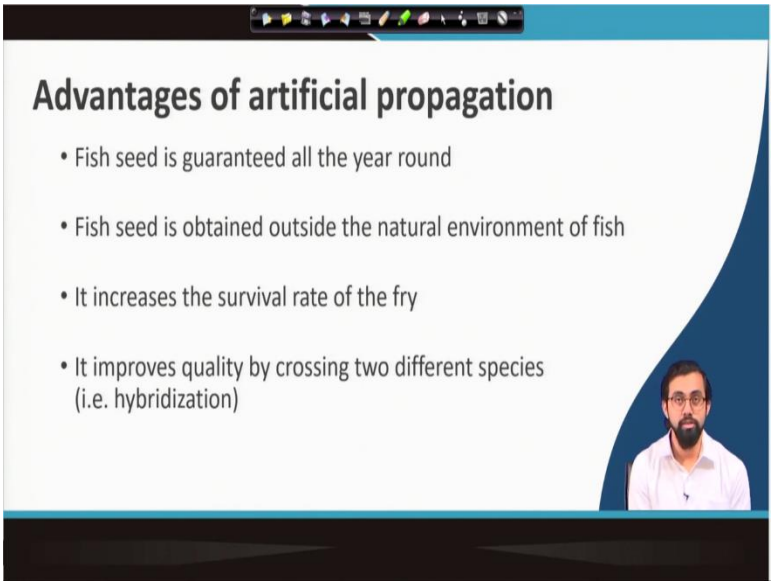

So, what are the advantages of this artificial propagation? So, definitely the fish seed are available for all year round. So, because in the other cases you have to worry about the proper particular breeding seasons. So, if it is there in like say, natural propagation or the semi-natural propagation.

Then you have to worry about like its breeding season and this particular season only you can go ahead with the supplying the particular criteria so that they are they will go and they will bid themselves but in case of artificial propagation, you do not have to worry about that you it can be done here all year round.

And will give you guaranteed how to set the yield the all year-round fish seed, which is obtained outside the natural environment of fish, it is sometimes well it is unnecessarily if you can provide it with the optimum environmental condition it can be a very high-quality seeds and your actually targeting the brooder fish, which are the best brooder fish possible.

So, in that case, what will happen the offspring will be having the higher body mass ratios and there are different indexes which we try to target when we go for the brooder fish selection of brooder fish which helps to have the offspring with the high quality and like according to our desire according to the market demand and all, it increases the survival rate of the fry rather than in the natural conditions there, they can be entrusted with the different diseases they can be the feed for other predators.

But in case of artificial propagation, we are trying to have it enclosed supervision methods. So, because of the close supervision, so we this price can have a very high survival rate compared to the natural ecosystem natural systems and all, it improves the quality by crossing two different species which we call the hybridization.

So, suppose we want to go for some hybridization of two different species, but it is not possible for it is a very much a difficulty in the natural conditions, especially the natural and the semi-natural propagation methods, but in this particular method, we can go ahead with the hybridization method, if you can provide, proper condition, proper environmental condition and it is doable, and it also improves the quality of the hybridization processes as well.

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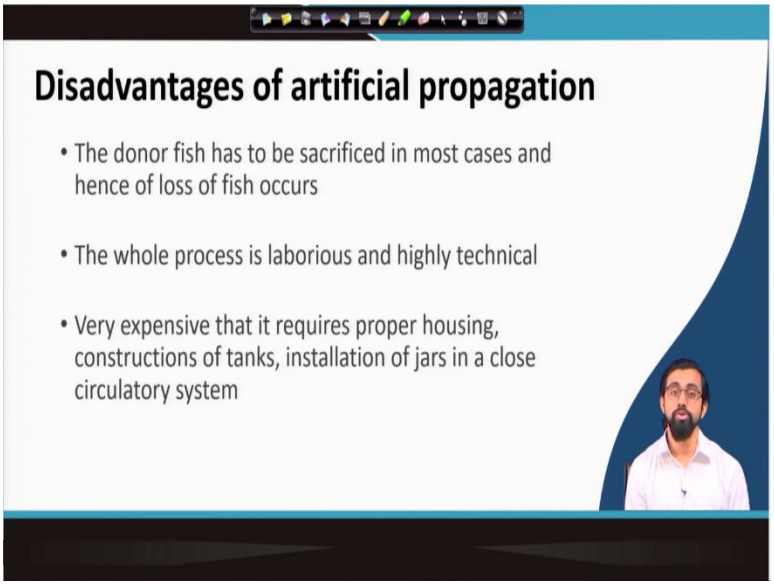

