

Advanced Aquaculture Technology
Professor Gourav Dhar Bhowmick
Department of Agricultural and Food Engineering
Indian Institute of Technology Kharagpur
Lecture 46
Green Aquaculture

Hello everyone, welcome to the first lecture of module 10 technology of cleaner production. My name is Professor Gourav Dhar Bhowmick I am from the Agricultural and Food Engineering Department of IIT, Kharagpur.

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The slide features a dark blue header with the title 'Concepts Covered' in white. Below the header, a list of five topics is presented in a light blue font. A small inset video of the professor is visible in the bottom right corner of the slide content area. The footer contains the IIT Kharagpur and NPTEL logos on the left and the text 'IIT Kharagpur' on the right.

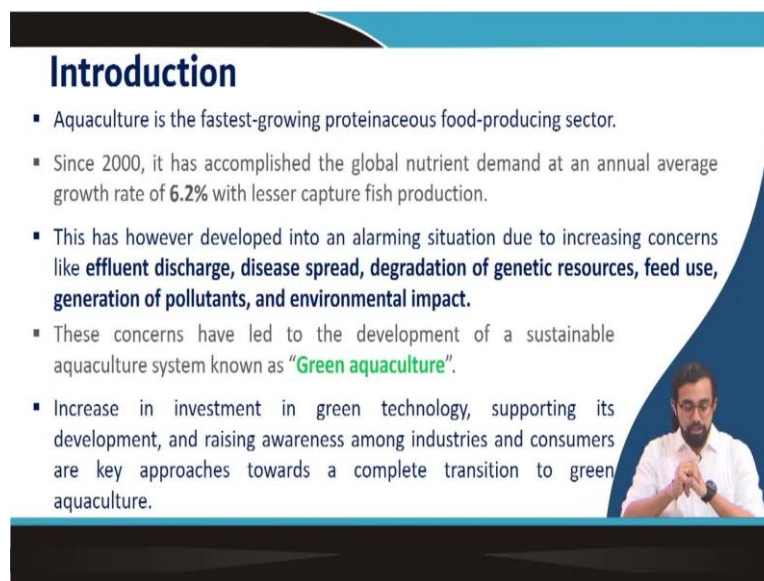
Concepts Covered

- Introduction to green aquaculture
- Aquaponics
- Biofloc technology
- Phytotherapy
- Biofertilizer

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In this particular lecture material, the concepts that we will be covering the introduction to the green agriculture, or aquaculture, the Aquaponics, Biofloc technology, phytotherapy and bio fertilizers, we already actually in the last module, we have already gone through the Biofloc technology here, I will just give you a very brief details about it just to continuing with the green aquaculture systems like just to give you a basic idea about.

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Introduction

- Aquaculture is the fastest-growing proteinaceous food-producing sector.
- Since 2000, it has accomplished the global nutrient demand at an annual average growth rate of 6.2% with lesser capture fish production.
- This has however developed into an alarming situation due to increasing concerns like **effluent discharge, disease spread, degradation of genetic resources, feed use, generation of pollutants, and environmental impact.**
- These concerns have led to the development of a sustainable aquaculture system known as **“Green aquaculture”**.
- Increase in investment in green technology, supporting its development, and raising awareness among industries and consumers are key approaches towards a complete transition to green aquaculture.

Video inset: A man with a beard and glasses, wearing a white shirt, speaking with his hands clasped.

Like aquaculture sector, it is like one of the fastest growing proteinaceous food producing sector in this world right now, with an annual average growth rate of around 6.2 percent response since 2000 like with a very lesser capture fish production day by day. So, if you remember in the module 1, we discussed about how the capture fisheries, kind of reducing and the culture fisheries gone increasing.

So, at this moment, it is almost 50 50 percent. So, like, almost half of the fish reserve when the fish production, aquaculture species production is actually done by culture fisheries and rest of the half by the captured fisheries. And it keep on increasing this aquaculture this culture fisheries is keep on increasing, there is a like, country wise data shows that some of the countries they want to go to complete aquaculture practices already there are a couple of countries actually already reached and couple of them are willing to reach by 2030 or 2035.

So in general, aquaculture though we talk about it, like, it is a very how does it is very holy systems like where we can have we can like it can provide us with the all the basic nutrients that is possible and not only all the basic nutrients, I would like, definitely not say this, but I would say like more of a proteinaceous nutrients and how it can also provide a livelihood to the local communities and all.

However, it comes with some detrimental effects. So, as we already know, like couple of them, we already discussed in earlier modules, that I think you guys are already explored about it like what are the consequences, what are the cons part of this aquaculture practices?

So, first of all the effluent discharge is really something to worry about the disease spread, the degradation of genetic resources, the use of feed, the generation of pollutants and the environmental impact all in all together.

So, first of all, the effluent like why effluent which has been generated from this kind of fish processing industry or say aquaculture practices are kind of creating a nuisance to the environment, because this pollutants are like, it is like very high nitrogen component and it needs to be treated.

And if we do not introduce any proper wastewater treatment practice like proper nitrogen removal techniques, it can cause high environmental impact on the receiving water bodies. And this aquaculture practices, it needs a huge amount of fresh water intake and also freshwater research and moreover, in order to troubleshoot this kind of problems, we go ahead with the identify solutions, like recirculatory aquaculture systems.

