Advanced Aquaculture Technology
Professor Gourav Dhar Bhowmick
Department of Agricultural and Food Engineering
Indian Institute of Technology, Kharagpur
Lecture 44
Integrated farming (Cont.)

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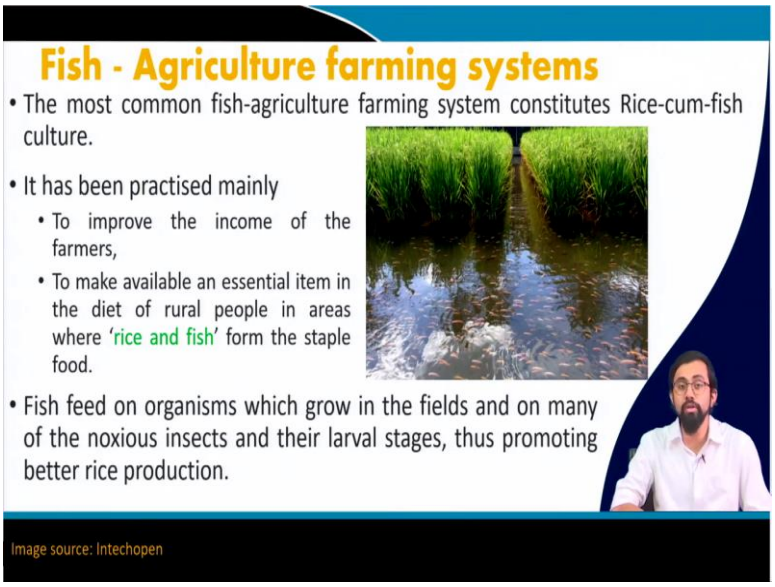

Hello everyone, welcome to the fourth lecture of module 9, technology of organic farming. So, my name is Professor Gourav Dhar Bhowmick, I am from agriculture food engineering department of IIT Kharagpur. So, the concepts that will be covered in this particular lecture material will be the fish agriculture farming systems, we have already gone through a basic discussion about the integrated farming processes and all. So, here I will be continuing it from the previous lecture. Fish and rice agriculture types, fish fields selection, horticulture-

fish culture, and agriculture-aquaculture-livestock systems, or sometimes we call them AALS also.

So, in general, when we go, when we talk about the fish agriculture farming systems that we in continuation with our previous lecture. In this particular example, I want to let you know about the fish and rice like culture, like or we call it rice-cum-fish culture systems. So, it has been practiced for long, even thousands of years back even it was seen in some pictures of some earlier days, like some there are literatures available people have mentioned that in China and in South-eastern Asia, even thousands of years back people used to practice this rice-cum-fish culture.

Because the rice normally they grow in a standing water, so, why not to culture it along with the fish, that water can be utilized by the fish and it can be beneficial for different purposes, that I will be discuss in detail. So, first of all, it has been practiced for long and there are reasons for it, first of all, it will improve the income of the farmer, definitely, because you are at the same footprint and the same, I mean, like the land that you are using, but you are getting much more higher yield, you are getting the crop as well as you are getting the fish production. I do not know the fish has a very high like market values and all in general.

And also, to make available the essential item, in the rural, diet of the rural items in areas where rice and fish normally form the staple food. Like, the world places like most of the rural areas in West Bengal, Jharkhand, in some part of the Jharkhand, some part of the Bihar, and this region specifically if I talk about even if you go to the Assam, and the north-western area. So, this is just an example where we can you can find people like very much fond of rice and fish at the same time. So, this, and especially Bengal is the famous where they are very much having, they are very much famous for their fish love and all.

So, anyway so this rice and fish culture can drastically improve the income as well as the nutritional requirement of the rural people like for the farmers who are culturing there as well. Fish feed in general on organisms which grow on the field, and on many of the noxious insects and their larval stages so it actually somehow promote the better rice production as well. So, it is like a win win situation for both of them.

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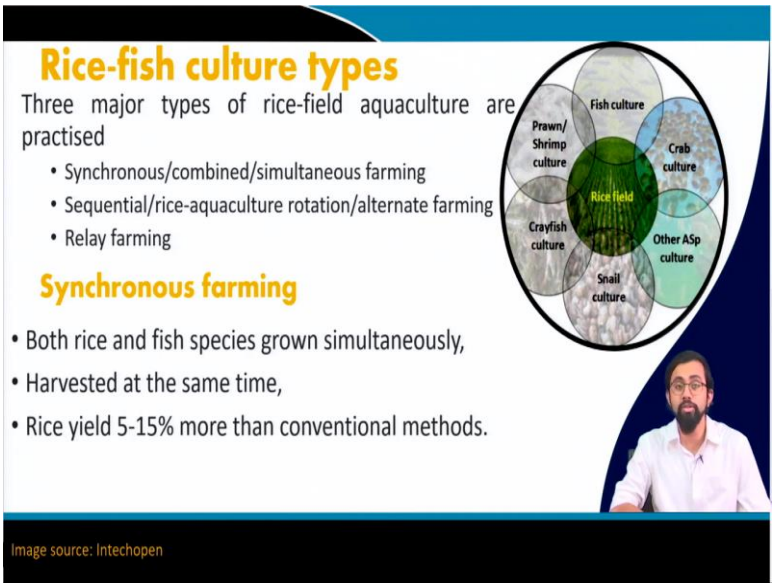

