Advanced Aquaculture Technology
Professor Gourav Dhar Bhowmick
Department of Agricultural and Food Engineering
Indian Institute of Technology, Kharagpur
Lecture 21
Topic - Larval Rearing and Hatcheries

Hello everyone. Welcome to this NPTEL online certification course Advanced Aquaculture Technology. My name is Professor Gourav Dhar Bowmick, I am from the Agriculture Food Engineering department of IIT, Kharagpur.

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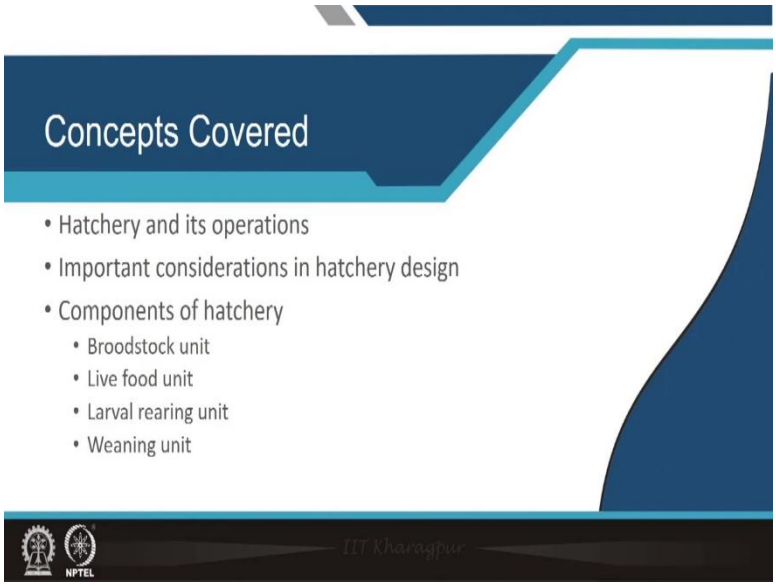

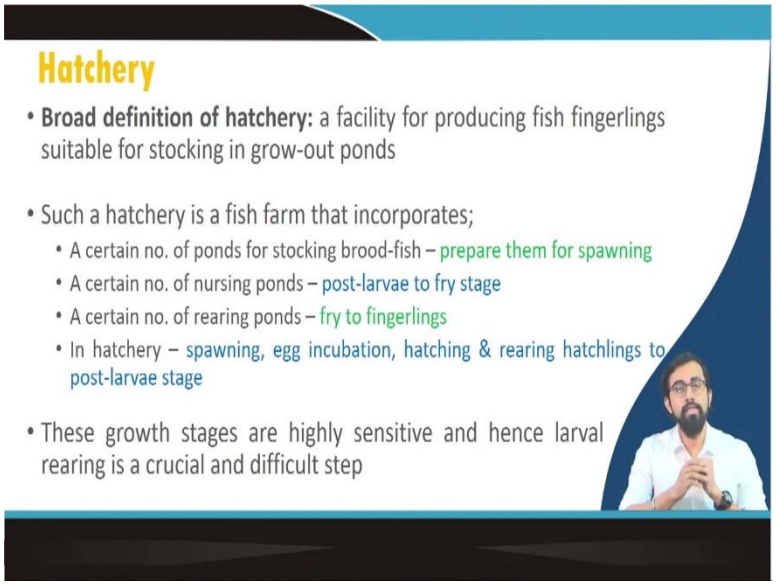

So, in this module, this module 5, we will be discussing about the Technology of Larval Rearing, Larval Rearing in the hatchery in the first lecture module that lecture material that we will be discussing. The concepts that will be covered in this lecture is like the hatchery and its operation the important consideration for hatchery design.

What are the components of hatchery, the broodstocks unit, live food unit, larval rearing unit, weaning unit, etc. I am discussing each and every units and how what are the design considerations and all that we need to think about we need to discuss about like before going for designing a proper aquaculture farm, the hatchery.

So, in general what is hatchery, you know what is hatchery. It is a facility for producing the fish fingerlings suitable for stocking in grow out ponds, so hatchery is the place where we start from like say like from the egg to the like even before like when we take the broodstocks and all, so from we try to help them to grow the help them to go forward this fertilizations and all, help them to sorry go for this like the eggs and all and at the end. So, we from that stage to the fingerling stage we take care of in hatchery. Then we the once it is it reaches the fingerling stage, we take it out and we put it in the grow out pond to go for the further mature, we will wait for it to be matured enough for its marketable stage.