So, altogether these problems are still there and people and researchers and experts all over the world, they are working on it like how to get rid of all this problems and how we can find out some solutions which will provide some sustainability in this matter, all this technology, which actually provide us this proper sustainability, like well adhere to the sustainability issues. We call them green aquaculture techniques.

So all these green aquaculture techniques, if you remember the Biofloc technology that we discussed in the last module, that is one type of green aquaculture technology, why it is called Green aquaculture technology. First of all, we do not have to worry about the resource, we do not have to worry about much of a resources here.

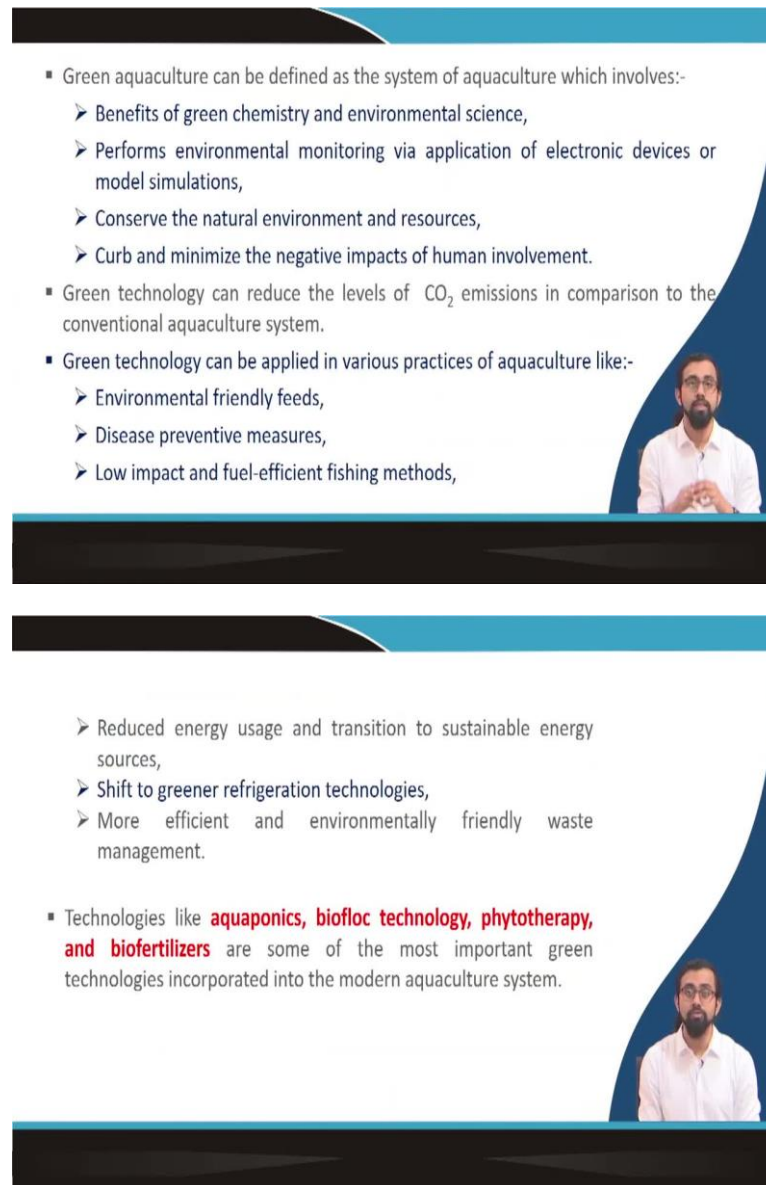
Because the water consumption is very can we minimize the resource the use of feed can we minimize in case of Biofloc technology to remember the microbial feed that is generated while treating the pollutant is actually the considered as a feed for your aquatic species or the rearing fishes and so this way you we can reduce the overall environmental impact we can reduce the water uptake, we can reduce the energy utilization in general if we can provide if we can corporately optimize the system.

So, this way, we can actually reduce overall environmental impact. So, that is the reason we call them green aquaculture technique. This lecture and in the follow of lectures of this module will discuss more about all this green aquaculture techniques, and I hope you will be

benefited out of it. So, in general and nowadays people are increasing their investment in the green technologies and like it is supporting its development and raising the awareness among the industries and consumers.

And is actually the one of the key approach for complete transition to the green aquaculture all over the world and especially in Indian scenario, we definitely need to focus on that.

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Slide 1:

- Green aquaculture can be defined as the system of aquaculture which involves:-
 - Benefits of green chemistry and environmental science,
 - Performs environmental monitoring via application of electronic devices or model simulations,
 - Conserve the natural environment and resources,
 - Curb and minimize the negative impacts of human involvement.
- Green technology can reduce the levels of CO₂ emissions in comparison to the conventional aquaculture system.
- Green technology can be applied in various practices of aquaculture like:-
 - Environmental friendly feeds,
 - Disease preventive measures,
 - Low impact and fuel-efficient fishing methods,

Slide 2:

- Reduced energy usage and transition to sustainable energy sources,
- Shift to greener refrigeration technologies,
- More efficient and environmentally friendly waste management.
- Technologies like **aquaponics, biofloc technology, phytotherapy, and biofertilizers** are some of the most important green technologies incorporated into the modern aquaculture system.

