Advanced Aquaculture Technology
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Lecture 42
Wastewater Fed Aquaculture

Hello everyone, welcome to the second lecture of module 9 of the subject advanced aquaculture technology. My name is Professor Gourav Dhar Bhowmick; I am from the agriculture and food engineering department of IIT Kharagpur.

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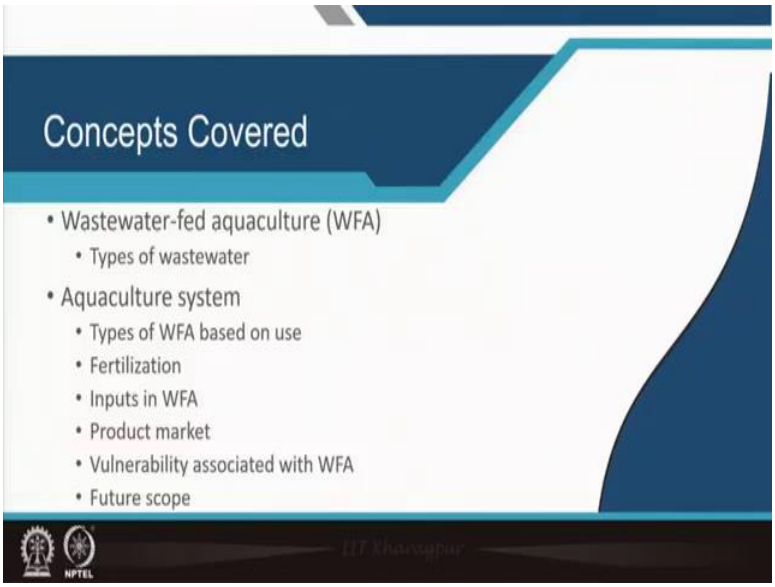

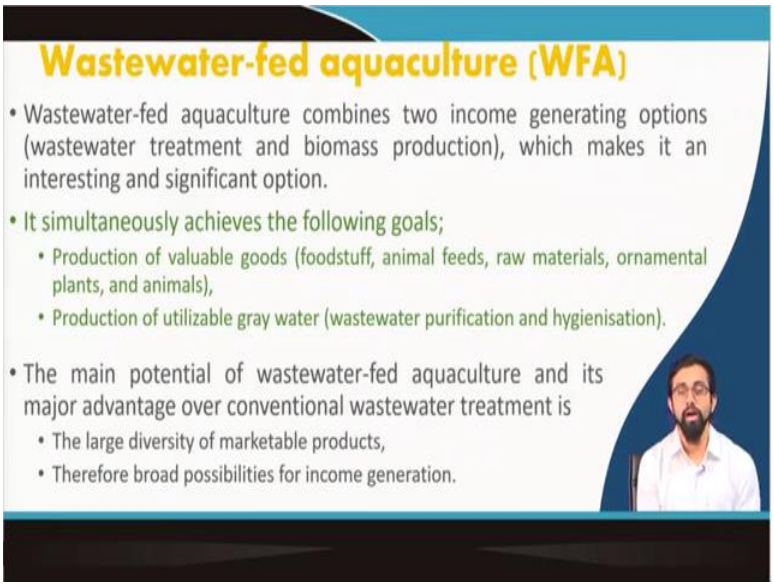

So in this lecture material I will be covering the concepts like wastewater fed aquaculture and what is wastewater fed aquaculture, how the aquaculture can be practiced in wastewater, and what are the benefits and what are the pros and cons of it that I will be discussing in details in

this lecture. The type of wastewater that I will be discussing also in general for you to understand like what are the wastewater constituents that actually involve in this wastewater fed aquaculture, what are the types of WFA based on use, the fertilization, inputs in WFA, the product market, vulnerability associated with the WFA and what are the future scopes involved with it.

So I will be discussing all these things so I hope you will be benefited with this knowledge like how this wastewater fed aquaculture has to be practiced and how it is done for a long period of time in this Asian region specifically, anyway so let us go ahead with the understanding of the wastewater fed aquaculture.

In general wastewater fed aquaculture it combines two income generating options, first treatment of wastewater because you need to feed the wastewater before throwing it to any surface water body say like rivers and lakes and the second is the biomass production. What do I mean by the biomass production, it is the production of aquatic species that you are culturing in that wastewater.

This aquatic species they will consume the nutrient present in the wastewater and by means of that the wastewater pollutant level will go down but yield will go up the aquaculture yield go up, so both ways it can give us some benefit. It simultaneously achieves the goals like the production of valuable goods like food stuff, animal feed, raw materials, ornamental plants and animals, and plus production of utilizable gray water the wastewater purification and the hygienization can be is possible. It is actually utilizable gray water what do I mean by the gray water do you have any idea what is gray water?

So the gray water is actually the water which is coming out from our household other than the the our human excreta, other than the human excreta whatever the uses of water that we do that we use normally in a household say like bathing purpose, cleaning purpose, washing purpose, all this together we call them gray water, so this is called the gray water and the human excreta that is the difference that we will discuss in details in differently.