So, that we can harvest it and we can simply sell it in the market or we can use it for other purposes. So, in general hatchery has a number of a certain number of ponds for stocking the brood fish, for prepared them for this spawning activity. We have a particular number of nursing ponds, because after this spawning is done this post-larval stage till the frying stage that nurturing period is covered in the nursing pond, then we go for this rearing pond when it

reaches the when the aquatic species it reaches the fry stage and till the fingerling stage, we keep them there.

So, it is like human like us only like we like from the bird like till the like certain age, we are like child and then we become adult, so, the moment where the adult will let them into the grow-out pond. So, the moment they reach to the adult stage we will throw them in the grow-out pond. So, once they are in the grow-out pond then it is not a matter of hatchery then it is a completely different sectors, so completely different ideal like fundamentals that we normally provide. So, that is the other part of the designing of farm.

In this lecture material, we will only be discussing about the hatchery. So, in hatchery we do like spawning the egg incubation, hatching, rearing hatchling to post larval stage all these things are happening in this the hatchery in like specially in the broodstock ponds and all.

So, this growth stages are highly sensitive and hence larval rearing is a very crucial and a difficult state and this is why the design of hatchery should be optimal and very clean, it has to be very how to say it has to properly maintained, cleanliness is one of the important thing and also the cheaper the design the better the productivity, better the how to say the economic greater.

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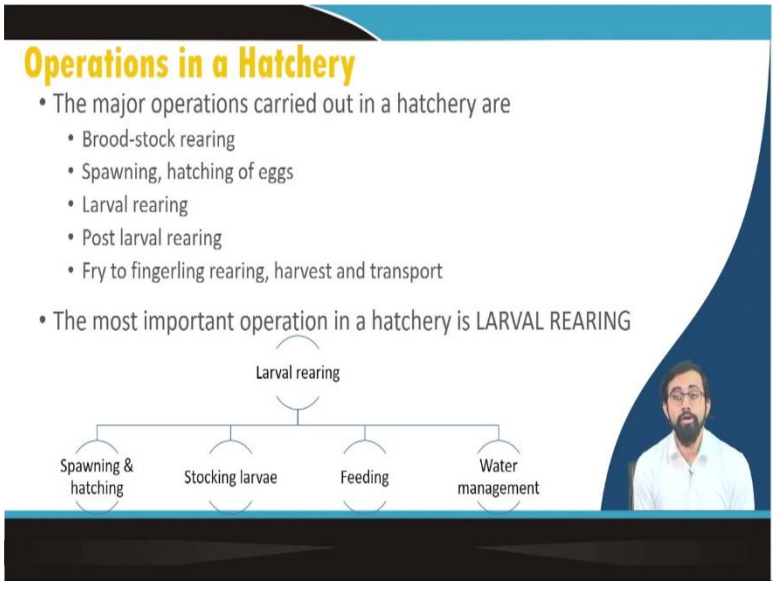

So, the operations of, operations in a hatchery, the major operation that is carried out in the hatchery as we already discussed first, the broodstock rearing you collect the broodstock, which are like in a perfect shape and perfect desirable body mass index desirable structural integrity

and all is there. So, we collect those broodstock and we manage them, we rear them in the in our ponds. So, this is called the broodstock rearing and all.

Then we let them come to the rearings once they are coming to the spawning stage. We put them in a proper spawning container with that we have a proper arrangements for their spawning activity to take place so that the eggs will start hatching after a day or two depending upon the aquatic species that we are culturing.

Then it will go for the rearings, larval rearing, then post larval and once it will reach the fingerling stage we harvest and transport it to the into the grow-out ponds. So, most important operation in the hatchery is the larval rearing, spawning and hatching, stocking larva, feeding and water management.

So, these four are very important points that we need to worry about when we will be discussing, when we will be designing a hatchery, when we will be operating a hatchery and these are the operating parameters also we can call like say like water management, feeding requirement or the feeding interval or the feeding capacity that you have to think about depending upon the size.

Because in this stage each day they will be multiplying, each day their body mass will be multiplying in nature like in certain manifolds like I am not talking about huge number but it is like it will go very fast it will grow very fast that the early stage of development of any animal any organism because of that their feeding requirement will also vary like anything.

So, and also their feeding can be initially you can in for the initial day or you just cannot just feed them with the like dry pallets and all. No, it has to be initial days their feeding requirement is different they cannot have those kind of food which are which they cannot digest even if they can even thy can like it is not be of their use actually. It will not help them for the development. So, you need to think about what type of feed you are giving, what is the feeding rate, what is the feeding capacity all this feed conversion ratio and all, all this you have to think about. The stocking density is very important what is the stocking density of larva that you are providing to your system and based on that you have to optimize the system and all.