In general, the green aquaculture it can be defined as a systems where which involves the benefits of green chemistry and environmental science, which performs the environmental monitoring via application of different electronic devices or like model simulations, we can

conserve the natural environment and the resources we can curb and minimize the negative impact on human environment and all.

If you realize that I have already discussed these 4 in the previous slide like how just giving an example like how Biofloc technology doing the same thing, how Biofloc technology is actually helping us to go for this green aquaculture producer. So, in general, not only this green technology, this kind of green aquaculture technology can also reduce the level of carbon dioxide emissions in comparison to the conventional aquaculture techniques.

Why so, if you realize the if we reduce the amount of water uptake, if we reduce the amount of feed uptake, if you can reduce the amount of energy requirement all these things comes with certain amount of carbon footprint, is not it? So all these carbon footprint can be utilized can be reduced if you go ahead with this kind of green aquaculture technology.

It can be applied in various practices in aquaculture first, say like environmental friendly feed production disease preventive measures, different low impact and fuel efficient fishing methods, you can go ahead with the reduced energy uses and transition for sustainable energy sources. What are the transition to sustainable energy sources?

Say the renewable energy source. You can go ahead with the proper solar roofing you can go ahead with the wind energy you can go ahead with the geothermal energy. So all this in a different types of renewable energies you can utilize in your farm to increase your production plus you can you can reduce the overall energy impact overall environmental impact to the surrounding vicinity.

Also shift to the greener refrigeration technology, if you realize the most of the water most of the like one of the major reason why we go for this always this freshwater exchange or we can provide them all the water because with time water gets evaporated right. Suppose you have a fish field or suppose you have a fish field come say like a crop field.

What will happen to this field, first of all from the crop how the water gets evaporated because of the action called transpiration from the leaves the water gets evaporated that is called transpiration. In case of pond body or in case of water body, it is evaporation. So, this combined effect of this transpiration and evaporation we call them evapotranspiration.

There is a, there is the concept we call it like, in order to reduce this evapotranspiration issues, evapotranspiration losses, and which is actually one of the major reason why we need to keep on adding water into the system into our farm, is not it? So, this loss can be minimized, if we can go ahead with some water condensing structure.

Water condensing structure means, I mean like it is not water condensing structure, some crystallization techniques, it is just some means, you can capture the moisture present in the air atmosphere and you can condense it in that water that clean water, you can again put it back to your farm.

So, this is happening the technology is already there, you just need to need to provide a proper refrigeration unit where the air the evapotranspired water from your farm. Suppose it is a closed bound technology like say like poly house or like in a normal clean house. So, what will happen the evapotranspired water can be collected in your air conditioning unit and the water will get condensed if you design it correctly.

And then this water, this moisture which is converted into the condensed water that can be throw, that can be put it back to your farm to your pond. So this way, you can kind of reutilize the water like more and more so water losses will be drastically reduced. Moreover, this refrigerant technologies it requires huge amount of energy, so how can you say that it is a you are using this kind of huge energy consumption because I am consuming unit.

And just to get it help you to remove or reduce the water consumption that is why we need to go ahead with a greener refrigeration technology. What do I mean by greener refrigeration technology? I think you guys already know like earlier days we used to use this the ceramic this we call it like a small drum or something this ceramic drums or this mud made drums or the soil made drums, what happens there because of their certain capacity.

Because there is some small water channels present in this membrane like structure in their body, because of that water channeling is happening in a very slow rate and the water gets evaporated from its surface and because of that, the water inside of it can be easily cooled down. So, this is an efficient technology that is being used for like 100 of years earlier when before the refrigeration unit actually being developed.

So, why not we use this fundamentals, why not we use this funda and we can develop our farm in such a way that it will create a certain like inside temperature can be much cooler

than outside you can have these like bottle like structure which are nowadays made in African regions what they do to increase to reduce the temperature inside the house, you can use small bottles, we know this bottles, the bigger size bigger mouth will be the outer side.

And the smaller mouth will be the inner side because of the change in surface area the pressure drops and because of that there is a chances of the cooler air inside your chamber that is just to give you an example, you can go ahead with a geothermal energy. Geothermal energy if you use it, you can always maintain the temperature inside your farm at a certain level.

Because geothermal energy is very easy to design you just put your, like this geothermal unit almost 20 to 25 feet below the ground, where the temperature is always same no matter what whatever the fluctuations happening over the surface, but inside that and that level, the temperature is always same, almost same. That temperature if you can mimic in your system in your unit or your farm, that is it you do not have to this is the greener refrigeration technologies.

Still you may need refrigeration, suppose you are from an equator region or so differently the amount of the temperature outside is pretty high. So, in that case, you may need some refrigeration in it, but the load in those refrigeration unit can be drastically minimized if you go ahead with this kind of geothermal energy or a structural modification for your farms.

I hope you understand like, why the greener refrigeration technologies are mentioned in order to go for greener aquaculture in general. More efficient and environmentally friendly waste management system has to be developed. Definitely, and because that is one of the major issues for your rearing aquatic species plus all the resource recovery.

