Advanced Aquaculture Technology
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Lecture 01
Introduction

Hello everyone, welcome to this new NPTEL online certification course on Advanced Aquaculture Technology. My name is Professor Gourav Dhar Bhowmick. I am from the agriculture and food engineering department of IIT Kharagpur. In this module, I will be discussing more very basic actually about that aquaculture and different terminologies that is

But overall, in this whole 12 week of lecture series, I will mainly be focusing on the advancement in aquaculture, in worldwide scenario, what are the technology that is available which can be replicated which can be you know utilized it can be, which can definitely make people benefit out of it, if they utilize it in Indian scenario to be precisely.

What are the employability options, those are available in aquaculture, how people not only think about employability, but also think about the R and D possibility, different R and D institutes I mean like research and development institutes are there in India, how they are working on it and what are the lacuna that is available still now in Indian context and how that can be you know minimized and that can be you know, troubleshooted that will be discussed in details in this 12 week of lecture series.

Majorly my focus will be on the advancement in aquaculture technology, which can be utilized which that knowledge can be utilized by the young generation. So, that is actually my main motto. Okay! To start with why I you know introduce this subject. So, first of all, in Indian peninsula, if you look up look into it like properly so, it's like almost 7500 kilometre of area is exposed to the sea, like this is the coastal area is available.

If you include the exclusive economic zone, it will be almost 2 million square kilometre of area, which is available considered under the Indian Territory where people can utilize it that area for aquaculture development. Okay! So, that is the, that is my main focus. So, for all of you, whoever is actually you know listening or like watching this video right now, to get yourself accustomed with the advancement in this sector, and also get yourself accustomed with the knowledge available in the R and D sector and the experts like us.

So, that you will get to know you will use that technology you can use those knowledge in your daily life or you can even think about being an aquaculture expert or maybe in future being an entrepreneur as well. And definitely there is a huge possibility of being a research scholar or being a doing a research in this particular field. There is vast possibility in Indian context as of now.

So, IIT Kharagpur is actually offering this aquaculture engineering specializations where people can go and admit and then definitely they will get some very advanced knowledge about this sector, and that can be very much useful for their own benefit and also for the development of our country in general. Okay! So, that's the basic that's the brief about the course that I will be teaching in next 12 week.

So, however, to start with, we need to start we need to start understanding the basic of aquaculture because many of you may not know about the basics of aquaculture, what is aquaculture? For you, if you think about it, if I ask you, what is aquaculture? What will come into your mind? The first thing is aqua is like you know its like it is something related to water. right! So, in water, you are culturing something or rearing something that can be considered as aquaculture.

So, aquaculture practices, what you are culturing something in an aqueous medium. In general, we consider only the water where we are culturing any particular aquatic organism and then that will give us for some particular reason definitely anthropogenic activities necessary, what do I mean by anthropogenic activity means human involvement. Okay! So, anthropogenic activity based aquatic culture systems are called aquaculture system. Okay! Just to give you a very overall idea about it.

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So, what will be the concept that I will be covering in this particular lecture? To start with I will discuss about the aquaculture. Second, what is the significance of it. We will be discussing some details about the global statistics. I'll discuss about the role of aquaculture in achieving the food security, in a world like you know knowing the whole world point of view and what's it way forward. Okay!

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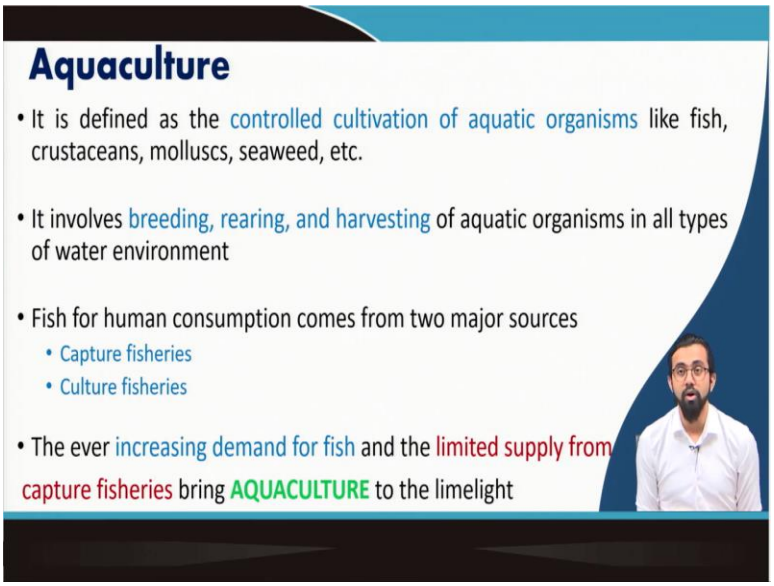

To start with as I already discussed about what is aquaculture. So, I think it is not very difficult for you to understand that any controlled cultivation of aquatic organism whether it be fish,

whether it be aquatic weed, whether it be molluscs, whether it be crustaceans, whether it be crocodile anything. So, anything and everything that you are culturing in an aqueous medium you know say in a pond, in a tank, in a open sea wherever it is, it will be considered under aquaculture. Okay! So, it not only involves, what do I mean by the culturing? It involves everything right from the breeding, rearing and harvesting.