So this is the gray water that normally and this gray water constitutes a huge amount of chemicals which needs to be replenished, organic matter which needs to be replenished and it is done by this aquaculture species whichever you are culturing. So that is possible that is doable and that has been done for long and I will show you how it is done and what are the future scopes and how can it be enhance this production capacity these things.

What are the main potential of wastewater fed aquaculture and what are its advantages or major advantages over the conventional wastewater treatment is the large diversity of marketable products and therefore the broad possibility of income generation other than the conventional wastewater treatment plant.

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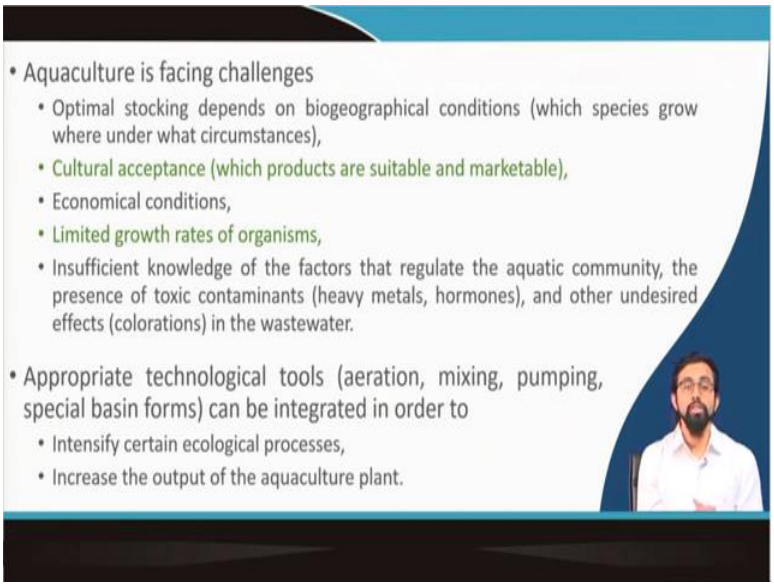

Aquaculture is nowadays is facing different challenges, first optimal stocking depends on the biogeographical conditions where like species grow, where and under what circumstances, cultural acceptance which products are suitable and marketable, economical conditions, limited growth rate of microorganism organisms, insufficient knowledge of the factors that regulate the aquatic community say the presence of toxic contaminants and the undesired effects in the wastewater, so all these challenges are normally being faced by the wastewater fed aquacultures.

However, appropriate tools can be integrated, appropriate methods can be developed which will help us troubleshoot these challenges, like appropriate technical tools like aeration, mixing, pumping, special basin farming can be integrated in order to intensify certain ecological process and also increase the output of the aquaculture plant.

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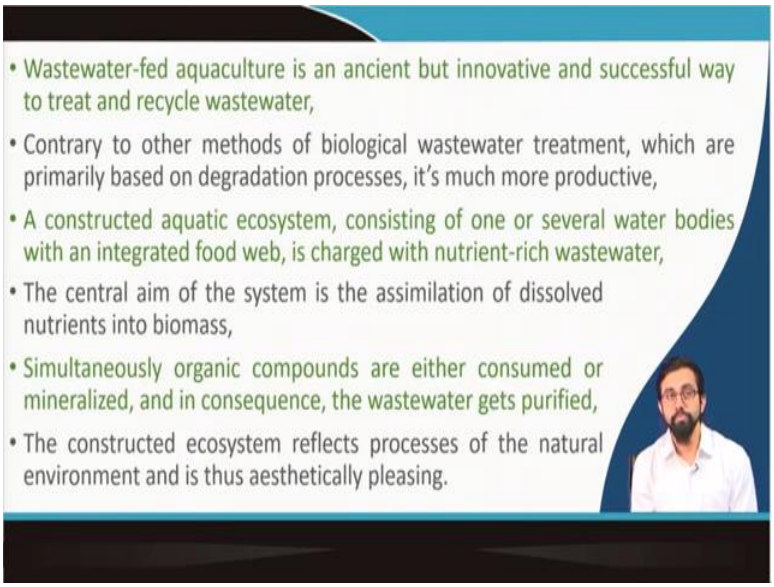

In general the wastewater fed aquaculture it is done from a very long period like it is done for like long long back; there are like studies in like even Aztec civilization where they have done it in like thousands of years back, however, the innovative and successful way to treat and recycle wastewater has to be developed and contrary to the other methods of biological waste water treatment which are primarily used based on the degradation process it is much more productive.

Because in case of normally primary degradation processes, biological degradation process that we follow if you remember in last lecture in last module we have discussed about the different type of biological wastewater treatment plant, they use this beneficial microorganisms, they consume the wastewater nutrients and they grow it in their biomass or they produce some by products like gaseous by products.

This biomass is not as productive as in this case that we are using, wastewater based aquaculture when we use it, because in that case that biomass is used as a sludge and it can be used as a manure, but the productivity wise, number of income wise this is much more productive this wastewater fed aquaculture, because it is aquaculture product, it has much higher nutritional benefits, it has much higher expect acceptance range for human consumption as well.