There are three different types of rice and field aquaculture systems. The first one which sometimes known as synchronous, or combined, or simultaneous farming. From the name itself you can identify, it is a like rice and fish is farmed at the same time and the same duration. And in case of sequential, or rice-aquaculture rotation, or alternate farming, from the name itself you can understand it is like rotation basis. The first rice then once it is harvested, then there is like fish culture like this. And then there comes a relay farming, relay farming is little bit complicated, like suppose you start with both, rice and fish. But say like, you are harvesting time is already there for rice, you take it out on but still fishes are there.

So based on the, their development or maturation stage and all, the fishes will be there, and then it will be, while it when their harvesting time will come. Maybe just before that only another season for rice has occurred. So, you have to make it very complicated, very precisely you have to take it out to a different pond and all. I will be discussing in details like how it is done. So, relay, farming is a little bit complicated, where there is no, like, it depends on the maturation stage of both of the stage of both of the species, rather than on the flexibility of our expectations.

So, synchronous farming both rice and fish this is grown simultaneously, harvested at the same time and by this method, it is witnessed that rice yield can be increased up to 15 percentage more than the conventional method using this synchronous, or combined, or simultaneous farming.

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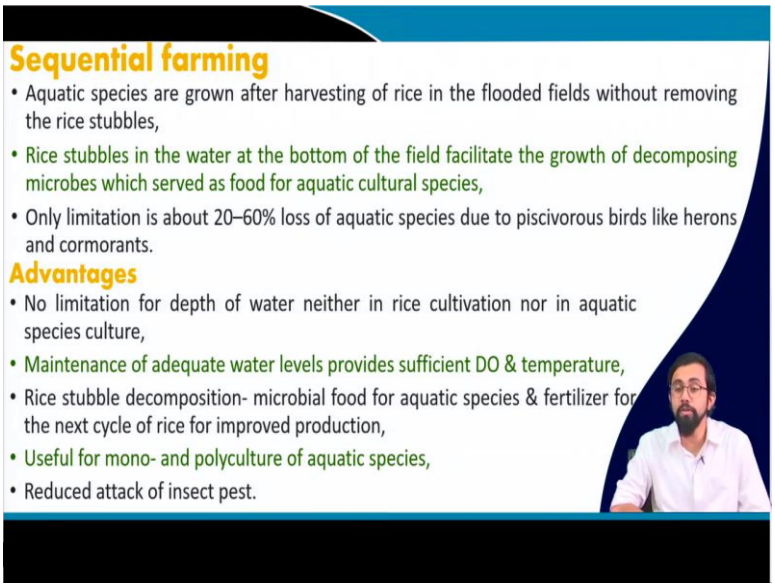

In case of sequential farming, as I mentioned, this in case of sequential farming the aquatic species are grown after harvesting of rice. So, normally rice tuples are still there in the water and the bottom of the field and which facilitates the growth of decomposing microorganisms and which actually act as food for your aquatic species. Only limitation is about 20 to 60 percent loss of aquatic species happened because of some piscivorous birds like herons, cormorants and etcetera. So, this is the only disadvantage of it, what are the advantage of it? Like no limitation in for the depth of water, and either in rice cultivation or in aquatic species what does that mean? That like it is not that after rice cultivation, you have to reduce the water, you have to increase the water, the water level can be as it is.

Maintenance of the adequate water level provides sufficient DO and the temperature, and also rice stubble decomposition and microbial food and because of this decomposition process, and this microbial food is available for aquatic species and also it can act as fertilizer for the next cycle of rice for improved production. Using the mono or polyculture of aquatic species is possible and it will reduce the attack by insect, pests, and all. Because their larvaes are being eaten by the those species and all.

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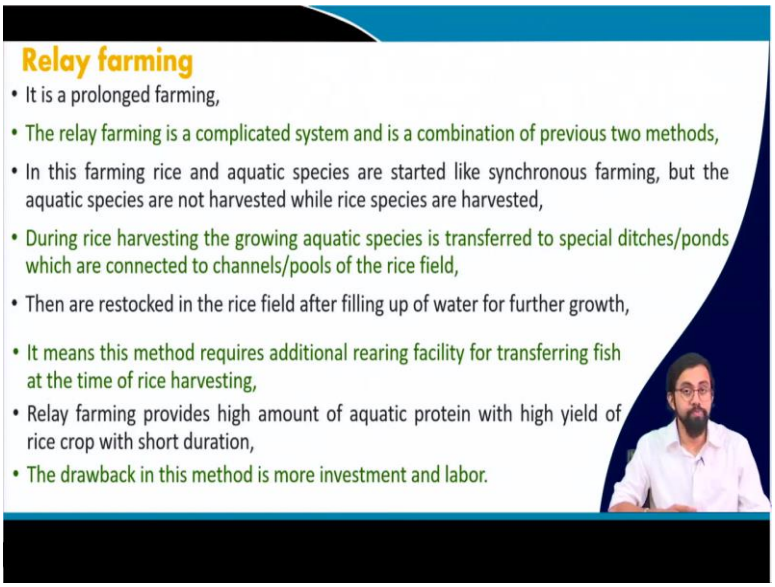