Everything comes with the advantages and disadvantages, there are other side of it. So, artificial propagation has also some cons part of it. So, specifically the what will happen the donor fish the brooder is that it has to be sacrificed in most of the cases the artificial propagation method that we follow, it has to be sacrificed and hence the loss of fish of course, but though it is not in a huge number.

So, it is doable, it is actually not that of a big have that big of a advantage. The whole process is actually laborious and also highly technical, you have to have a proper technical team ready with you and you have to have a proper expert who has all the ideas and expertise possible to go for this artificial propagation methods otherwise it will not give you the proper results that you are actually expecting from your system.

It is actually expensive in nature. Because you have to have a proper housing you have to have a proper the incubators you have to install the jars you have to install the construct the tanks and et cetera and et cetera in a close circulatory systems and this because of the circulatory system the water that you will be using there that has to be also re-circulating in nature.

So, or at least the freshwater exchange has to be happen very frequently. So, all these things makes it a little bit expensive compared to the natural or the semi natural one, but it can be neutralized by or even it can be definitely suppressed if you go for proper scientific methods and it will even give you additional fruits as well because if you go for the proper propagation methods, you will get

proper good amount of off-stream and this good amount of off-stream will give you a good amount of economic benefits as well if you can, if you target proper scientific if you go for proper scientific approaches.

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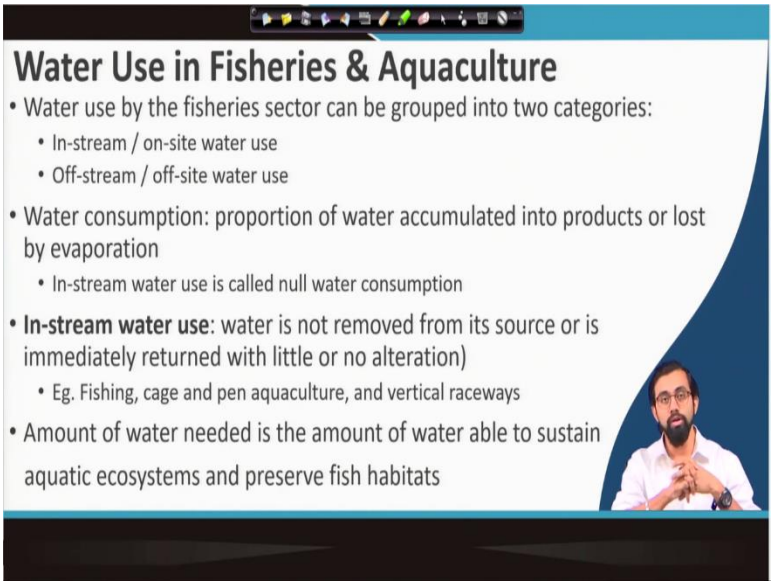

The next topic that I will be discussing about the water uses in fisheries and aquaculture. So, in general the water use by the fisheries sectors can be grouped into two categories In-stream or say like on-site water use and the second one is Off-stream or like off-site waters use. So, water consumptions it is actually the proportion to the water which is accumulated into the products and the loss by the evaporation.

So, because what does that mean it does mean like see the water in general fisheries sector what are the sources of water, you use the natural streams, you use the sea water streams by the dikes say like tide fed farms and all and you can use the groundwater by using the pump and and all pumps and all so, you can use different means of, natural resources or even the artificial resources as well.