So the technologies like Aquaponics, Biofloc technology, phytotherapy and biofertilizers are some of the most important green technologies incorporated into the modern aquaculture systems. And I am going to discuss about all these things in this particular lecture. However, I want you guys to give more elaborated lecture on Aquaponics.

This is a very high end technology which is coming up all over the world and it will generate a huge amount of I would say employment opportunity in Indian context in near future. So, this Aquaponics I want to discuss more in details in the coming lecture though in this lecture, I will just give a brief about all these 4 technologies, 4 greener aquaculture technology just to

give you some idea about why it is called greener technology, greener aquaculture technology.

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First to start with the Aquaponics systems, I hope what is hydroponics? Right Hydroponics is the culturing of crops, different kinds of crops, agriculture crops, without the presence of soil. So, we can provide it with the proper nutrient media, you can provide it with some porous media. So, this nutrient media will provide the water along with this nutrient media will provide enough amount of nutrient possible for the growth of your crop.

So, that is the hydroponic system it can be elevated, normally we put it in the elevated ground, you can do it in the ground itself, you can do it vertical hydroponics. So, however, the requirement of the growth media is one of the major concern in hydroponic system, whereas aquaculture in aquaculture one of the major aquaculture if you do it in a tank if you do it in a pond, it is okay but one of the major nuisances is the wastewater that it generates, is not it?

Because this wastewater contains a huge amount of nitrogen nutrient, nitrogen rich polluted. This nitrogen rich pollutant normally ammoniacal in nature. So, what happens to the ammoniacal nitrogen? How you can utilize this nitrogen, this nitrogen rich wastewater. Somehow if we can convert it to the some more crop friendly nitrogen spaces say like nitrate, then this nitrate can be supplied to your, nitrogen rich wastewater can be supplied to your hydroponic system and the plant will consume the nitrate from the wastewater and all the other nutrients that is present there, it will consume it or it will convert it to its biomass.

By this way, the water can be treated right because the pollutant load gets depleted when the hydroponic system the plant consume it through the root system. At the end, the water which you are getting out of this hydroponic systems are free of this kind of obnoxious pollutants alone. Now, you can again put it back to your aquaculture pond. So, this way are symbiotic, a technology can be developed, which works in agglomeration with aquaculture and hydroponics systems, as we are using aquaculture technique and hydroponic systems.

In short, we call them aquaponic system. It is a type of organic hydroponic or bioponics system also, because we use we do not use the chemically induced this feed and all or hydroponic solution whether we use aquaculture wastewater, so that is why we call them organic hydroponics system, one type of organic hydroponics.

So I hope you realize that what is Aquaponics system, and I am again telling you that this is the future farming system, the future lies in this kind of technologies. It is gone, like it is not like I would not say like it is gone gone, but it is really gone to that soil based agriculture systems nowadays because of major anthropogenic activities and that especially the crunching in the land area, the climate behavior got like drastically changed.

It is not in our hand anymore, and the seasonal variability is like, very horrible situation right now, because of the global warming and not. All this matter can be solved and all this matter can drastically affect your crop and drastically affect your food source, how it can be solved? It can be solved with the hydroponic systems, it can be solved with this vertical farming units, it can be solved by these kinds of Aquaponics systems.

And not only it will be solved, but it will give you high yield, high livelihood like high economic benefit, which can provide you some employability opportunity to your nearby region. So, all together this is something sustainable one kind of very well sustainable solution for and also we call them we can call them like proper green aquaculture technologies, Aquaponics systems.

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Aquaponics (Cont.)

- Aquaponics is an organic farming system that integrates recirculating aquaculture and hydroponic (vegetable/flower/herb) production into a single unit.
- It serves as a model of sustainable food production by following principles:-
 - Wastes generated by the aquaculture system serve as nutrients for the hydroponic system.
 - The generated water is reused and recirculated after biological filtration.
 - Integration of aquaculture and hydroponics results increases diversity and yields multiple products.



- Production of food locally provides access to healthy food and also boosts the local economy.
- Generally the nutrients generated from fish fecal waste, decomposing fish feed, algae, and manure are contaminants that would otherwise build up to toxic levels are supplied to the hydroponic system and this nutrient-rich effluent acts as fertilizers for the growing plants.
- The hydroponic beds function as biofilters and remove the residual ammonia, nitrites, nitrates, and phosphorus and recirculate the purified water back into the fish tanks.