Each and every activities involved with this you know rearing or cultivating species will be considered under the aquaculture practice. Okay! In general for the human consumption, and I wouldn't say the only human consumption but also I would say like different other purposes as well. We normally focus on two different type of fisheries. Okay! First one is capture fisheries and second one is culture fisheries.

Majorly in a broader perspective, in aquaculture, we sometimes include capture fisheries as well. But actually, aquaculture not always necessary to be included with the capture fisheries. Capture fisheries means you go and get a wild catch, means you have your fishing vessel, you take your vessel you go to the open sea, go to say inland water bodies, and you catch fish from there, that is not aquaculture in general look at that is called capture fishery. You are capturing Okay! from wild collection that is called capture fisheries.

Then there comes the culture fisheries, where you will be doing the these all these practices rearing and the culturing of your species, by you all by your own that will be considered as under culture fisheries. Okay! So, what makes this aquaculture so important nowadays, you know, people earlier, we do not worry about it, aquaculture and all, that is not something to be, you know, you know it's like thought about just like it just, it's something which is you know just go and catch some fish, it's like you know, some hobby kind of thing.

But time is changing you know for the last couple of decades, it's becoming a very big industry all over the world. And believe me in coming decades, it will be one of the major factor differentiating between different countries GDP. Okay! Aquaculture in Indian context, as of now, it is not contributing even 1 percent of its GDP, whereas it has the capacity to go up to 4 percent of its GDP contribute to 4 percent of its GDP.

And India has that capacity, that's why we are introducing these kind of subjects to let you know that what you can do, what you can what changes that you can made. So, to change the scenario

to involved with the this change involved with this blue revolutions that is happening all over the world. Okay!

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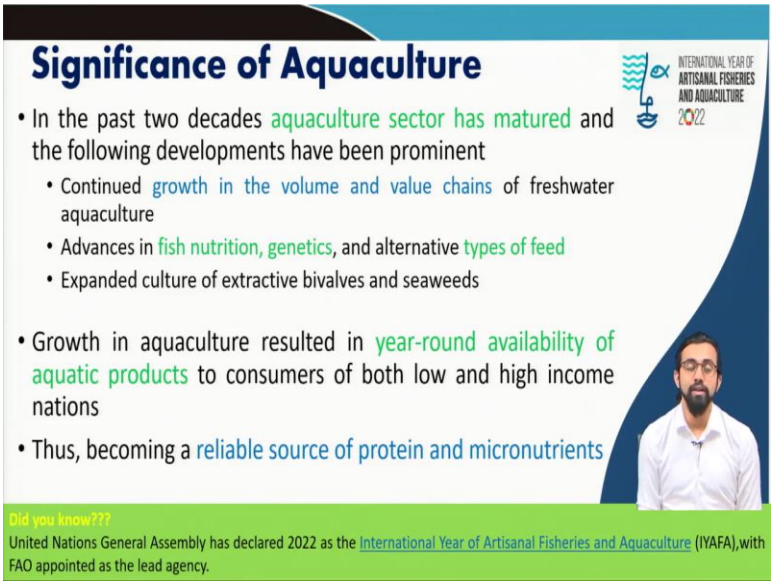

So, what's the significance of it? In couple last couple of decades. I would say the last two decades to be precisely aquaculture sector has been matured like anything. Lots of experts and the specialists are working all over the world in this sector and then try to develop you know some technology and high end information centre and all, where you can get all the necessary data necessary information related to aquaculture. Okay!

In aquaculture, there is a recent trend of huge growth and the growth in the value chain as well. The fish nutrition, genetics and alternate type of feed are being experimented and researched all over the world now, and which is actually helping the aquaculture to bloom in a multiple way. Other than that, the expanded culture of extractive bivalves and the seaweeds are also considered under this aquaculture and which are one of the major reason of one of the major source of you know how to say the economic return.

This seaweed, I am telling you this seaweed is like a green gold for you know if you consider about you know marine environment and the seaweed has tremendous amount of like the properties the chemical that it has. It has a lot of applications. I would say like you can go ahead with a pharmaceutical, you can go ahead with a food chemical, human consumption, personal care products, medical products, like it's like it has a lot of application. Okay!

And at the end if you are not after utilizing everything after the extraction is done, this extracted this all the nutrient extracted biomass the final biomass that will be getting that can be used as a livestock fodder as well. It will reduce the overall methane emission, you will be surprised to know that these kind of activities are not being practiced in most of the part of the most of the part of the world actually.