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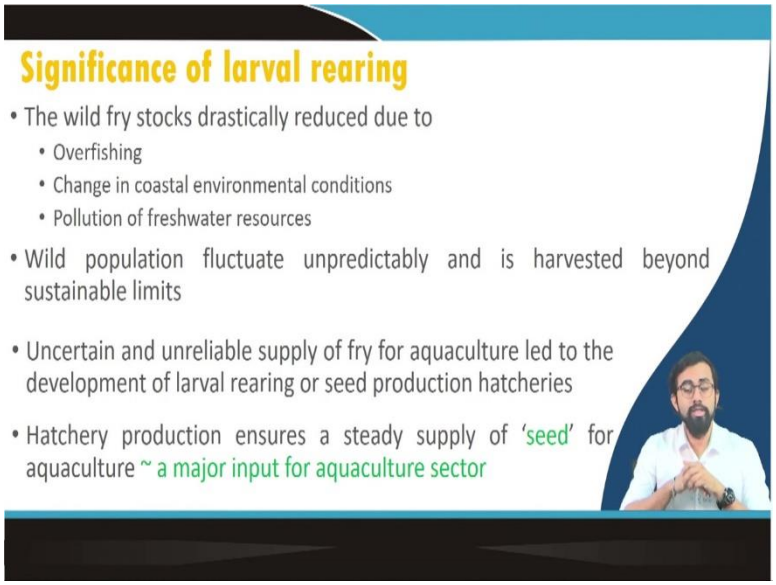

So, what is the significance of larval rearing because wild fry stocks drastically reduced due to the overfishing, change of coastal environmental condition, the pollution in the freshwater sources and all, because of all these reasons so the wild fry stocks are getting lost so we need to have hatchery, we need to have this we need to have more and more this kind of system so to grow our own like aquaculture products.

Wild population obviously it fluctuate unpredictable earnings harvested beyond sustainable limits. So, that is why you could just cannot rely on wild production and the most often there is no wild production available at this moment like it is like I am not saying no means it is like 0 amount there are ample amount but they are already in a very extreme deep stage.

So, we just do not go for it is better to practice as an engineering point of view, it is better to practice to better for us to practice for sustainable engineering solutions for growing this biological systems for this living organisms. And it is doable there are ample amount of research available, experts available on this field to just go and just do it. It is very much affordable also. Another thing is like in case of wild catch, it is wild fry stocks, they are uncertain and unreliable supply. So, you cannot be 100 percent assured that you will get a certain amount of fry available for your grow-out pond to have certain amount of marketable products.

So, for that the development of larval rearing or the seed production hatch in the hatchery seems like it will have an impact on it. Hatchery production ensures the steady state supply of seed for the aquaculture which is like the major input for the aquaculture sector.

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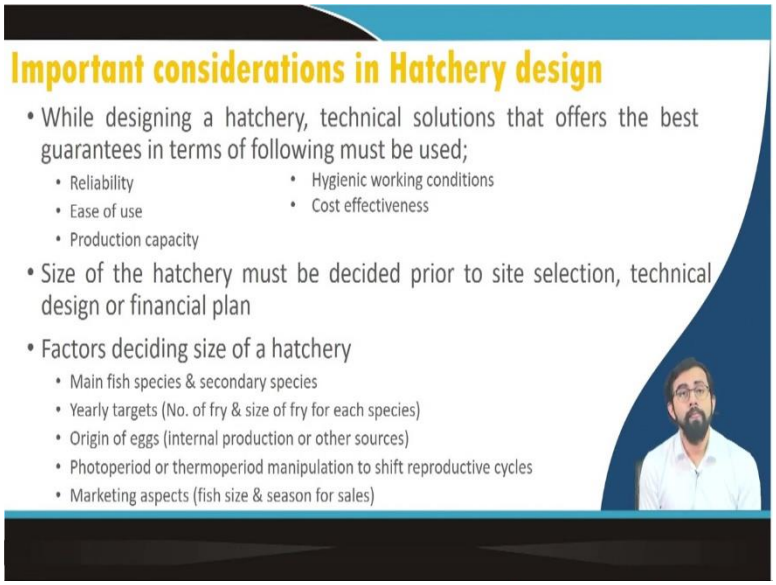

So, what are the consideration for hatchery design? As I already discussed, when we will be discussing about designing or like developing or constructing of hatchery there are lot of technical solutions that has to offer for the best guarantee in terms of the reliability, ease of use, production capacity, hygienic working conditions and the cost effectiveness. These are the five very basic criteria that has to be fulfilled, is it?