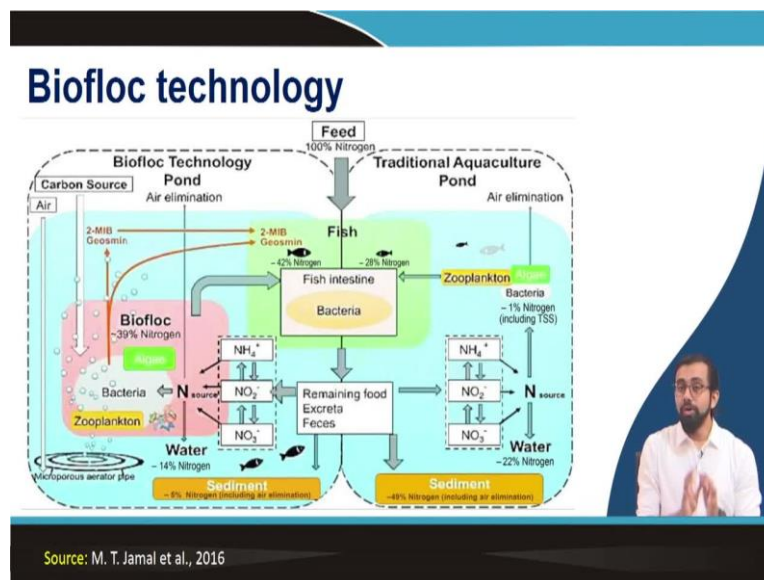
In general this, it serves as a model of sustainable food production by following the principle of what as I discussed, the waste which is generated from the aquaculture systems serves a nutrient for the hydroponic system, the generated water is reused and recycled it after the biological filtration and integration of aquaculture and hydroponics results in increasing in the diversity and it yields multiple product.

Other than that, production of the food locally provides the access to healthy food and also it boost the local economy. Generally the nutrient like generated from the fish, fecal waste decomposition of fish feed, algae, manure or contaminants, that would otherwise build up toxic levels that can, but it can be supplied to the hydroponic systems they will consume it and this nitrogen rich effluent acts as a fertilizer for growing your plants.

The hydroponic beds sometimes can act as a bio filter, which remove the residual ammonia nitrite nitrate, phosphorus or recirculate the purified water back into the fish tank. However, sometimes if you only having this nutrient media, so, in that case, you need to provide a biofilter beforehand, it would be better to provide a biofilter beforehand with the proper nitrifying organisms. What it will do?

It will convert the ammonia present in your wastewater like fish... this aquaculture wastewater into nitrate because of the nitrification technique. Now this nitrate nitrogen, NO_3^- negative it will be you can provide it to your hydroponics and it will increase your yield and it will act as a source of nutrient.

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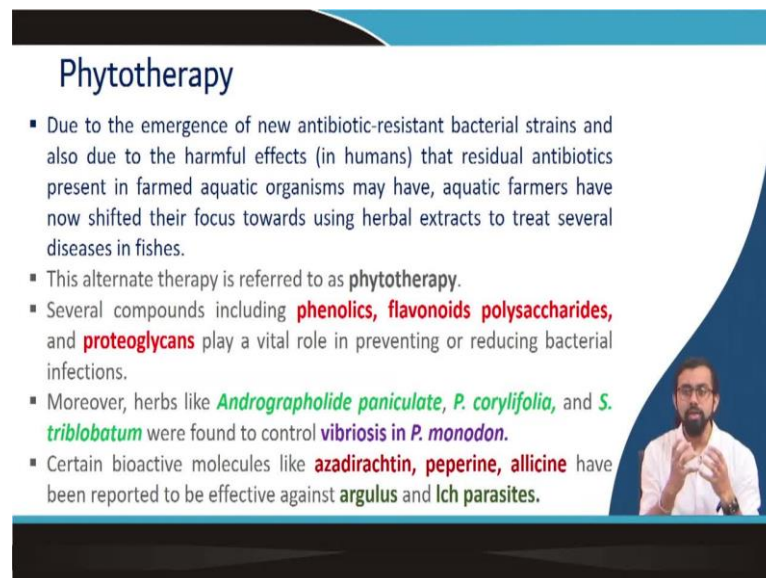
Second greener technology Biofloc technology I am not going into details about this, because we have already discussed in a lecture material in last module. So, this Biofloc technology is also one type of greener technology because why because water uses is minimum, the Biofloc that is generated Biofloc means like the microorganisms, this heterotrophic microorganisms which are consuming the wastewater it will make it into their biomass.

So, it increases the biomass and that Biomass concentration that biomass is actually being fed by the fish again or say like your aquatic species again. So, this way there is a nice organic cycle is like generated and what it happens like it will it will reduce the water consumption, it will reduce the food requirement for your fish.

Only in certain cases you have to provide it with a supplementary feed but most of the cases the Biofloc technology provides ample feed and also it is lightweight and it is very healthy for and also healthy and also it can replace the fish meal and fish oil which is like one of the major concern and whole world like all the aquaculture specialists are working on the technologies that can be developed or feed that can be developed.

That can replace fish meal, because you do not go ahead with the culturing fish by providing them fishmeal for that you need another culture of fish and that culture of fish, it will cost you a lot or otherwise you have to go for capture fisheries. So, both the cases is detrimental. So, aquaculture can only be called Sustainable when the feed requirement can be sustainably handled like in this particular case, in case of Biofloc technology.

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Phytotherapy

- Due to the emergence of new antibiotic-resistant bacterial strains and also due to the harmful effects (in humans) that residual antibiotics present in farmed aquatic organisms may have, aquatic farmers have now shifted their focus towards using herbal extracts to treat several diseases in fishes.
- This alternate therapy is referred to as **phytotherapy**.
- Several compounds including **phenolics, flavonoids polysaccharides,** and **proteoglycans** play a vital role in preventing or reducing bacterial infections.
- Moreover, herbs like **Andrographolide paniculate, P. corylifolia,** and **S. triblobatum** were found to control **vibriosis in P. monodon**.
- Certain bioactive molecules like **azadirachtin, peperine, allicine** have been reported to be effective against **argulus** and **Ich parasites**.