In a constructed aquatic ecosystem when it consists of like one or several water bodies with an integrated food web is normally charged with nutrient rich wastewater, the central aim of the system is the assimilation of the dissolved nutrition into the aquatic biomass like their species biomass, it will convert the assimilated into the animal biomass, the species biomass.

Simultaneously, organic compounds are either consumed or mineralized and in consequence the wastewater gets purified, the constructed ecosystem reflects the processes of the natural environment and is thus aesthetically pleasing, this kind of treatment option.

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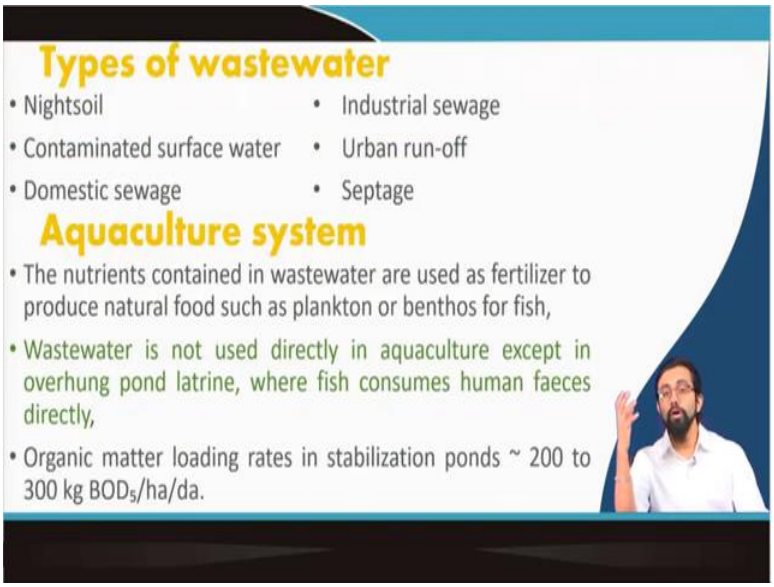

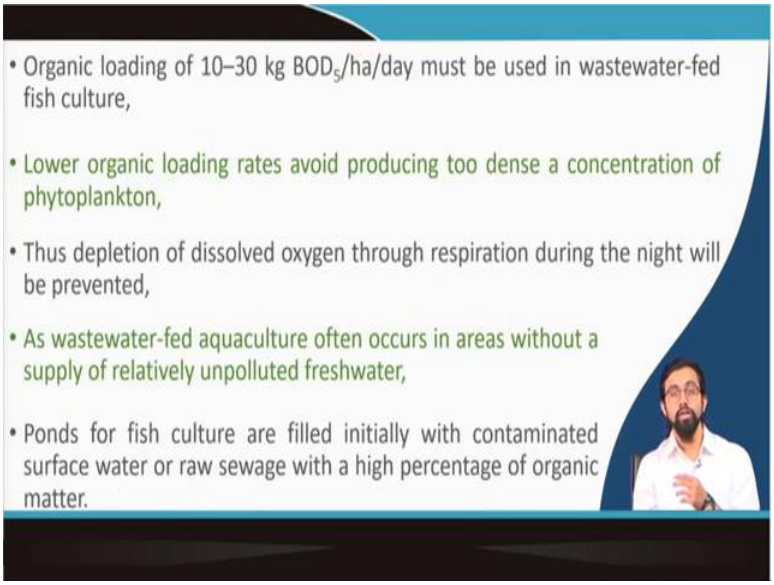

What are the type of wastewater in general is there like nightsoil, what is nightsoil is simply human excreta we call them nightsoil when we collect it and we use it for manure fertilization purpose, industrial sewage the wastewater that is coming out of the industries major of the industry say like in our context we can talk about the food processing industries, contaminated surface water, urban runoff because of rainfall or because of some urban activities car washing, domestic sewage mostly it is coming from, it is like considered as the

gray water that we normally discuss here, the septage it is again the liquid solid mix for fractionate which is available from the septic tank or sea spools.

So these are the different types of wastewater you need to understand before discussing when we discuss about that what about what type of wastewater is fed to your system, so it is better to remember all this fact.

Aquaculture systems in general the nutrient contents in the wastewater are used as fertilizer which produce the natural food such as plankton and benthos for fish. Wastewater is not directly used by the aquaculture except in overhang pond latrines, where fish consume the human faeces directly other than that wastewater is not directly utilized by their culture, they actually utilized by the planktons and benthos, and this plankton population this phytoplankton or zooplankton population they are actually being consumed by the fish.

Organic matter loading rate in stabilization pond like say 200 to 300 kg of BOD5 per hectare per a day is like acceptable and and based on that this is the way we normally use the load that we normally provide in west water fed aquaculture systems. Organic loading can be like as low as 10 to 30 kg of BOD5 per hectare per day when we talk about the wastewater fed fish culture to be specific, lower organic loading rates we can provide to avoid producing too dense of a concentration of phytoplankton, which can cause the different kind of unwanted result like eutrophication.