Simple change in the feed of livestock and reduce the greenhouse emission like anything. You know, the agriculture is especially the livestock is one of the major reason of greenhouse in the world. Especially the cow farming and all. It can be reduced because their colon their system has developed the greenhouse gases very frequently very you know in a very high amount, that can be minimized just by changing the food ingredients.

So, the food that you are providing to your livestock, if you added with the seaweed and some extract of the seaweeds, there is a there is lot of investigations and expert has been said a lot of time that it is possible to reduce the greenhouse emission gas emissions from livestock culturing just by changing the feed ingredients and all.

So, it has a multifaceted application not only that this seaweed wherever you will be culturing, it can clean the wastewater it can clean the water also. Because it consumed the nutrient from the surrounding ecosystem and suppose it is in the coastal region or suppose it is in the say estuary region, where the river water is just in a river is just in come in contact with the sea which we call river mouth sometime.

If we grow the seaweed there they will consume this wastewater they will consume the pollutant present in the wastewater and by this way, you can get a fresh water out of it, I would not say like it's like fresh like anything, but definitely it can reduce the pollutant level. So, these are the these are the you know applications different applications that experts have been they have found in especially if you do the seaweed culture in your territory or you say like in in your coastal region and all.

And not only that, it will give you a lot of employability opportunity as well.Okay! The local people can get a lot of you know lot of job and all if you start working on this kind of new opportunities and all. Okay! Perfect! So, other than that, another you know good thing about aquaculture is like it's year-round availability, you do not have to worry about you know, like in

a specific time of the year you will only get it because it depends upon your scientific knowledge and the way you have design your system and where design your value chain.

So, you will get year-round availability of your aquatic products and all. Okay! It becomes a reliable source of protein and micronutrients for the I would say human food human consumption, but in future there is will be a time when it will be more and more you know dominating foods source of nutrient and protein for human consumption for sure.

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	1986–1995	1996–2005	2006–2015	2016	2017	2018
	Average per year			(million tonnes, live weight)		
Production						
Capture						
Inland	6.4	8.3	10.6	11.4	11.9	12.0
Marine	80.5	83.0	79.3	78.3	81.2	84.4
Total capture	**86.9**	**91.4**	**89.8**	**89.6**	**93.1**	**96.4**
Aquaculture						
Inland	8.6	19.8	36.8	48.0	49.6	51.3
Marine	6.3	14.4	22.8	28.5	30.0	30.8
Total aquaculture	**14.9**	**34.2**	**59.7**	**76.5**	**79.5**	**82.1**
Total world fisheries and aquaculture	**101.8**	**125.6**	**149.5**	**166.1**	**172.7**	**178.5**
Utilization[2]						
Human consumption	71.8	98.5	129.2	148.2	152.9	156.4
Non-food uses	29.9	27.1	20.3	17.9	19.7	22.2
Population (*billions*)[3]	5.4	6.2	7.0	7.5	7.5	7.6
Per capita apparent consumption (kg)	13.4	15.9	18.4	19.9	20.3	20.5
Trade						
Fish exports – in quantity	34.9	46.7	56.7	59.5	64.9	67.1
Share of exports in total production	*34.3%*	*37.2%*	*37.9%*	*35.8%*	*37.6%*	*37.6%*
Fish exports – in value (*USD billions*)	37.0	59.6	117.1	142.6	156.0	164.1

[1] Excludes aquatic mammals, crocodiles, alligators and caimans, seaweeds and other aquatic plants. Totals may not match due to rounding.
[2] Utilization data for 2016–2018 are provisional estimates.
[3] Source of population figures: UN DESA, 2019.

Now, if we talk about some global statistics.Okay! Remember we discuss about the culture fisheries and capture fisheries. If you see this capture fisheries in the first three rows, the third row says the total captured including inland and marine culture at the end in the beginning it shows in the column wise 1986 to 1995 data on an average per year actually and there is at the end you will get the at the last column you will get 2018 data.

If you see the total capture from starting from 1986. It was as low as 86.9. Now, it goes up to 96.4. The difference is not much right? Definitely because it is capture fisheries, we have a limitation in the in the while we have limitation in the nature. You cannot just keep on capturing because you keep on capturing and all of a sudden the fish started in a you know school of fish started producing like anything and you have multi you know, you get a huge amount of cash in a single and a particular day this not possible.

There is a nature has limited source and the replenishment needs time. It's same as like you know renewable and non-renewable energy sources, isn't it? Fossil fuels has its limitation we have specific amount of fossil fuels reserved in the earth you cannot just keep on extracting it will come out of nowhere. That is why the capture fisheries is always is almost at the same stage till 19 30 years back till now and it's 96.4 you know the million tonne. Whereas if you go to the aquaculture, total aquaculture at that point it was only 101 I am in like total 14.9 million tonne. Now, it becomes at 82.1 million tonne in 2018 data. This data has is given from the source of food and agriculture organizations data in 2020.