So, those are the intake of your water use, I would say like the water which are intake in which your intaking through your systems are which are actually like the water which are actually the source of that water that you are actually utilizing your system, the what are the consumption methods that the what are the water consumption that actually involved with that, with this with

our pond with our farm, definitely the first thing is the evaporation right? because the pond or the tank that you are using, it has a high surface area.

So, because of its high surface area, what happens because of the sunlight and because of the normal wind movement also, the water gate defuse back to the water evaporates to the atmosphere. So, the water it is keep on evaporating to the atmosphere, because of that, we call it the evaporation loss. So, this evaporation loss is now one of the major losses in the in any kind of ponds and all this what are the other type of losses.

It is like the freshwater exchange that you need to do. Why you need to do the freshwater exchange I have already discussed briefly when we discuss about the intensive aquaculture that because of the intensive that when we go for semi intensive or intensive aquaculture, we need to treat the wastewater either we have to treat it or either we have to just simply throw it to the surface water bodies.

Because it contains a huge amount of unwanted pollutants, which does not let the fish or the aquatic species that you are targeting to live properly in your system. So, because of that, what we do we try to go for the freshwater exchange. So, to have a proper amount of less amount of pollutant in your pond or tank or also the higher amount of dissolved oxygen in your system. So, in order to do that, you get read of a lot amount of water from your systems.

So, which also comes as a loss of water the, these are the water consumptions that we normally like these are the different parameters of the water consumption that we normally talked about. Other than that, there are losses like the seepage losses, so you know what is seepage losses, like in a suppose you have a pond, so you have, the pond bottom, so there are a lot of water which get leached out of the system.

So, it will go to the either go to the nearest surface water bodies, or it will go to the groundwater go and recharge the groundwater. In one way it is good, it is recharging the groundwater, it is somehow getting collected to the river bodies and all but actually economic point of view, we are actually losing huge amount of water and water comes with the price?

Because in order to exchange that water, you need to go for the freshwater exchange, you have to go to the municipality, if you are from the rural sector, you have to go and it comes with the cost

because of the conduit system, the pipelines, the pump to let the water come to your systems or maybe if you want to build a canal that also comes with a certain amount of cost involvement and all.

So, all these things are involved, which are actually the main sources of water use and water consumption in your farm or in your aquaculture ponds. So, in general, the in-stream water use is like water, which is not removed from a source and is immediately returned with a little and or like no alteration.

It is called the in-stream water use like fishing cage or pen culture and vertical raceways and all in general, these are the in-stream water use you know in-stream water use means like in these kinds of cases, we are using the water which is not something that you are applying to your systems not something that you are having a say suppose what we do in case of cage culture or pen culture.

In case of cage culture, we do it in a it is a type of offshore mainly it is a type of offshore aquaculture system, what does that mean? You go to the seaside, you go to the seaside from the bank say like a couple of meters away a couple of kilometers away, you go and develop a cage like structure.

So, in that cage like structure, you go for your target, culture your target species and all, and the target species is found inside the cage aquaculture systems, but there you are not utilizing your any you are not putting any effort to introduce the water into the systems or you are not putting any effort to somehow neutralize the water losses from the system.

So, this is called in-stream water use. So, because the water is not removed from its source, it is immediately returned with a little and very almost no alteration. So, then the amount of water that is needed is the amount of water that is able to sustain the according ecosystems and preserve the fish habitat. So, in this kind of tech treat, this kind of aquaculture systems we call it in-stream or on-site water use.