The depletion of dissolved oxygen through respiration during the night will be prevented, and wastewater fed aquaculture often occurs in areas without a supply of relatively unpolluted fresh water, so it is also done in the areas like that, ponds for say like fish culture are normally filled initially with the contaminated fresh water or raw sewage with a high percentage of organic matter or maybe like they are doing it slowly for your aquatic species to get accustomed to the system.

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What are the types of wastewater fed aquaculture based on use; in general the wastewater aquaculture can be delineated into two distinct categories based on their way of use say like direct reuse and indirect reuse. What is the direct reuse? Suppose you are using a planned and deliberate way the wastewater, you are using this as a very planned and deliberate way to be used as a nutrient or the water resources for your aquatic species, you are culturing, you are feeding your say like aquatic farm with the wastewater coming from the nearby vicinity say the gray waters or like say the industrial wastewater that will be considered as a direct reuse.

What is the indirect reuse; without the recognition of its previous use in a water waste contaminated and indirectly enriched with wastewater, it happens sometimes in the regular water bodies or regular surface water bodies like rivers, lakes, ponds, etc.

They are normally in a standard state but however there may be a possibility of indirect contamination from any industry or any nearby municipal areas that will be called the indirect reuse, and that can cause some natural ecosystem to thrive there as well. In general this wastewater aquaculture is most widespread in Asia around Kolkata also in India you will find it and Hanoi in Vietnam also it is very famous.

In Kolkata if you know the places in Kolkata there is a place called Salt lake so behind the Salt lake there is Nalban area and all where if there is a very intensive wastewater fed aquaculture is practiced there for long period of time and it is one of the very famous example of wastewater fed aquaculture in this world.

I would really suggest you to go and google about it and try to learn more about it and it is a very interesting phenomena. Allmost at one point of time almost one third of the wastewater generated from municipal wastewater generated from Kolkata are being treated in those wetland areas and in those wetland areas what they were doing they were culturing different plants, wetland plants and also their culture in different kind of fishes there.

This aquatic species and this culture of this wetland plants are used to kind of treat that wastewater, can you imagine it is like a very natural way of creating the wastewater and at the end after the treatment is done that water is coming contact with the tributaries of Ganges and in the surface water body. So that is what is being done there and if you are lucky enough you can go there and you can check it by yourself and it is really interesting.

However, the one major problem with this kind of treatment system is that it requires a huge land, huge amount of land is required, and the land footprint is very high in this kind of the aquaculture practices. So if you see these ponds cover around 3500 hectare in this region and with the production of carp tilapia is estimated to be 18,000 ton per year. It is giving a huge benefit to the local fish farmers and the local people are getting a lot of employability while working in this field plus they are getting some nutritional benefits, plus they are getting the government is benefited by reducing the treatment cost for the wastewater that is being generated in that area.

The fish sold through the nearby market in central Kolkata and serving the not only the poor communities but also to the people like in the nearby vicinities. So there are some psychological concept regarding that come on it is been done in the west which is normally the culture species they use the wastewater as a feed so they must be very bad they must be contaminated with a lot of things this is all works and it is possible even it is not possible at the same time, so it is better to always make a track on your the aquatic species that you are consuming.

So in general so I would suggest like in Kolkata scenario I am not sure about it but in general it is a standard practice that time to time you check the biomass of the fish and the cultured species, so to regularize that if there is any unwanted chemicals that is bio accumulated inside the fish or not and whether it is actually being utilized or consumed by the local people or not or like it is transportable to the market or not.

So in general concept it is not at a very high rate, in general we use a lot of other polluted products at the every day each and every time even whatever the finest of the vegetables you

are having it might also contain some micro plastic. So I am not suggesting you to go ahead and just have it without any concern but the concern should not be wide enough that you just simply deny to have it, you can have it actually this kind of products are very good and it can be much more healthier than in its natural habitat, because of availability of the huge amount of nutrient.

So that is the thing that I want to discuss and I really hope you will you will understand that my concern.

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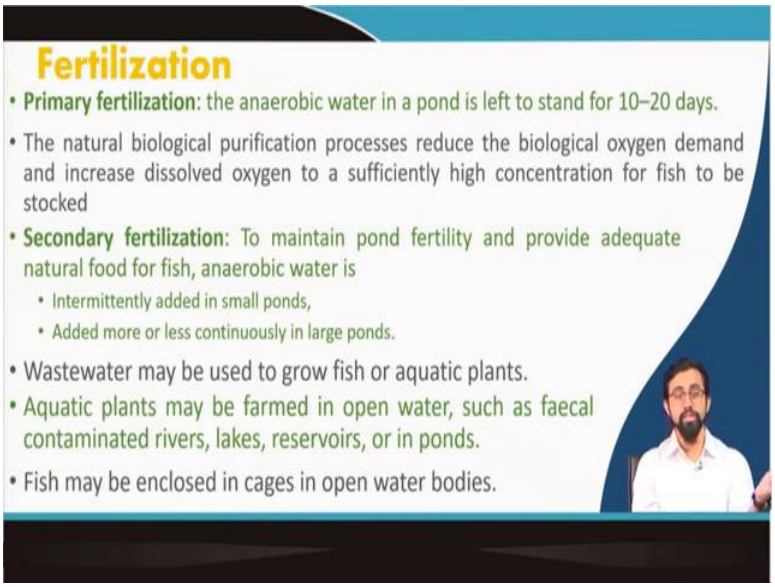

In terms of fertilization, primary fertilization the anaerobic water in the pond is left to stand for 10 to 20 days in general. The natural biological purification processes happen and it reduces the biochemical oxygen demand and increase the dissolved oxygen to a sufficiently high concentration for fish to be stocked. As a part of secondary fertilization it is used to maintain the pond fertility and provide adequate natural food for your fish.