If you think about in last 4 years, I can guarantee you though there is no data available for that, but people are working on it, I can guarantee these values are almost same now this capture fisheries and culture fisheries it is contributing almost 50 50 percent of world fish demand right now. And in coming decade, it will drastically change. It will just the other way round. The culture fishery will bloom like anything and the capture fisheries will not sustain at all and that is because obviously it is it is not a sustainable way of doing fisheries in capture most of the cases. Okay!

Because your it's our you know, it's our hunger that our hunger that we even if we want say like 1 kg of some stuff, but if you are getting like say 5 kg we keep on extracting the 5 kg we do not think about that extra 4 kg that if we left in nature, that can give us another 16 kg in say, like coming year. But we are greedy enough. So, we whenever we find an opportunity, we try to extract as many as for as many stuff as possible and get the maximum return.

And we do not think about the future. So, that will happen and that is why capture fish is not at all a sustainable way of you know culturing capturing the fisheries and all. And so, culture fisher will develop aquaculture will develop the total world fisheries and aquaculture contribution right now is around 100 almost 180 million tonne. Out of them if you see almost if you think about the human consumption almost 156 million tonne out of 178 is for human consumption non-food uses is like almost 22.2.

If you divided with the population in billion say like 7.6 billion net and it was there in 2018. It will be if the per capita current consumption will come down to 20 point come to 20.5 kg per capita. This is per year, Okay! this is per year I am talking about. So, in 2019 85 7 86 it was 13.4

kg per capita per year. Now, it is 20.5 kg per capita per year this human consumption are increasing they have this is like apparent consumption of per capita is increasing.

Trade if you see like, you know, as of now this fish export in value, it comes as high as 164 US billion USD. It is a huge amount of money. And that is what I am saying I was discussing, like, you know, it's the time is changing, like in aquaculture will become something very special. And there will be it will not be under some specific like the if you see the changes in the United Nations in the government, everywhere they started building a specific fisheries department, fisheries ministry, every day because they know, this is something, it's something it's revolution is happening and in the coming decade, that is that will be the future. Okay!

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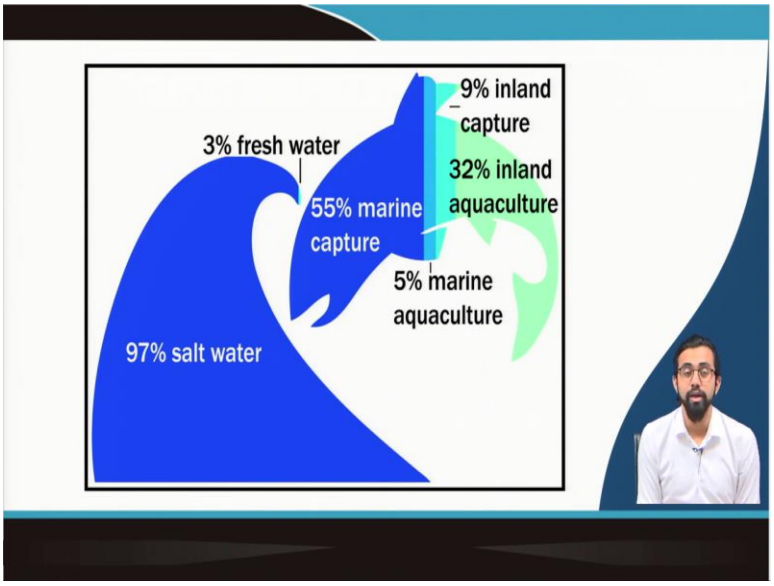

So, if you see this in a world scenario, in this particular picture, this water 97 percentage salt water and 3 percent freshwater, however, almost 55 percent of marine capture is coming from the salt water and whereas 32 is coming from the inland aquaculture, 9 percent from inland capture fisheries and total 5 percent of marine aquaculture.

So, if you see these 9 percent capture and 55 percent marine capture total almost 64 percentage of capture fisheries and rest is it should be you know 30 36 but it's like you know this point difference and all. So, 32 plus around 37 36 37. So, almost two third is coming from the capture fisheries one third is coming from the culture fisheries this data is from like 2010 or something.

But now things are changing it is almost same same, you know 2018 as we discussed in the last graph.