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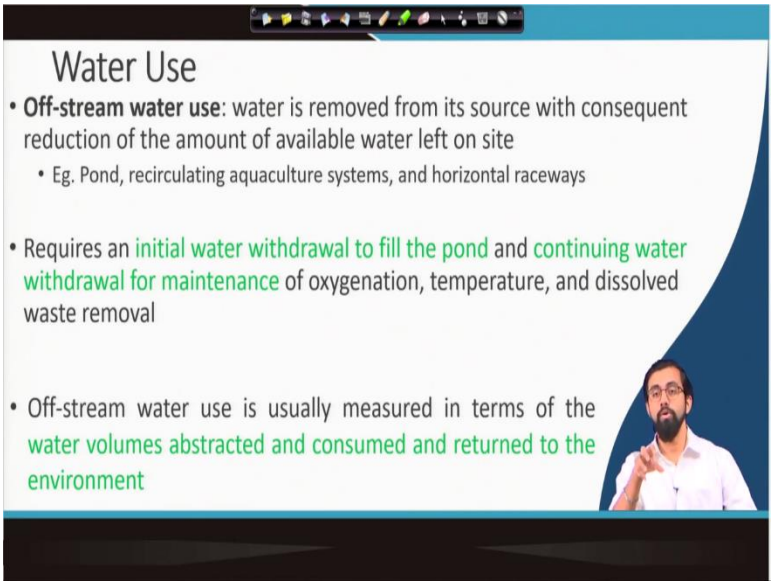

The next thing is the off-stream or the like the off-site water use, in case of off-stream water use what we do we the water which is getting removed from this sources consequent reduction in the amount of available water left on-site. So, in order to fulfill the this reduction in the amount of available water we what we do we add some water we by means of freshwater exchange we add some water by means of treatment of that wastewater itself or there are other ways.

So, this is called the off-stream water use or the off-site water use systems what can be the examples differently you know it like pond, recirculating aquaculture systems horizontal raceways et cetra. So, which requires the initial water withdrawal to fill the pond and continuing what are you withdrawal for maintenance of oxygenation temperature and then dissolved solids remove, waste removal as I already discussed.

Oxygenation is one of the major factor for this kind of off-stream water use because you have to maintain a certain amount of dissolved oxygen for your culture species to survive and also you have to maintain the temperature also if suppose in the summertime the temperature go keep on keeps on increasing what you need to do you have to supply it with the cold fresh water.

Otherwise what will happen that temperature that I told you like there are the aquaculture species they cannot survive even a very minimal amount of temperature differences, unless until it is there are specific species which can do that, but most of them they are not, so in that so that is why we

have to be very much cautious about the temperature dissolved temperature the pollutants and oxygen dissolved oxygen content of our farm of our pond.

So, this off-stream water use is usually it measures in terms of the water volumes that is abstracted and consumed and return to the environment. So, based on that, we go for understanding measure the off-stream water uses or the off-site water uses of our farm or of our aquaculture tank or aquaculture pond or whatever it is.

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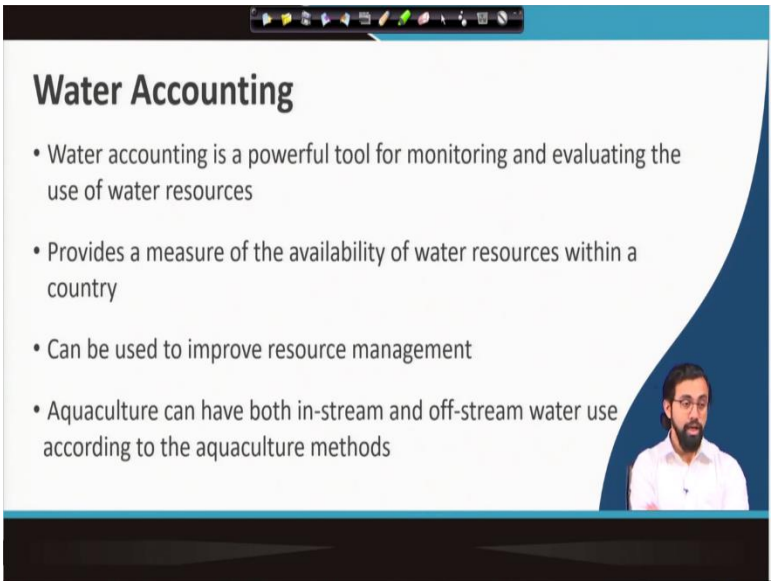

So, it is so one of the major thing that we need to know in this particular in matter is like water accounting? What is water accounting? Suppose you have you like being a country like huge country like India, we have to think about the water accounting. The water accounting phenomena it is very typical for in our case, for a country like say Singapore.