Why reliability, because you cannot just go for designing a hatchery for a particular aquatic species, which has like suppose they needs a certain amount of space for that particular stocking density, but you are providing less than that, so differently they will be having (())(9:50) like first of all, they will they cannot survive because of the requirement of the environmental point of view because say like say they need high dissolve oxygen but you increase the stocking density like anything.

So, they cannot sustain in that particular situation. Second thing, they will have a competition among themselves about the feed, they will not survive. So, there are lot of things. Ease of use, production capacity, you have to think about like what is the production capacity and based on that you have to design the hatchery from the beginning. So, you cannot just first design the hatchery and then think about the what will be the production capacity that is a very foolish design, foolish ideology. Hygienic working condition that is very important, because unless until you have a hygienic working condition, there is a chance of very frequent a disease outbreak in your farming product.

So, the moment you will have a very frequent disease outbreak what will happen it will reduce your economic return even sometimes if you are not lucky enough it can give you a huge loss also for your systems because these are living organisms. So, you just kind of play with it like there is even small disease outbreak can cost you like for sure because it will just completely lose your product.

So, hygienic working condition is very important that we need to rely we need to think about. Cost effectiveness obviously like you just we have to design it accordingly, so, that the our capital cost or the even recurring or all non recurring cost has to be has proper and it is designed in such a way that it has a very low payback period and all so and also it will definitely start giving you return after a couple of month or a couple of years depending upon the size of the farm depending upon the species that you are targeting and all.

In general, the size of the hatchery must be decided prior to the site selection, technical or the financial plan. The factors which is deciding the size of a hatchery is like the main fish species and the secondary species. Yearly targets, number of fry or the size of the fry for each species. Origin of egg, is it the internal production or some other sources that you are collecting the eggs from, that is an important factor, photoperiod or the thermo period manipulation to shift the reproductive cycles, marketing aspects like fish size and the season for sales. So, these five are the very important factors which decides the size of the hatchery.

What is photoperiod and thermoperiod manipulation, every reproduct cycling or like every species has its own comfort range for the amount of sunlight requirement, amount of temperature that it can grow very easily. So, all these things are there. So, for how long suppose you are growing a pond in a some polar region where there is like 24, like in a winter season there is like 24 hour of like continuous night, like it is like not 24 hours, it is like couple of months of continuous night there is no sunlight at all.

So, I am just giving you an example, this is do not take it serious like it is not just an example like in this case what you got to do, you have to design your hatchery in such a way so that you can kind of manipulate the photoperiod and you can utilize either by using the artificial sunlight by LED lamps and all these things or you just go for an obviously a thermoperiod manipulation for the to shift the reproductive cycle in such a way so, that the temperature also you can maintain and that particular period the hatchery, the particular period of production is enough for the temperature that is aware that is dwelling that is available there. I mean like that is there at that particular time is enough for the reproductive cycle. So, you have to do this kind of

design when you are designing you have to think about this before head before when you start your farm.

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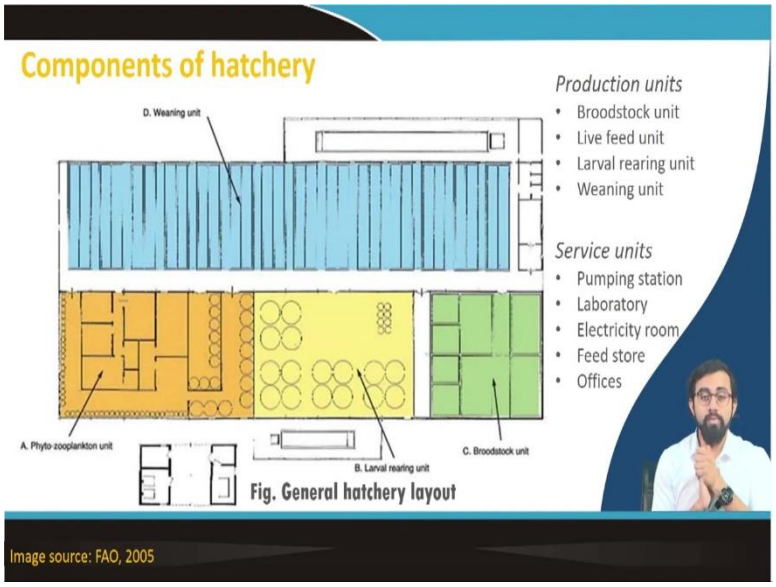

If you see this design, it is like a very generalized design, it is a general hatchery layout. So, these blue lines are the weaning units. The one is the phyto zooplankton units. A, the dark yellow one, light yellow one is the larval rearing units. The green one is the broodstock unit, so these four are the important points.