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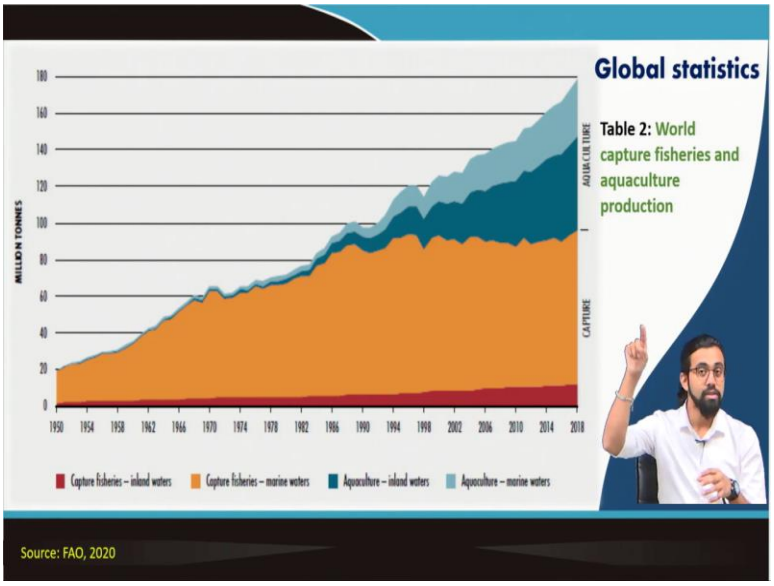

The same way to discuss about the same, you know, the different representation of the you know world capture fisheries and aquaculture production is shown in this figure, capture fisheries is shown in this you know, this yellowish line and this orangish line and culture fisheries are given in this bluish line. So, the blue and the light blue light blue shows the aquaculture in marine water, deep blue shows the aquaculture in the inland water. So, it see this curve is increasing as we discuss right this capture culture fisheries line is increasing.

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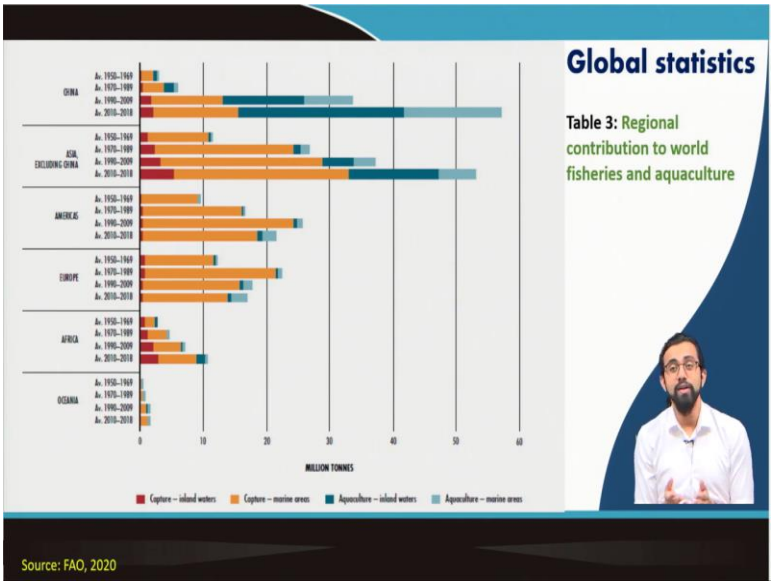

If you see the regional distribution, China once upon time 1950 1969 and in that period, that 20-year period if you see the US, the America, USA and I mean like Asia and Europe has huge amount of aquaculture production and all compared to China, but now China is dominating like anything. It has surpassed all the other countries and it is like the almost beyond reachable right now in aquaculture industry.

But still a that is why you know India is also focusing on it and it has a lot of opportunity so, really can do that in India scenario India has the capacity to reach that stage, that's why people are working on it and government we need a collaboration from philanthropist we need collaboration from NGO's, policymakers, normal young population like you. So, everyone should have to come forward and start working on it to make the things you know in a different way.

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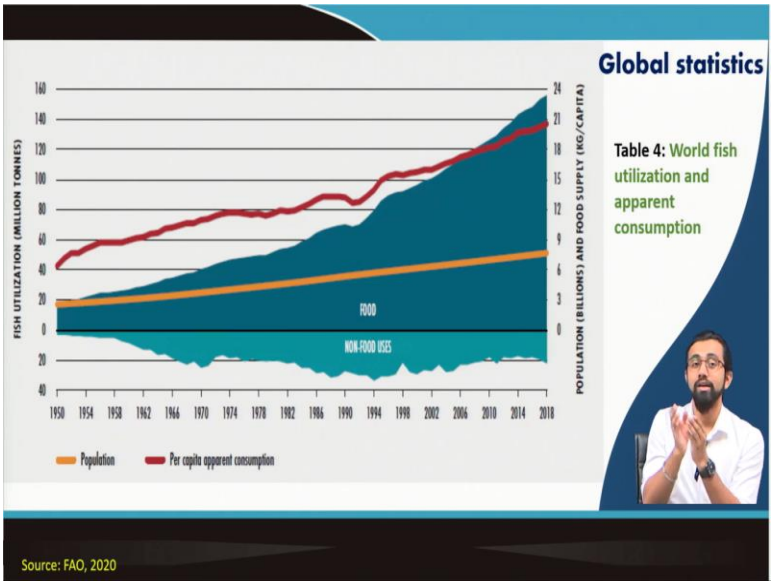