It is very easy. I am giving you one a very nice example in case of Singapore even few years back also they were completely depending on the Malaysia they will completely depending on the Malaysia for the freshwater supply and all I think its Pecan or river or something. So, anyway so but later on they started they were some issues and also then they Singapore started they do not have any surface water resource.

They almost they have null surface water resource. So, what they do they started having a treating the wastewater by themselves and they use that treated wastewater for the consumptions also, even

for human consumption also, the whatever the water that is getting generated from the gray water or black water or say like industrial wastewater.

They try to treat it they have a very high standard. The high like amount of the proper regulations or rules or regulations by their regulatory bodies, their pollution control boards and also, they properly maintain the treatment criteria and all then they revert it back to the day they again use it back to the, to its source or to its like, for the human consumptions and again for the other purposes like irrigation or the household, all the other necessary uses and all.

So, for human consumptions definitely they go for the maximum amount of treatment, the best quality treatment they want to go ahead with like primary, secondary, tertiary treatment, all the treatment procedures possible. I will discuss about these things in later slides say how what are the different treatment procedures like primary and secondary treatment, tertiary treatment, which are involved with the wastewater treatment technology.

So, what they do they do this kind of thing. So, in there for them, the water accounting is a very important tool to monitor and evaluate the source of water resources and how they are utilizing them and how it can be minimized further like the losses in water, the consumption in water, so, how they can minimize this part.

So, you have to know this water accounting, it gives us a measure it provides us a measure of availability of water resources within a country, it can be used to improve the resource management as I told you, by means of developing idea developing structure or infrastructure for proper management of the water that is already available in your country or the water that is supplied or imported from other countries.

And how you can properly utilize it so that you the minimum amount of loss can be happened and maximum amount of economic benefits or the economic loss you can add in particular financial year also. The aquaculture can have both in-stream and off-stream water use according to the aquaculture methods that we are utilizing in our form.

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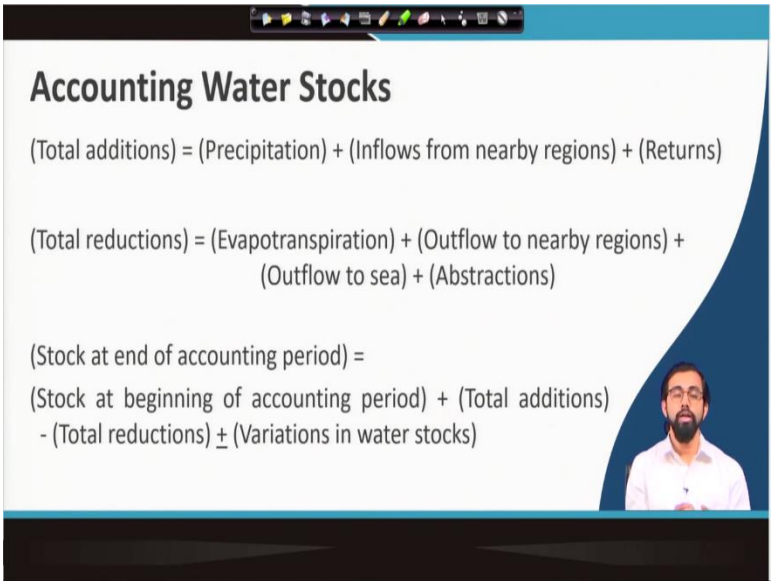

So, in general water in when we go for this water stock in water accounting, so, what are the methods, this is very easy this you guys already know I think so, the first thing is like the total addition of water, total additional water addition of water it contains the precipitation, the water inflow because of the from the nearby regions, and the return.

What do I mean by the nearby regions it can be from the surface water which is available there or the groundwater inflow of groundwater incharge, it can be the return water or the return wastewater from the treatment of the wastewater treatment on the wastewater that is being generated or maybe the fresh during the procedure during the procedure itself, we find some there are some fresh water availability in that procedure in the treatment plant itself.