What does that do? If you see the number A, phytozooplankton unit, what do you think, why do we need zooplankton why do we need phytoplankton? This is nothing but this is the leaving feed that will be available for your hatchery for your stream hatchery for suppose you are doing for mud crab hatchery, so you will be like these are the this is the leaving feed that you are culturing in your hatchery itself which is very important.

You cannot have you cannot supply leaving feed from outside source because it will take time and it is a highly perishable item. So, you will have a high loss, you have to design your hatchery such a way that you will provide all the feed most of them at least by your hatchery itself like in your hatchery itself. So, this leaving feed can be for the earliest stage of development, it can be artemia pond, small artemia pond or the brine fishes and all you can have a phytoplankton or zooplankton small units. So, that will be helpful for your larva for your as a feed for your larval stage.

So, first we have this proper, this we call this female in the broodstock unit. So, they have this unit. So, from the broodstock unit they will be properly culture properly taken care of and then

from there the ones they will spawn there is proper spawning units from the spawning units it will come to the larval rearing unit, in the larval learning unit once it will reach up to a fry stage then it will be taken it will be transported to the weaning unit. So, it is like a huge one where they can easily sustain they can they will grow up to the fingerling stage and then they will be transported to the grow-out ponds, you got my point. So, that is how it works, what are the service units that it requires in a hatchery, first of all the pumping station.

So, which will take the water does if it like a sea water is necessary, it will take the sea water from the nearest sea water station and from there it will take it to the your farm, you have to have a laboratory to, in a proper laboratory it can be any size like if you can see this long panel on the very top or in the right side there will be like say like door there you can have a small laboratory and all or you can have it outside also you can see in the bottom left also there also you can have the laboratory to discuss to do the research on the amount of food that is required based on the size that you calculate.

So, you can check about that disease if they are having any disease or not you can have underwater cameras by which you can do the behavioral analysis by which you can identify that if your farming product is already catching any disease or not.

So, there are adverse technologies available and all, so, which you can read more in the literature. So, I cannot give all the details in this lecture, I have a very limited time for all this. So, if you ask me I will give you more details in later like in my other lecture materials or you can even simply Google it to find more in details.

There should be room for electricity room, electricity for feed storage, for offices and all where we will be doing all the official formalities and all, so all this has to be here. So, all these units has to be there when you will be designing a proper hatchery just so remember these points.

So, also remember this you this drawing also will we are going to discuss more in details in coming slides about this first blue weaning unit, deep blue photo and zooplankton unit, larval rearing unit in between then the broodstock unit, how they are will be corrected I will be discussing soon.

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So, in case of broodstock unit what we do, we maintain adequate stock of parent fish to ensure that the timely supply of fertilized egg of the best quality to the larval rearing sector. So, the broodstock units have the facilities placed both outdoor or maybe the indoor, outdoor facilities are mainly used for long term stocking purposes and also for the quarantined treatment.

Indoor facilities are mainly used for overwintering or where the severe winter conditions could affect the fish survival. We can shift the reproduction period by manipulation of temperature and photoperiod as we discussed and also for the spawning purpose, we do not do spawning in outdoor tanks, we keep it inside we because spawning is a very sensitive phenomena. So, we keep it in the inside is a very controlled environment, in the indoor tanks.