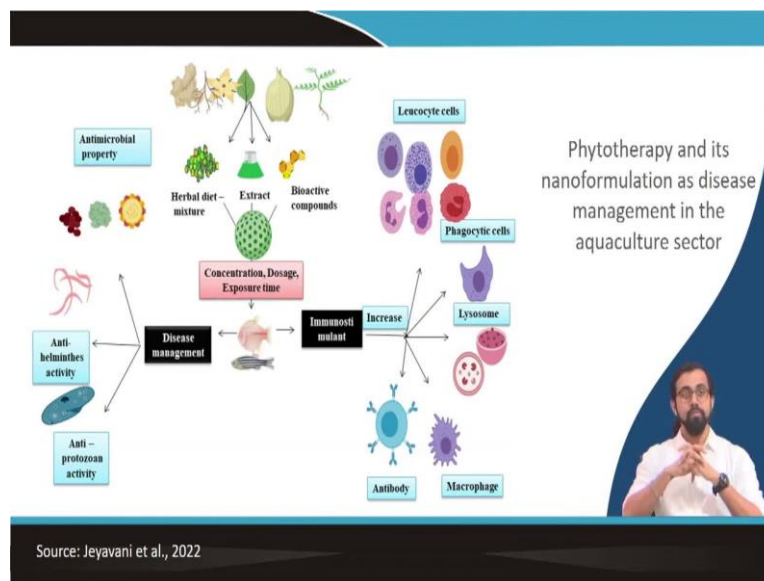
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What is the third one like phytotherapy from the name itself, I think you have understood like phytotherapy means this different compounds like phenolics, flavonoids, polysaccharides and proteoglycans and all these kind of compounds can be harvested from the herbal extracts that can use for different use different purposes of in aquaculture, this herbal extract, which are now like you can extract from this herbals.

I mean, like from different plants and all that can be well utilized for disease control, that can be well utilized for healthy outcome from your fish. So, this is called as that is why it is called phytotherapy. Just to give you one example, in *Penaeus monodon*, it has this vibriosis this disease. So, this vibriosis is can be controlled by herbs like this andrographolide paniculate or this *P corylifolia* or *S triblobatum*.

So these are the some of the herbs which can be utilizable which is found suitable for controlling vibriosis in *Penaeus monodon*. Certain bioactive molecules like azadirachtin, peperine, allicine have been reported to be effective against argulus and the ich parasites. So I think you know where we find this allicine like, so different kinds of plant extracts azadirachtin, so, these are found in different kinds of plant extracts like turmeric. So this you can use this allicine and you can use it for regulating this kind of disease causing reason.

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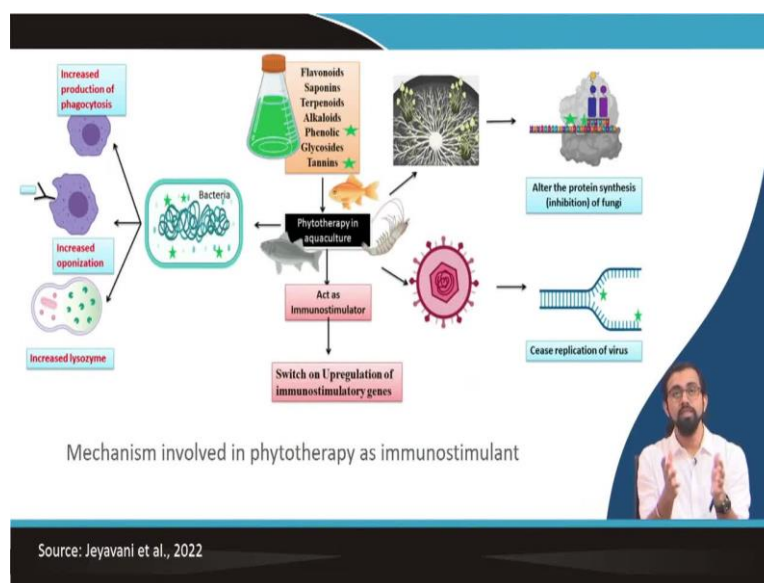


So, in general, the phytotherapy and its nano formulation as disease management in aquaculture systems if you see the fish, like first is turmeric and all different kinds of plants are used their extract or herbal diet mixture or biotic compounds are provided as a doses or you can provide it as pellets so on along with the pellets along with the feed, you can provide it to your fish.

So, it will help in disease management, it will help to go ahead with the anti-helminthes, anti-protozoan activity, anti-microbial property, in immunostimulant also, it will increase the lysosome it will increase the phagocytic cells, it will increase the leukocyte cells, it will increase the macrophages and antibody.

So, what will happen because of the increment of this particular cellular parts it will increase the capacity of sustaining in a harsh situation, and it can choose to fight against the disease. So that is why we provide these we call them phytotherapy.