The anaerobic water is intermittently added in this small pond and added more or less continuously in case of large ponds. The wastewater may be used to grow fish or aquatic plants of your choice or on the basis of local availability, aquatic plants may be found in open water such as fecal contaminated rivers, lakes, reservoirs or in pond and fish may be enclosed in cages in open water bodies or even you can just simply make a proper bund like structure and that also is possible and like proper earthen bund and at the end say like the discharge point you can put the any filtering unit or any a normal cage or net like structure so that your culture species will not go away with the effluent.

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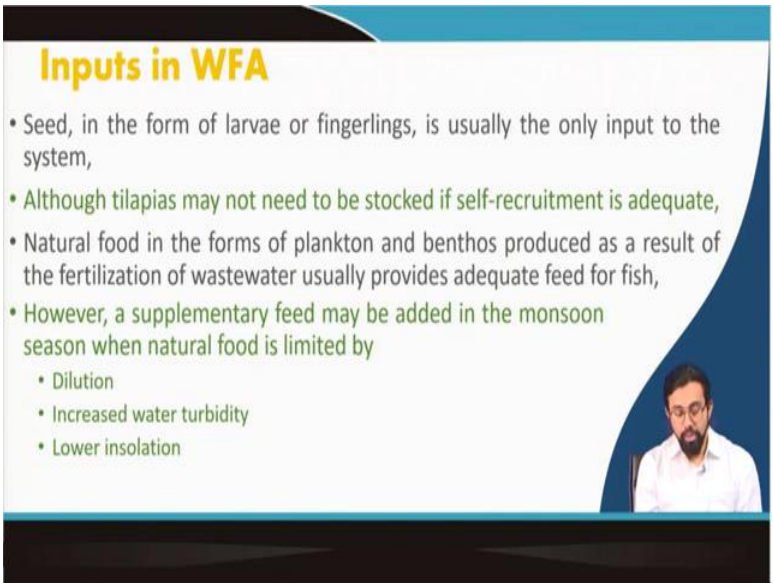

So in general when we talk about the wastewater fed aquaculture it is very important to discuss about the inputs that it involves, so what are the inputs of wastewater fed aquaculture?

First thing is the seed, in the form of larva or fingerlings it is usually the only input in the system, because all the other things are well taken care of by the wastewater that you are feeding or the wastewater that is there, the aeration, everything is natural so it can be semi-intensive or extensive but everything is natural. In some cases maybe you need to provide it with some secondary fertilizer but it is not mandatory,

Although the tilapias may not need to be stocked if self recruitment is adequate but sometimes it is better to provide some amount of additional fertilization in case of other issues and also even for tilapia also depending upon your requirement and the situation, the scenario. The natural food in the forms of planktons and benthos produced as a result of the fertilization of wastewater that is the thing that usually provides the adequate feed for your fish.

However, a supplementary feed may be added in the monsoon season when natural food is limited by dilution, definitely the rain water intrusion is taking place, increased water turbidity because of the rainfall because this is the shallow lines we normally provide shallow water bodies is we normally have this in this kind of cases the water turbidity getting is because of the water splashing around and water turbidity, clay turbidity or whatever it is because of the plantary turbidity it may cause huge health disadvantages for your culture species and also the lower insulations.

So in all these cases you provide them with the supplementary feed, so in that case what it will be called it will be called semi intensive aquaculture systems, you know, it what is aquaculture, what is intensive, what is semi intensive, what is extensive?

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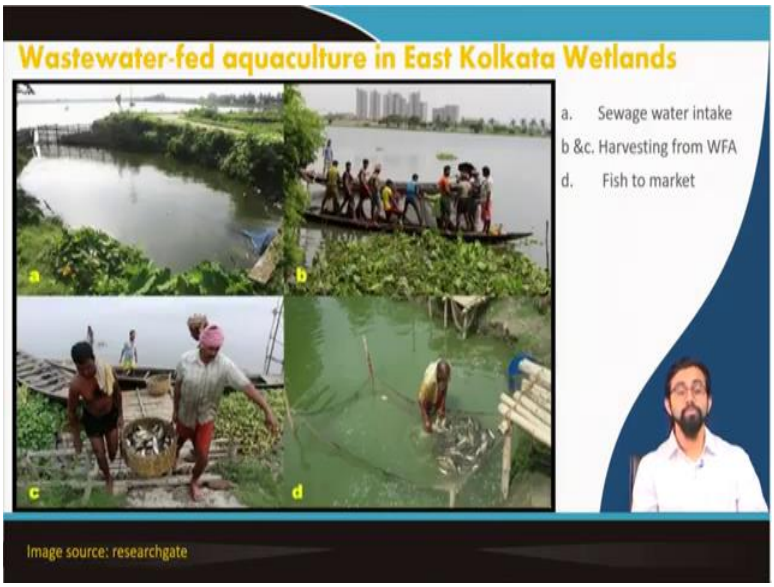