This is also another interpretation of the graph that the tables that we have seen the let this yellow line is showing the population is and this red one is the per capita apparent consumption see the population is not increasing in a like almost in a how to say you know, not in a that the fluctuation if you see the difference in the per capita apparent consumption is much higher than the changes in the population. You understand right what I mean to say and the same way this is the food and non-food sources, this non-food source uses almost the same, but food source as a

food source even food consumption that is also increasing like anything this value is increasing like anything.

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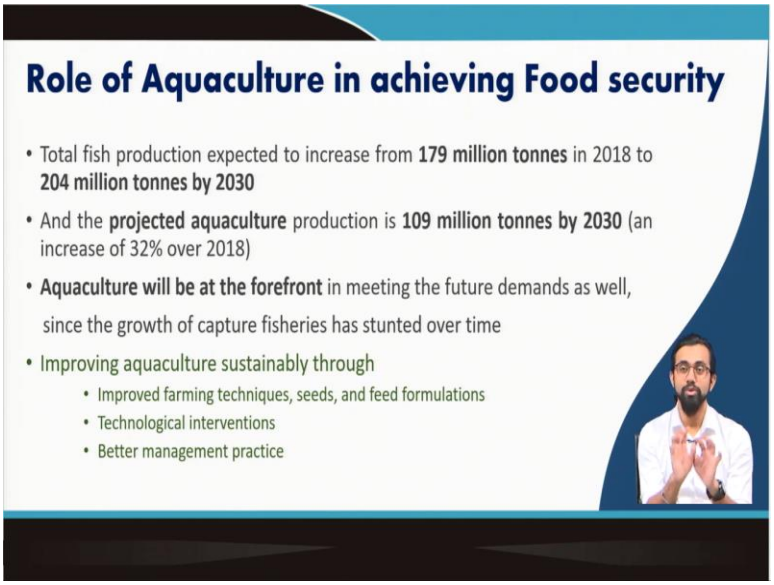

So, if you ask me that, what is the role of aquaculture in like, in terms of food security, in terms of food security of world all in a overall in a world scenario. In general, the total fish production is expected to increase from 179 million tonne in 2018 to 204 million tonne by 2030. It's It's the number you may seeing like it's just nothing like around 24, 25 million tonne that's nothing. But it is a lot to see the number of 0 that is there so it is a lot. And the projected aquaculture, it's it's to be like for 109 million tonne in 2030 to it can go up to 109 million by 2030 as it's said like almost 32 percent higher than the value that is projected in 2018. Okay!

It can be in forefront a forefront in meeting the future demand as well as demand for food demand for non-food uses like pharmaceuticals and all the chemical uses and all. Because another reason of it, as I discussed the growth of capture fisheries has stunted over time. It has the capacity, it has a limitation it cannot go beyond that. Okay!

Improving the aquaculture sustainably is possible through what like definitely we have this improved farming techniques, we can improve the seed quality, we can improve the breeding technology, we can improve the feed that we are supplying, uh we can introduce some advanced technology to monitor to observe to get rid of all the disease to identify to classify them. These

are important and this all these things if we have it all this data, we can definitely manage them in a better way. So, that is what our goal should be, isn't it?

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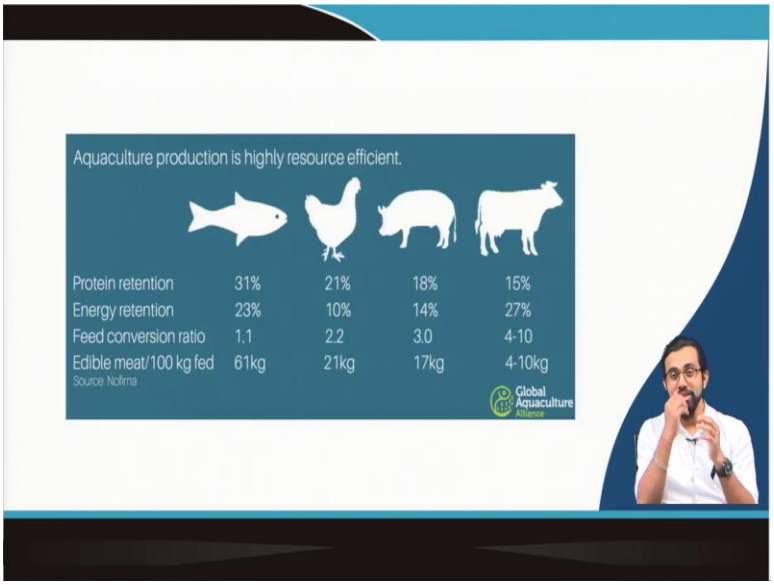