So, even before the completion of the treatment, you can also return it back to the, to your system to incorporate some amount of say like for nutrition requirement or for normal usage or the water quality is good enough. So, you just return it back to your system to return back to your farm total reduction first of all the Evapotranspiration what do I mean by the Evapotranspiration?

You know what is Evaporation? And you also know what is transpiration? Transpiration is the loss of water that has been happening because of the plant leaves because through the plant leaves the amount of water that is getting transpirated, we call it this process we call it transpiration process. So, Evapotranspirtation is like a mutual process, because of the presence of the different aquatic trees and the trees which are there in your farm.

So, the losses occurred because of the losses incurred because of the presence of those aquatic trees or the normal or the land trees and the evaporation losses because of your farm pond and all. So, all these together we call it the losses occurred because of the evapotranspiration, outflow to nearby regions, because of the difference is like in the slope the gradient and all.

So, what happens sometimes the some amount of water is getting lost or sometimes they can be somehow leached out of the system. So, that is the outflow to the nearby regions, the outflow to the sea, because of the as I told you already, it is because of the change in this gradient or the change in slope and because of the other parameters the water get, it gets somehow we lost some amount of water to the sea or to the ground water to the ground itself.

So, an abstraction so these are the different processes abstraction is also involved with this kind of leaching phenomenon. So, the all this together is the reduction that occurs during the, which accounts this accounts to all this water losses and all this in when we go for the water accounting and all.

So, all together stock at the end of the accounting period is what is the stock at the beginning of accounting period plus the total addition minus total reduction and plus minus variation in the water stocks. So, all together if we can go ahead with this kind of calculations, we can find out the total stock at the end of the accounting period and that value can be easily calculated.

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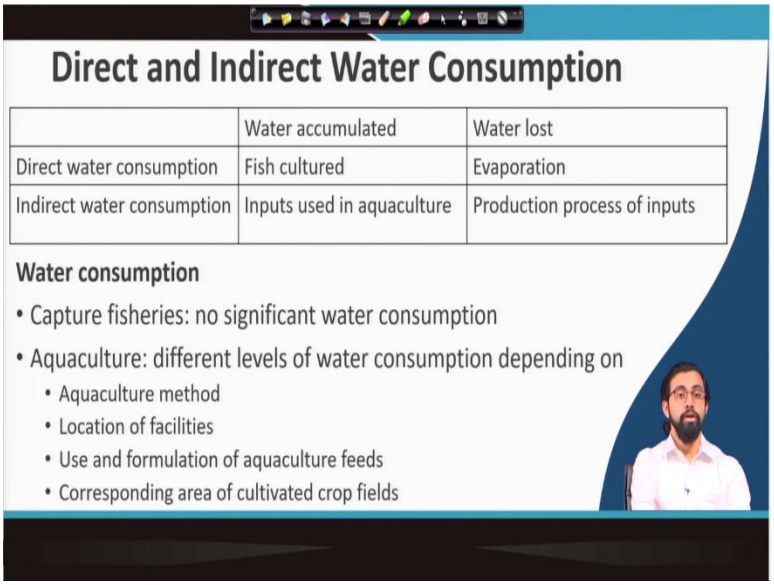

So, what are the direct or indirect water consumptions, the direct water consumptions for the fish cultures. And also, the evaporation which actually costs for the water loss for indirect water consumptions in terms of water accumulated inputs used in the aquaculture and the water lost. Indirect water consumptions during the water loss is the production process of the inputs.

So, like the fish feed, we do not talk about it, we do not talk about the total amount of water requirement in the aquaculture we only talk about the water which is in a view you can see it, the visible water losses, what about the fish feed? What about the materials that you are utilizing whatever the water that is required to like, establish or to prepare or to procure that particular material.

When you go for the lifecycle analysis of a particular of your farm of your final product, it also involves all this water losses, passive water loss as well also, so recently, we started talking about this, you started discussing about this, and it is a very major factor and we need to think about it this passive water losses and all, it is a major water loss.