See this is a picture of taken from east Kolkata wetland if you see here the sewage water intake in the first picture and after the sewage water is collecting come in contact with there and then the fishes are harvested there, you see it is like a kind of enclosed structure, in this enclosed structure because of the net or the bamboo sticks are provided, bomboo nets are provided at the at one end, and the there is a possibility of harvesting of a huge amount of fishes from this kind of wastewater fed aquaculture. Then you see in the picture d showing that the fish is actually taken to the market.

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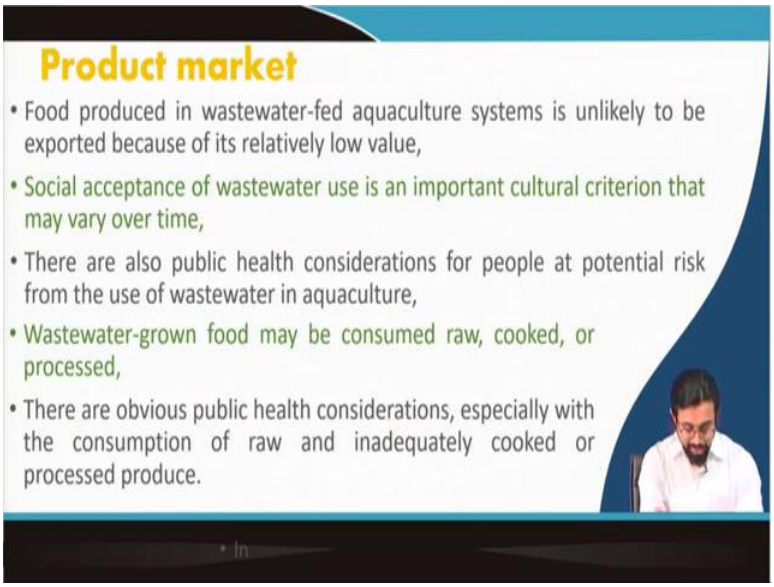

So now it is a very important thing it is like what do you think about the product market?

The food produced in the wastewater fed aquaculture systems is unlikely to be exported because of its relatively low value, there is one problem related to it; it is not exported in general because of its relatively low market value. I am not talking about nutritional value here I am talking about the market value, why it is so, because of social acceptance. Still now we have this mentality like no if it is fed by human excreta, it is fed by any contaminated water bodies then it is a very bad to have it.

So just realize other than what about the; aquaculture is just a recent practice it is last 30, 40, 50 years like intensive aquaculture if I talk about what happened to the earlier days, people used to have those things it is not something very detrimental. Now it is definitely there are a lot of different type of chemicals coming out which are different kind of genovatic chemicals which are very harmful, which were not there even like 10 years, 20 years back also.

However, still you can believe in it and you can still have it because they have their natural way of segregating the unwanted particles it is same as like we normally when we have food we do not have food which are contaminated which have some insect infestation on all these things we try to have only the food that is actually we can have it and it is good for our healthy being. The same way for the aquatic species also do the same mostly and also for your aquatic plants also do the same so you can simply have it or you can just get it tested sometimes and then you can have it like it will get rid of all the problems or the psychological barrier and you can simply have it afterwards.

There are also public health consideration for people that potential risk from the use of wastewater in agriculture, wastewater grown food may be consumed raw cooked and processed, however there is an obvious public health consideration when you are having it raw. Just try to imagine you are culturing it in a polluted condition, you cannot have it raw, and you can have it only after properly cooking it.

That is mandatory, that is one of the major thing you cannot just have those fishes, you cannot touch them, you cannot have them in raw conditions because that is highly unwanted, because there is a chances of different kind of pathogenic microorganism in your produce, because it is fed by the wastewaters and wastewater does contain huge amount of pathogenic microorganisms.

If the condition is not prepared in a certain place of your pond and there is a huge amount of infestation of different unwanted microorganisms or pathogens and the fish or any of your aquatic species come in contact with them definitely it is better to not to have it in a raw condition or inadequately cooked or process produce, you should go for proper cooking of it and then only you can have it properly have it for your consumption purpose.

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See there are some examples of the wastewater fed aquaculture system, in general the wastewater types are given and the delivery systems and aquaculture system is given in the second column, third column is providing us the information about the produced cultured organisms and in the location at the end.

So if you see the nightsoil in pond used for culturing fish in China, Indonesia, Vietnam, in Bangladesh duckweeds are cultured in nightsoil, China even in Bangladesh, Indonesia, Vietnam they are also using fish culture in pond with the supply from the contaminated surface water. In widespread places in Asia they produce some aquatic vegetables stakes in water or river or shallow ponds which are supplied with a contaminated surface water, even sewage is used to produce the fish and duckweed in China, Germany, India, Vietnam and Bangladesh.