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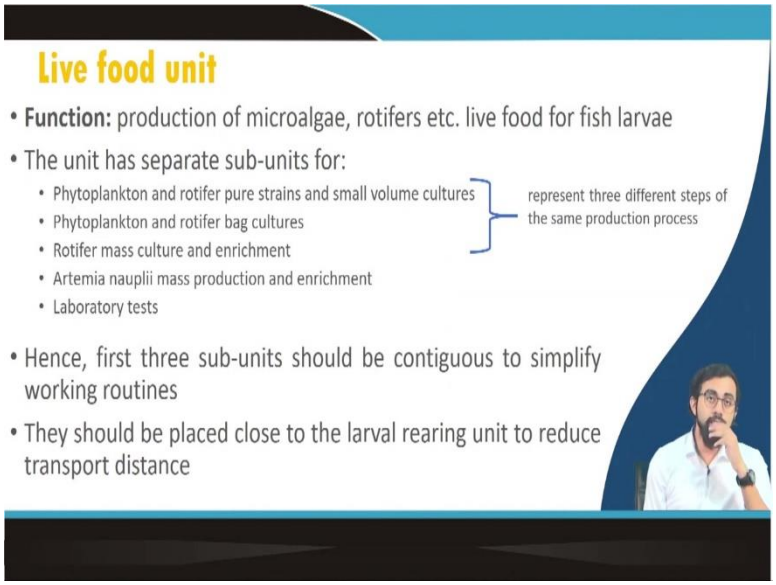

Then the live food unit as we discussed you remember the live food unit it is like the deep yellow one, the left bottom side we discuss in the design. It is what is his function, to grow the rotifers, microalgae, which is like I said before as a live good for the fish larvae. The unit can have a separate sub-units, first the phytoplankton and rotifer pure strains and the small volume culture for very beginning of your culture species or the say like for your fish larva, for your shrimp larva. Then phytoplankton in the rotifer back culture, then rotifer mass culture and enrichment, then artemia nauplii mass production or enrichment and the laboratory test.

So, these units should be there in the live food unit where from there you can taste and you can identify, you can capture different stages of your live food and you just provide it to your cultural spaces. Hence, in general way the first three sub units, it should be contiguous to simplify the working routines as we told you let the phytoplankton rotifer pure strains, their back culture and their mass culture. This actually these three different steps of the same production process actually, we collect it and we give it at different stages of our larval rearing unit or cultural spaces.

They should be placed very close to the larval rearing unit to reduce the transportation distance because it is a perishable item, you just catch it, you give it as a feed, you do not or otherwise it will take a lot of distance, definitely it has to be stored properly in a how to say proper ice tanks or ice even we just do not go for it, it is better to not go for any kind of freezing technology in this kind of small live feeding techniques. Live feedings we do not go for, it is to have it even it is if it is really not possible then go for it but prefer not to go for any kind of preservation techniques for or any freezing techniques for transporting these live feeds for your food and

all. It has to be live feed from the name, you can understand it has to be live, why it has to be live because most of the cases the larva it will be very hard for them to find out this date when I mean like find out the pallets and like feed they will keep on moving.

So, the what happened is larva they can sense it and they can go and they can have it. So, it is like additional requirements for them to have food. That is why we go for this live food and all.

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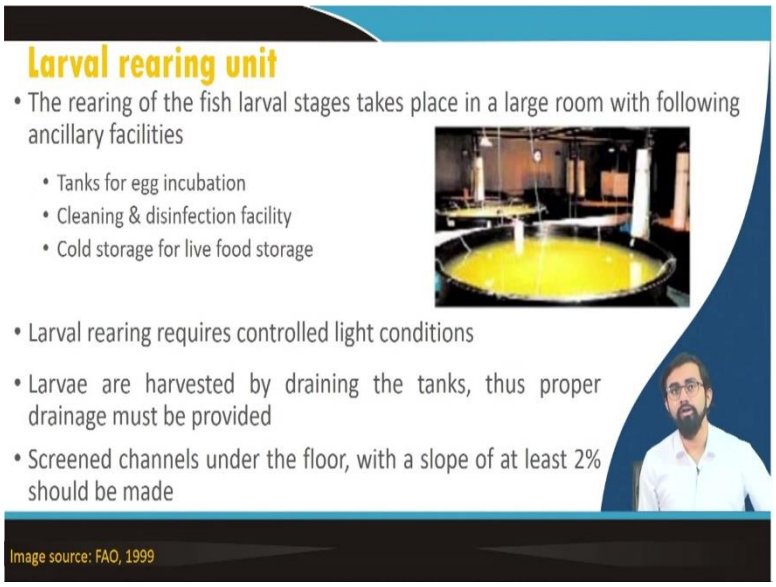

Then there comes a larval rearing unit the light blue one that you remember you saw. So, in this light larval rearing unit in general it place in a large room with the tanks for the incubation, cleaning and disinfection facility and other cold storage for live food storage. You can have it if it is like a completely different a very far away.

Larval rearing it requires a very controlled light condition, you are kind of manipulating the sunlight the natural sunlight here, larva are harvested by draining the tanks and thus proper drainage must be provided under screen channels under the floor with a slope of at least two persons should be made to get rid of the unwanted mattress.