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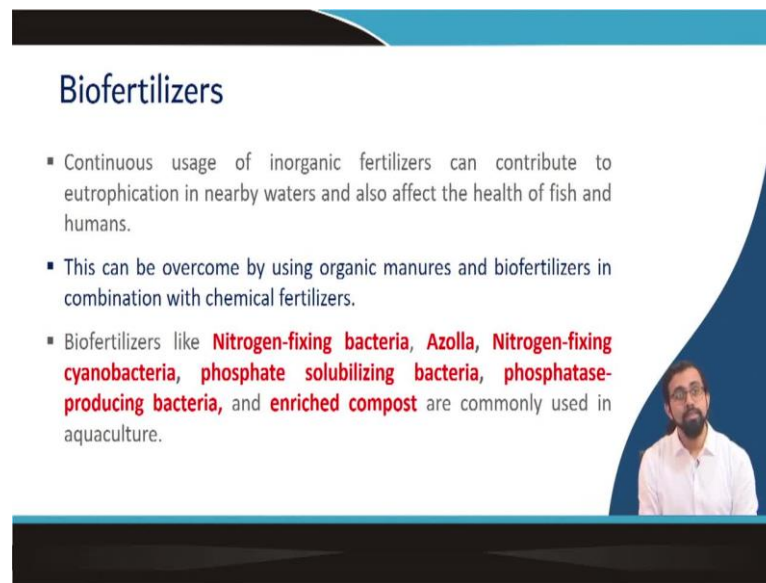
So, what is the mechanisms that involves in general say like when we supplied with the flavonoids, saponins, terpenoids alkaloids and phenolics or the glycosites or tannins component. This phytotherapy in aquaculture they provide, if suppose you are attacked by a bacteria, when you increase the phagocytosis... increase the production of phagocytosis what will happen is this phagocytes cell they consume this increase in the opsonization, what is opsonization? It increases capacity to target a particular bacterial cell.

It increases the lysosome presence. So, by increment of all this cellular organisms, cellular targets, cellular products, it will help get rid of the bacteria, how we get rid of the viruses, it sees the replication of viruses, this kind of phytotherapy, that is why it is used for seizing the replication of viruses, how the fungi attack can be minimized, it altered the protein synthesis or protein in general we call it the protein inhibition in case of fungi.

So, by this way, and also it act as a immunostimulant it switch on the upregulation of immunostimulatory genes. By all this means it helps your aquatic species to act against your disease causing microorganisms or say in general it will increase their health. It cause a huge amount of healthy benefits to your systems.


So, that is why we need to focus on these kinds of technologies which will give you a production organically strength and you do not have to provide some any additional chemical things, but rather all these chemicals extract from the biological components I mean like this resynthesis procedure can be utilized and it can be used for the medicinal purpose.

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Biofertilizers

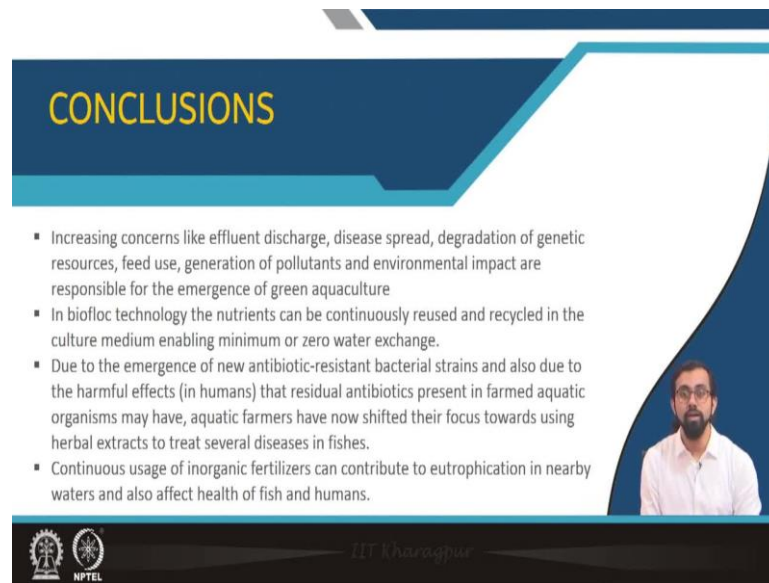
- Continuous usage of inorganic fertilizers can contribute to eutrophication in nearby waters and also affect the health of fish and humans.
- This can be overcome by using organic manures and biofertilizers in combination with chemical fertilizers.
- Biofertilizers like **Nitrogen-fixing bacteria, Azolla, Nitrogen-fixing cyanobacteria, phosphate solubilizing bacteria, phosphatase-producing bacteria,** and **enriched compost** are commonly used in aquaculture.



What are bio fertilizers? Because the continuous uses of these inorganic fertilizers it can contribute to the eutrophication and also it can drastically affect the health of the fish and fish consuming humans in that case. How we can overcome this we can go ahead with the organic manures or bio fertilization. What is this organic manures or bio fertilizer?

I think you all know about it in mostly most of the cases the bio fertilizers like nitrogen fixing bacteria, Azolla, nitrogen fixing cyanobacteria, phosphate solubilizing bacteria, phosphatase producing bacteria and enriched compost are commonly used in aquaculture. So, these are the fertilizers these are the bio fertilizers that is used to enrich the overall natural, supplementary natural supplementary available to your system to your like, it is like a natural compost to your unit to your farm.