So, this graph is actually I mean this particular figure I want to give it you know, just to give you some idea about how efficient the fish is compared to any other meat sources. The protein retention if you think in case of fish, it's like 31 percentage, chicken 21, pig 18, beef 15, energy retention 23 percent is fish, 10 percent in case of uh chicken, 14 percent in case of pig and 27 percent is good in amount in case of beef. But if you see the food conversion ratio now, it's 1.1 in case of chicken 2.2. In case of pig 3. In case of beef, it's 4 to 10 kg.

Now, you must be confused, what is food conversion ratio? Feed conversion ratio. Feed conversion ratio means suppose in the numerator you will be having the amount of feed that you have supplied. Okay! In the denominator, you have the amount of feed that is actually converted into their biomass. Suppose you have supplied 10 kg of say like 11 kg of feed and your supply is having like at the end your fish production is like 10 kg. So, what will be the fed conversion? 11 by 10 ,1.1 that is the scenario in case of fish.

Now, suppose you have supplied 100 kg of feed 100 kg of like you know it's a lot of feed you have to give for one cow for there is 1 kg of body mass conversion. So, what will be the difference 100 sorry 100 say like 10 kg of body mass conversion. So, 100 by 10. So, that's why 10 of feed conversion ratio is 10 that means it to give 100 kg of feed to a cow they it will only

convert to 10 kg of their body mass. Same way edible meet these are some you know, some number that you should understand. In future it will be very handy for you, you know there will be discussing I do not have to give every time the description all the detailed definition of each and everything. Okay!

Third fourth one is the edible meat per 100 kg of feed out of 100 kg of feed that you are providing, you can have only 61 kg of edible meat from fish, I am saying only because it's still good enough actually, if you talk about the beef is like 4 to 10 kg only. So, the difference is a huge, isn't it?

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So, the discussions that we have in the last 20 25 minutes. So, I would say like we need to introduce some high-end technology to this sector to make it to a better to give a better performance or to give more efficient way of culturing these different aquatic species and rare them in our hatchery, in our tank, in our pond.

So, everything everywhere like say in your if you are going to onshore practices if you are going to high sea practices. This term are maybe new to you onshore, high sea, high sea is like high sea just think about it high seas like far away from the coastal area. Onshore is like not somehow is coastal region and all think about it. Inland means in the land inside the land, we will have a say like pond, it is inland culture.

And so, these are the different terms terminologies that you will get accustomed with it at the moment you will finish this lecture series. So, technological intervention and innovations are very much important in aquaculture, design of better facilities are required. So, that the fish can grow in a more sustainable way, high tech fish farming techniques has to be introduced.

And the good thing is they are already there, the experts have already find out are like 10s of different practice techniques or like you know ideas and all. Ideas are already floating in there, you just have to capture it you have to grab it and you have to introduce it to you in your own field or you can make it further you know better just doing your own research. Climate smart aquaculture, precision aquaculture and integrated aquaculture.

Remember these three term it will you will get to see this get you know, learn I mean like the you know hear this word more frequently in coming decade. Climate smart aquaculture, where the aquaculture practices will be done without harming without causing any environmental disruption or I would say it can it will be carbon neutral or maybe carbon negative in such a way. Precision aquaculture where you will use the system which give you like each and every, the precision agriculture involves your data you will be using your machine learning or artificial intelligence and all.

This ML AI techniques will be introduced to the aquaculture it is introduced already in the aquaculture and even we are working here in IIT Kharagpur as well. Where we are trying to see you know, use this machine learning techniques and all to develop the betterment, you know the develop the fish in a better way. So, to identify that if any small animals is there, we try to change them we try to put it in the quarantine tank and try to feed them as soon as possible.

So, there are different techniques which are already available and the technologies are there and can be if it can be useful, if you are using in a better way in a perfect you know the way or road it can give you a better food definitely in near future. Integrated aquaculture, aquaculture is not to be done in it cannot go solo you can do it. You can do it as well as paddy culture. It’s called rice cum paddy culture, you can do it with a duck culture with the duckery with the piggery with the livestock it is doable and what will happen their excreta can be utilized to for fish culture, like the aquaculture feed and all.

And this way, you know, like you can you know increase your economic return from your farm. Small scale fisheries and aquaculture are also gaining attention for their contribution to food to produce food for billions of population and achieving zero hunger. So, that is what our main target is. Right ? Like, you know, you, as of now, I'll say the fish is considered sometimes, you know, very costly product and it is only mean like, you can go and capture it, if you can do that one or two pieces or some like. If you go to the most of the developing countries, they are not getting enough food they are not having it's not accessible for them, this fish and all this meat product and all.