It is something like, it is like, we call it some amount of some type of technologies, which are very much energy efficient or energy sufficient and all but at the end of the day, if you calculate their lifecycle, if you calculate properly, what is the total amount of energy, it actually requires, like not the direct energy, not the direct energy consumption.

So, if some type of renewable energy has direct energy consumption, which like, when you use those energy, the direct energy consumption is very less, but actually, the actual loss of energy which occurs due to the production of that particular product, we try, we sometimes avoid that, it is not a good practice, you have to go ahead with that calculations as well.

You have to go ahead with incorporate those losses those energy consumption process as well to make that production to make that raw material which makes that further process easier or less energy consumable or less in a more energy efficient or select less water use and all so, whatever all this process actually involves.

So, you have to abide by these things, whenever you calculate the total water incorporation in your system, you have to incorporate the what production process water incorporated already in your

production process of the inputs say like feed and all, that also should be incorporated. When we go for this water stocking.

The water consumption in case of capture fisheries, definitely there is no significant water consumption that is the good thing about it. But in case of aquaculture depending upon the aquaculture methods, the location of the facilities or the farms that you have the use and the formulation of the aquaculture feeds as I already mentioned. So, this is also that is very important and the corresponding area of cultivated crop field. So, all these things are very much important when we go ahead with the consumption of the water we calculating those things in your systems.

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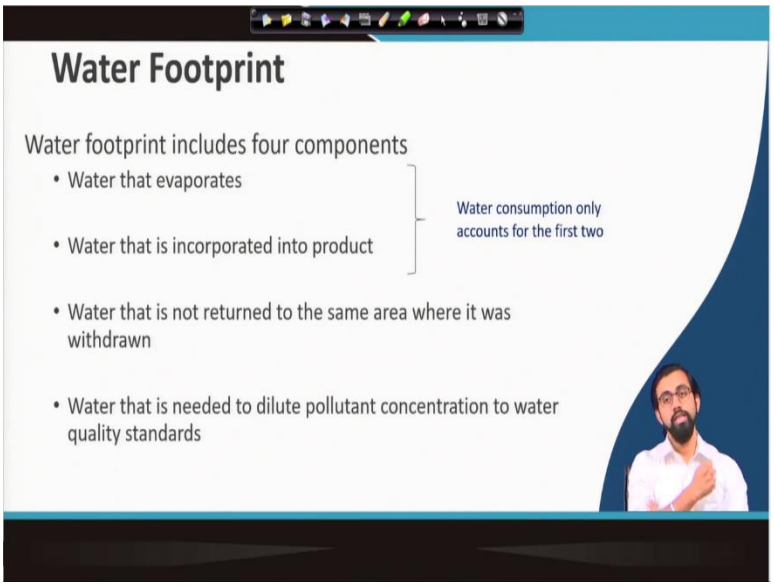

So, these are the values that we need to remember, when we go for the water footprint analysis water footprint it includes generally the four components. The first of all water that evaporates water that incorporated into the product, water that is not returned to the same area where it was withdrawn and the water that is needed to dilute the pollutant concentration to water quality standards to maintain the water quality standards given by the local authorities.

Say in case of Indian perspective, its central pollution control board or than the this Namami Gange they have. So, they have this Namami Gange mission. So, they have also started having their own rules and regulation that is mandatory for all the grocery polluting industries to follow, when they will discharge their wastewater to the Ganga to the Ganga basins and all. So, these are the different

regulatory bodies that we have to these rules and regulations by this regulatory bodies that we have to abide.

That and because of that, we need to provide some additional add some additional amount of water to dilute the pollutant concentration before putting into the surface water body or before releasing into the surface water body. In general water consumptions only account, the water that evaporates and the water that incorporated into the products. We do not talk about the water which is coming, which is not returned back to its source or water that we actually add additionally to dilute the pollutant concentration in the water quality, so, that is not incorporated in the water consumptions calculations.