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CONCLUSIONS

- Increasing concerns like effluent discharge, disease spread, degradation of genetic resources, feed use, generation of pollutants and environmental impact are responsible for the emergence of green aquaculture
- In biofloc technology the nutrients can be continuously reused and recycled in the culture medium enabling minimum or zero water exchange.
- Due to the emergence of new antibiotic-resistant bacterial strains and also due to the harmful effects (in humans) that residual antibiotics present in farmed aquatic organisms may have, aquatic farmers have now shifted their focus towards using herbal extracts to treat several diseases in fishes.
- Continuous usage of inorganic fertilizers can contribute to eutrophication in nearby waters and also affect health of fish and humans.

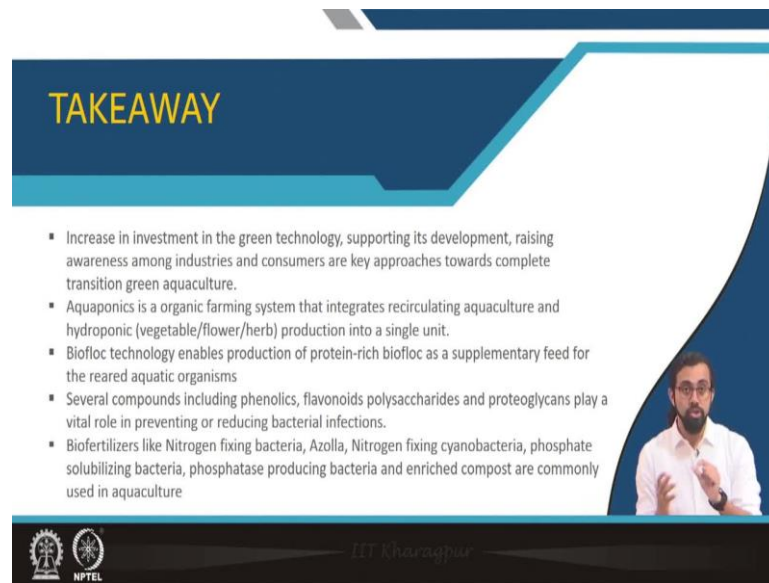
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So, these are the things that we need to focus on this 4 technologies nowadays people are using like just to give you an example of general technology, these are the 4 different technologies that I can discuss you about and there are plenty of more, I really expect you to go and find out, go and study some of them and just Google it about the remote greener technology that will definitely give you a much wider knowledge, much better idea about what it is exactly all about.

So, in conclusion, our increasing concern about, effluent discharge, disease spread, all this generation of pollutants and environmental impacts are responsible for the emergence of green aquaculture. Biofloc technology nutrients can be continuously reused and recycled in the culture medium, enabling the minimum to zero water discharge due to the emergence of new antibiotic resistance, bacterial strains.

And also due to the harmful effects that residual antibiotics present in farmed aquatic organisms may have so aquatic farmers now have shifted their focus towards herbal extracts to treat different diseases in fishes. Continuous uses of inorganic fertilizers can contribute to eutrophication and that is why we need to focus on organic fertilizers or the bio fertilizers in general.

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TAKEAWAY

- Increase in investment in the green technology, supporting its development, raising awareness among industries and consumers are key approaches towards complete transition green aquaculture.
- Aquaponics is a organic farming system that integrates recirculating aquaculture and hydroponic (vegetable/flower/herb) production into a single unit.
- Biofloc technology enables production of protein-rich biofloc as a supplementary feed for the reared aquatic organisms
- Several compounds including phenolics, flavonoids polysaccharides and proteoglycans play a vital role in preventing or reducing bacterial infections.
- Biofertilizers like Nitrogen fixing bacteria, Azolla, Nitrogen fixing cyanobacteria, phosphate solubilizing bacteria, phosphatase producing bacteria and enriched compost are commonly used in aquaculture

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So, what are the takeaway? We should increase the investment in the greener technology supporting its development and raising awareness is one of the major issue nowadays we have to go ahead with this. Aquaponics, we know about the Aquaponics, very basic about the Aquaponics in the coming lecture I will discuss more about what is Aquaponics, how it works.

Biofloc technology we discuss about it we discuss about how different plant extracts like the different components like phenolics, flavonoids, polysaccharides proteoglycans can play a vital role in preventing and reducing the microbial infections in general. Biofertilizers like nitrogen fixing bacteria, this enriched compost can normally we used in aquaculture and it is very much famous nowadays. And this can increase your production in a very sustainable manner.

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REFERENCES

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So, all this technology that we discussed today is mostly the sustainable ones and that is why it is called a greener aquaculture. So, when we talk about greener aquaculture, these are the technology that we talked about, you can go ahead with this reference to get more information regarding this technology, regarding green aquaculture.

So, in the coming lecture, in the second lecture, we of this model will majorly been focusing on the Aquaponics systems smart Aquaponics system. Why we name it smart Aquaponics system we will discuss in general. So, thank you so much. See you in the coming lecture.