For them, it is something you know, if they think about it they dream about it having you know, one or two times this fish meal or chicken meal and all. Whereas some other part of the society like us, like we can even think about it, we it is not something that we think even. If we even think about it, because we can achieve it, we can easily get the food we can and it's not it's not something that we are bothered with. But for some people there are like out say like maximum portion of the population are still facing these kinds of issues where they cannot approach to get a fish in a meal in a daily basis.

So, what we can do this kind of aquaculture practices in a very sustainable and low cost manner introducing technology, governments approach and all. It can make the difference, there were a lot of people they can involve with it this protein, this very well needed protein source can be made available for each and every citizens of any country. So, that is what the goal is like, you know, the aquaculture practice aquaculture as an expert, I would also say like that is what we are actually working on.

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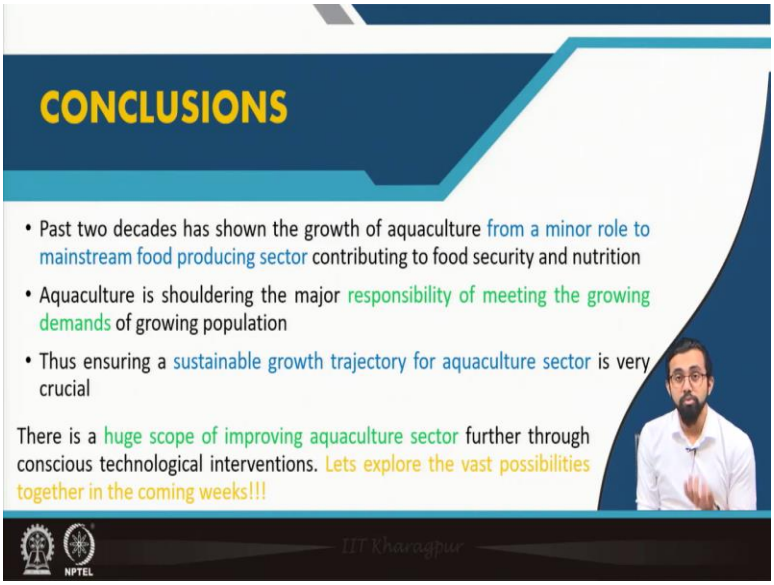

In conclusion I would say it this aquaculture is soldering the major responsibility to meet in the growing demand of growing food demand of this population explosion that is happening all over the world and thus ensuring a sustainable growth trajectory for aquaculture sector is very crucial. And it only possible we and you know that there is huge scope of improving this aquaculture sector.

It only possible when we do it through a conscious technological interventions and that is what will be discussing in coming weeks. I hope you will get to know a lot of new technology lot of new information from this 12 weeks lecture series. And so, good let us explore these possibilities in aquaculture sectors together in the coming weeks.

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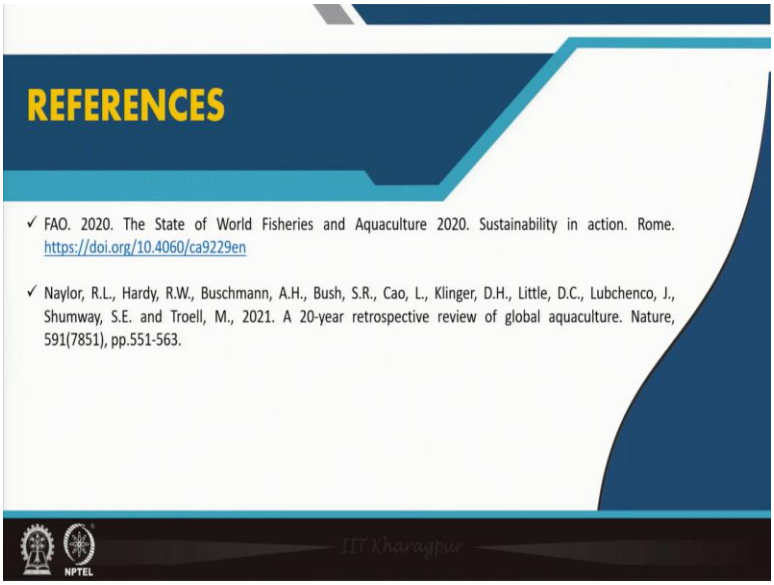

So, these are the references you can take a picture or you can go through it. It will help you understanding these factor better. If you are interested you can go through it will give you much better lot of new information about this aquaculture sector in general. I hope I can give me some basic idea about what I'm going to discuss in the last next couple of weeks I mean like next 12 weeks and this is only the starting I hope you get to know a lot of very important information in a coming weeks which will definitely help gather knowledge about this sector and may be you can make it helpful for you as well in future, Okay! thank you so much. See you in the next lecture video.