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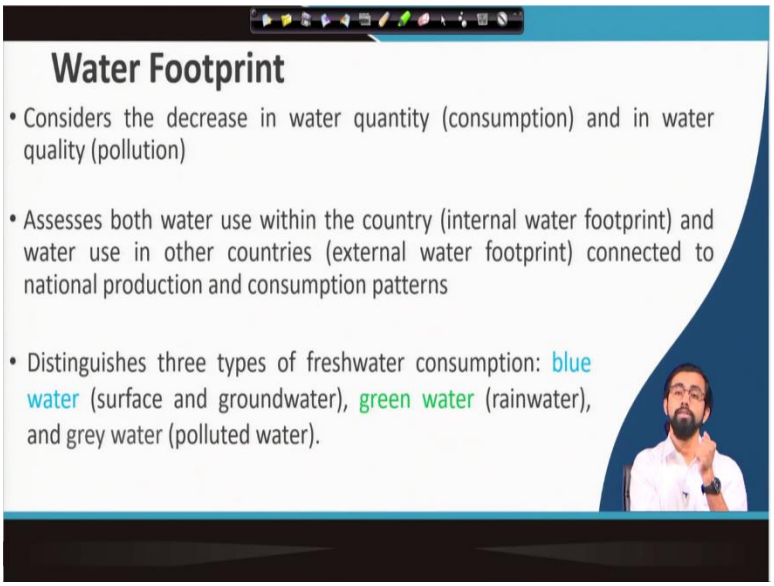

But water footprint in corporate every other details of this water footprint and all water incorporated in the system and all. Considering the decrease in the water quality and it actually this water footprint is good, why we should go ahead with the water footprint analysis and all, because it considers that decrease in the water quality that is the consumption and also the water quality like, water quantity first of all, that is the consumption and also the water quality, the pollution.

So, both of these is actually in involved in the analysis of the water footprint, it also can give you the access to the both water use within the country like internal water footprint and also the water use, because of the incorporation of the other countries mostly the neighboring countries, it is very

often we actually export it import it from other countries like, other than the neighboring countries is very few examples are there in the Middle East country, they do it also.

So, for them it is a external water footprint. It distinguishes between the three types of freshwater consumptions the blue water that is the surface and the groundwater, the green water that is the rainwater or the precipitation and the grey water which is like the polluted water. So, water footprint gives us a overall view of the all the water and where all the water is involved and how it is directly or indirectly involved and what are the consumption pattern what are the water uses criteria what are the water recirculation that is happening inside the system and all.

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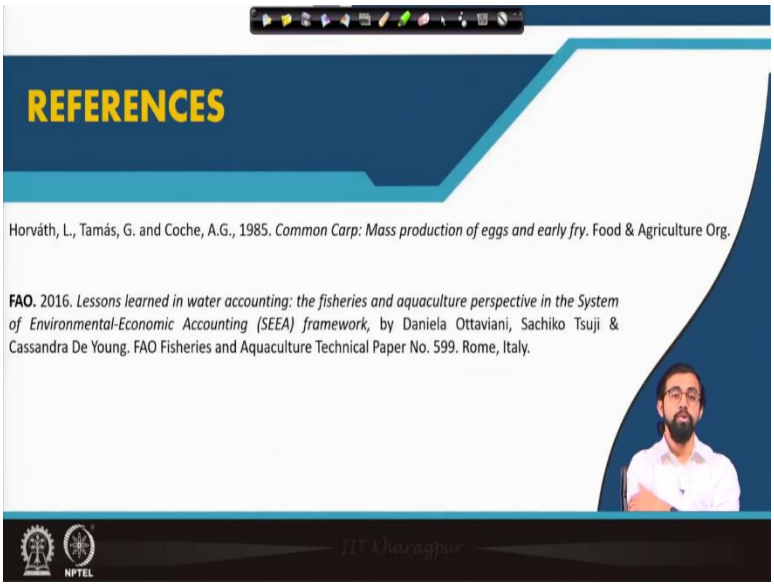

So, I have taken these references to prepare this particular lecture material. So, thank you so much. So, I think you have had a nice idea about the different water consumption criteria what is water footprint and what, is the water cycle that is involved in the aquaculture systems and all. Thank you so much.