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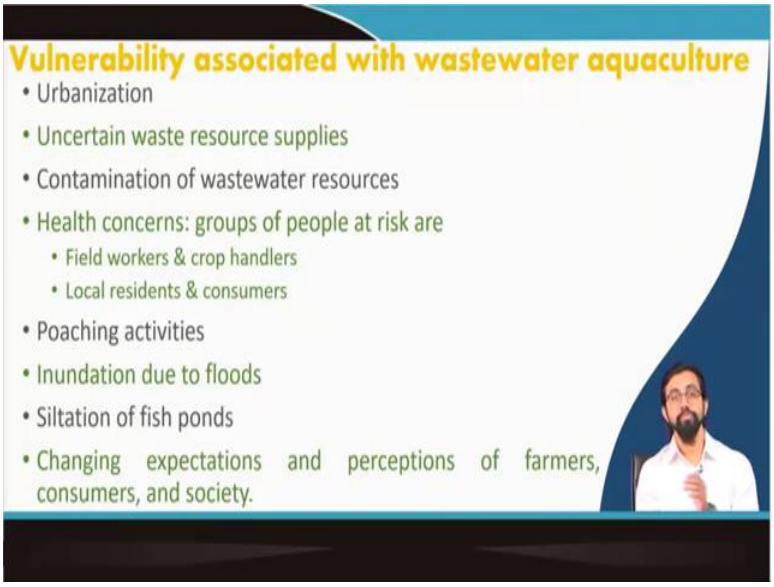

So what is the vulnerability that is associated with the wastewater aquaculture, urbanization; the more the urbanization is happening the more you lose the effective land or land footprint. So when you lose the land footprint definitely you cannot go ahead with the production of

your aquaculture species in wastewater fed condition right, so urbanization is one of the major factors.

Other than that uncertain waste resources supply sometimes what happen suppose you are not providing with supplementary feed you do not have provision say just as an example you are 100 percent sure that whatever the wastewater that is coming into the pond or into the land is enough because they have enough organic matter, enough constituents those minerals for the development of aquatic plant or aquatic species, but somehow say at certain moment of time there is a very less amount of contaminated water is coming into the picture or say there are same amount of water coming but it is not as contaminated or pollutant load is not as high which can supply enough amount of nutrient for your rear species, what will happen in that case, simply I am giving you example.

Even in diurnal basis if you realize in a municipality area, in a city area when are the time when the water uses are maximum, especially in the morning from say 6, 7 to 9, 10 am, because that time everyone goes to office or to their work space so they do their bathing they go for their morning calls they do everything in that time period. So the water which is coming out in during that region I mean the gray water the concentration is much higher like I mean not consideration the amount, the quantity is much higher than other time of the day when is the next time that this surge can happen is the evening when people come back from their offices and the workplace they took take their shower and that is the time when there is another surge, so it will go like this.

So in the morning say like 6 to 9 and again in the evening it is like 6 to 9 is the time when there is a huge surge of water coming into the picture which does not contain much of a pollutant because it is like it is like shower water mostly, so it does not contain much of a pollutant load.

So what will happen in this case that is actually sometimes detrimental to your aquatic expressions because they would not find enough because if there is not enough contaminated water coming into the picture they will not be enough for feeding the plankton or the benthos growth in your system. If the plankton and benthos are not growing in your systems definitely it will kill your culture, so that is how it works that is one of the major concerns in this case.

Health concerns, particularly the field workers or the group or these crop handlers and also the local residents and the consumers can be of health concerns that has to be well taken care of, poaching activity because it is a widespread area there is a chance like in the night time

people will come and they will just go and do netting and they take all your the rear spaces. So you have to manage proper security of your land also but it is sometimes not possible because it is a huge land, it is not possible in an individual basis it is possible in a governmental basis. So you can arrange some proper security from the government side and you can take care of it.

Inundation due to flood in case of flood what happened this water level with all your reared animal can escape from your pond, it can be somewhere else and definitely it is a drastical calamity for your rearing, changing expectation and the perception of farmer consumer and the society, I told you this customer, customer behavior and this perception of the psychological awareness about the market is very important in case of wastewater fed aquaculture systems.

So discussing about the future scopes of WFA or wastewater fed aquaculture the need for improved access to knowledge concerning constraints and also the object opportunities for operators are very important, developing effective dessimination pathway for information and improve the collective decision making will ensure the continuous operation.

It will increase the knowledge about the health risks associated with the farming, processing, and marketing of products grown in wastewater field agriculture would also help reduce the associated health risks in general. What are the principal benefits that are associated with the wastewater aquaculture; majorly considering the poor communities are income generation, employment, and enhance the food security.