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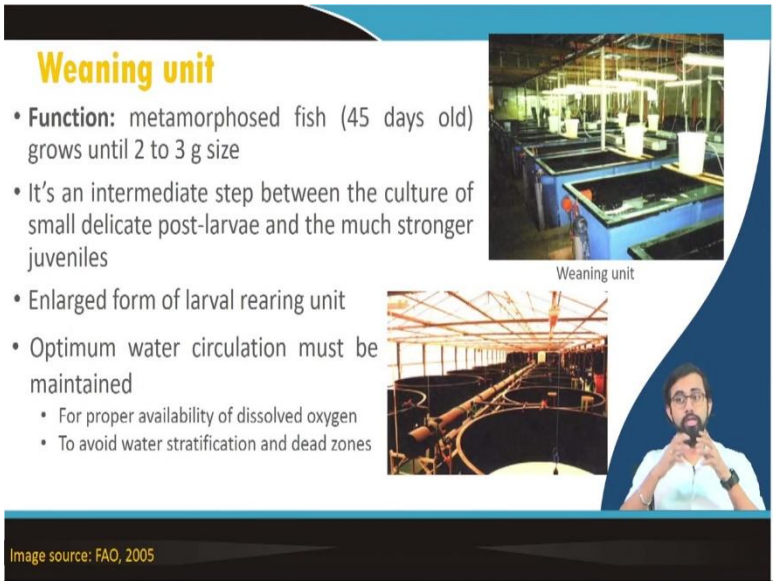

And then this weaning units, where it function as a metamorphosed fish can grow after 45 days old, and they can grow up to 2 to 3 gram of size and it is an intermediate step between the culture of small delicate post larva and the much stronger juveniles. In this weaning units, it is like a enlarge form of larval rearing units already its designed can be as same as that. Optimum water circulation is very much important for to provide the ample amount of dissolved oxygen and to avoid any water stratification or the dead zone in this kind of systems.

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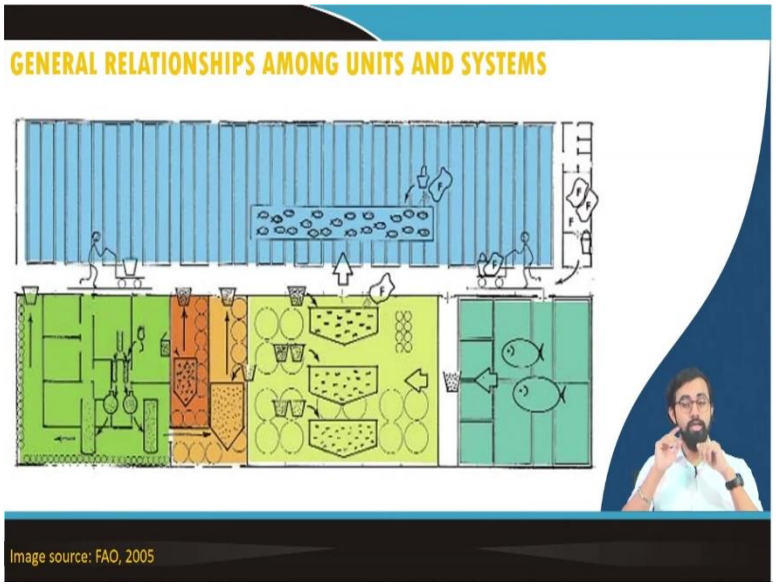

Here comes the system again, here comes the design again, it is a generous design, just to give you an idea about, you do not go for it as the standard it is not a standard design, you just I am giving you just a conceptual idea about it. So, if you see in this kind of structure in this kind of

hatchery design, how they are interrelated, among the units and the system, green unit, the deep green, it is what we are doing, we are doing the phytoplankton or any micro algae production here. Then there comes this deep yellow one on the maroon there will be producing artemia, we can produce the zooplankton unit, from there, it will come to the larval rearing units, what is the larval rearing units, this is like this light green one.

So, there is a larval rearing units and there right bottom, it is like the green one, deep green one again. So, it is like the broodstock pond from where it is the parent ponds, parent fishes, they are ready to spawn and they actually when they spawn that fishes that spawning, the optimizer is like spawning tank or spawning units. So, in this small spawning unit, we wait for a couple of hours or so, once it will hatch once the eggs are hatched, then we transfer them into the larval rearing units. From there it will go once it will reach to the fingerling unit will go to the, I mean so, the fry stage it will go to the weaning unit which is like the blue one which is in the top.