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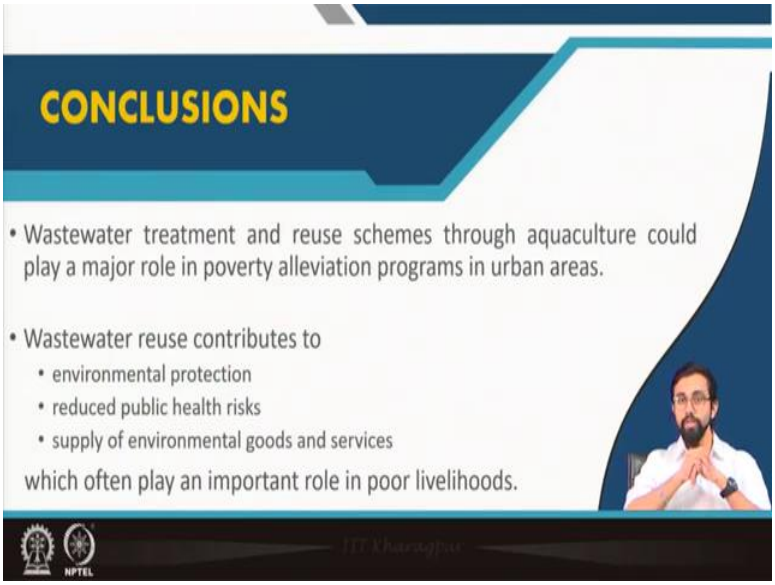

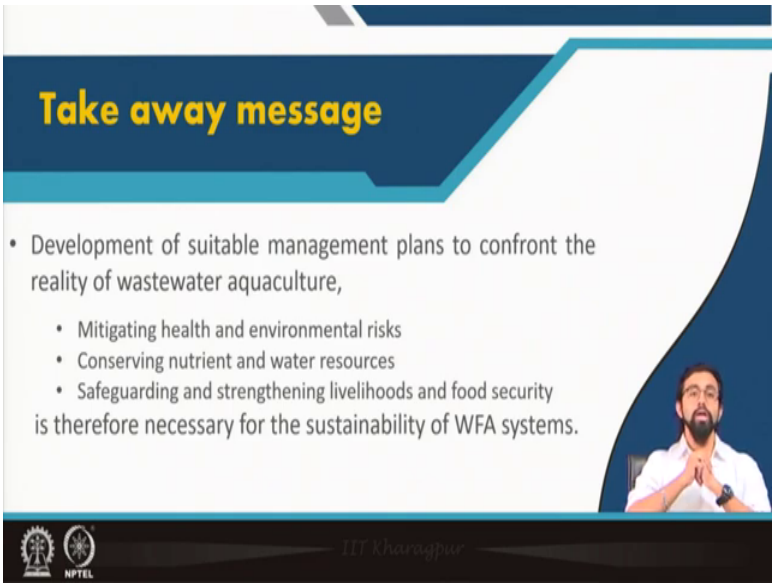

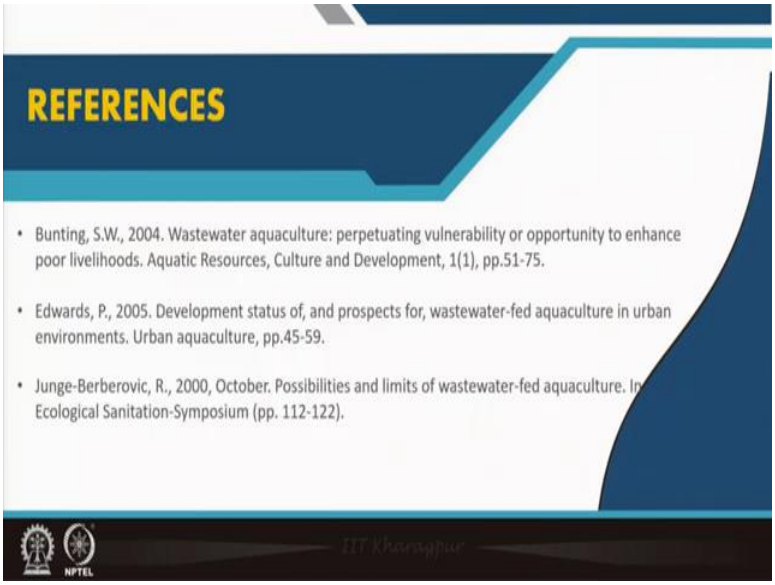

So in conclusion the wastewater treatment and reuse schemes through aquaculture could play a major role in poverty alleviation programs in urban areas, even in rural areas and wastewater reuse contributes to environmental protection, it can reduce the public health risk, it can supply the environmental environmental goods and services which often play an important role in poor livelihoods.

Take away message, development of suitable management plans to confront the reality of wastewater aquaculture, mitigating health and environmental risk, conserving nutrient and water resources, safeguarding and strengthening the livelihoods and food security for the neighboring human beings like the population, it is therefore necessary for the sustainability of wastewater fed aquaculture systems.

So I hope you got to know some interesting information about the wastewater fed aquaculture, how it can be utilized, how it is used, how it has been done and what are the pros and cons related to it, and how we can troubleshoot all the problems related to it.

I really suggest you all to go ahead with this reference and also specifically search in Google for wastewater fed aquaculture systems in Kolkata to have a better picturesque about how it is done and it will get a very interesting informations from there I hope. So if you have any questions we will discuss in the live discussion session and so for now thank you so much, see you in the next lecture.