So, all these cases the feed is has to be delivered you see the feed if that is to be delivered at each stage. Sometimes feed can be delivered in the larval rearing tank also. But most of the cases, larval rearing tank are okay with the feed coming from the live feed units that is how they are connected that is how when you will be designing you have to think about all these things, all these units available in your farm, available in your hatchery.

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In a well designed hatchery it should consider proper production flow, harmonious distribution of systems to facilitate the work like every hour, increase safety and obviously the hygienic condition it reduces it has to reduce the construction and the management cost. These are the

important parameters that you have to think before you design a hatchery. The most important groups of relationships to be taken into consideration are those related to the production, systems and the works. Production relationships involves the production flow which first comes from the live food unit then larval rearing then the weaning unit.

System relationships, various units may share the spaces or facilities, what is work relationships, between the hatchery systems and the manpower requirements. So, this production relation, system relation and the work relation these are these management terms that you have to you can Google it, you can search for it, you can what is this things and how to develop your knowledge more about it and to, so once you will be a technology provider for an aquaculture sector, or you will be having your own aquaculture farm. So, we will think about all this relationships better and you can utilize it in your design.

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So, in conclusion, so, hatchery it plays a major role in ensuring the reliable supply of seed or the fingerlings for the aquaculture sectors and the design of the systems must be carried out in such a way that the best possible technical solutions are applied. So, it is really doable and there are like ample amount of research available, ample amount of facilities available papers available, all this kind of a and I will discuss more in the coming lecture also like about the design and construction of hatchery, but I hope you will, you have already understood and the importance of the larval rearing and why the hatchery is very important at this stage and why in aquaculture sectors hatchery is one of the major components.

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So, the larval rearing is in general is a crucial operations which governs the availability of most important input in aquaculture that is the fish seed. Rearing of fish larva is a challenging part of fish culture because of larvae's are mostly they are sensitive to the water quality, they have a very high nutritional requirement. And they require the use of live feed I told you live feed because they are in larval stage, they are all these sensory systems are not as established as once they reach the juvenile stage or once they reach the fingerling or the adult stage.

So, because of that, the live feed are more useful, they can easily identify because of their locomotion and they can go and have it. Then also the nutritional requirement, because they are in their early stage of development, they needs a very high nutrition and proper diet has to be maintained for them to grow. And also they are very sensitive to the water quality as I already discussed because even if only certain very minimal changes in the water quality, so, like only the pH is changed. Because of that for us, it is like it does not matter like if an increase like from 7 to 6 or 5.5.

But for larva it will happen it will affect a lot because they are very sensitive their overall shield like the skin is like the body is very much sensitive to even minor environmental changes. That is why we need to think about the water quality and all these things as well.

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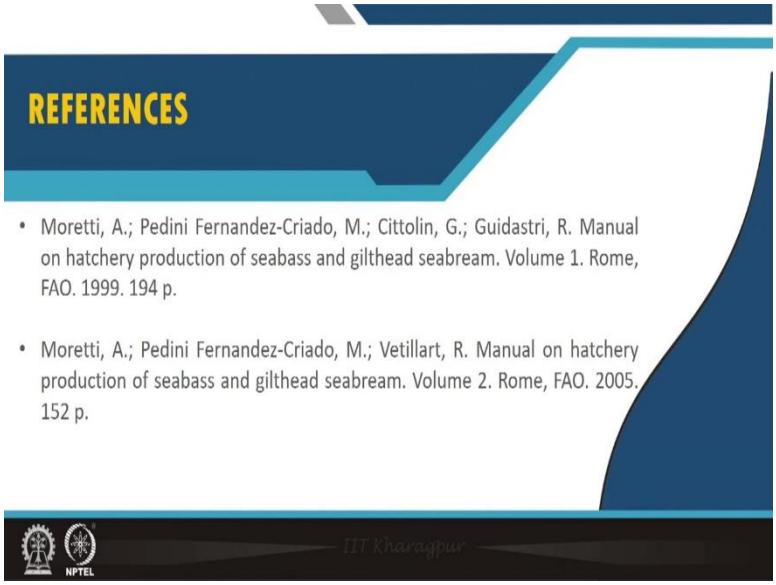

So, these are the references from which I have taken the information's and you can go and check those papers. So, if you go through it, you will get a more knowledge about how this how these things are happening. In general, so, thank you so much. We will discuss more details about the design of hatcheries in coming lecture, see you, bye.