So, this is the second one, what is the third one? Is the relay farming, so what is a relay farming? It is actually a very, it is an ultimate prolong method, and little bit complicated, because it is like a combination of previous two systems. In both farming of rice and aquatic species they like say they started together, but the aquatic species is not harvested by rice is already harvested. Now, during the harvesting period of rice, what we need to do, we cannot just go and disturb the fish species. What we need to do, we need to transfer all the aquatic species in the, in that land to a special ditch or special pond which should be connected with the proper channel or tools on the rice field.

Now, they are again restocked when the rice field, after filing of the water for further growth, it means this method requires additional rearing facility for transferring fish at the time of rice harvesting. Other than that, good thing about it be relay farming it provides a high amount of aquatic protein with high yield of rice crop with short duration, the drawback of this method is the investment and the labour. So other than that, you what you can do after the harvesting is done you can put the fish back to the system, or you can put the back in the, you can grow it in the special ditches of this different rearing system also, it is up to you.

But so in general, this is the problem with the relay farming that you are doing two things together, but they are not matching with the time, and also sometimes it is latest, little problematic and you have to optimize the problem, the like at which time you are going to harvest and at which time here the fish will reach its maturation stage, and what will be the next period of run like for your rice crop? So, all these things you have to calculate and based

on that you have to start like study your business, start your farm. Like this kind of rice-cum-fish farms and all.

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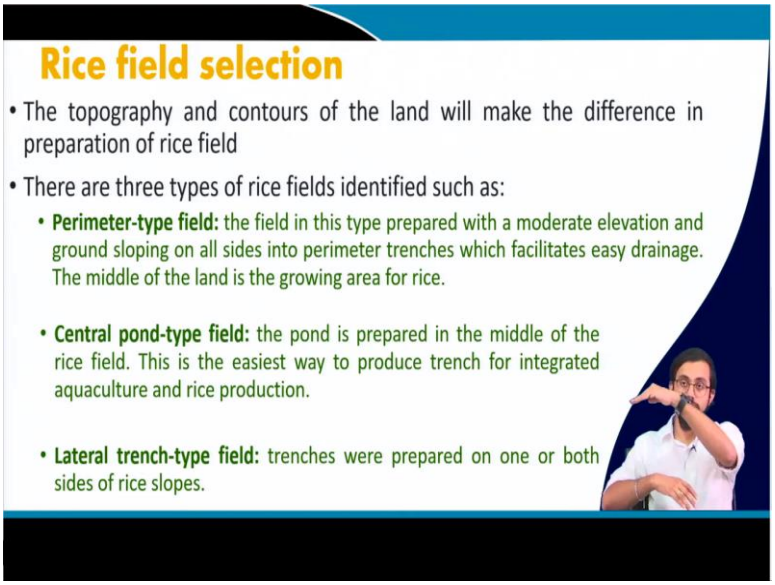

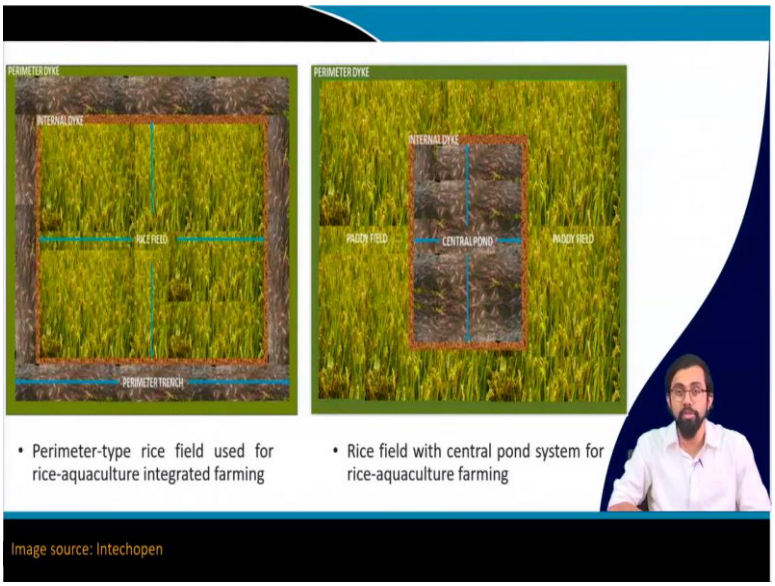

So, we already got to know about this rice-cum-fish farm and all. So, what about the selection of rice fields? So, which type of rice field is like kind of optimum for this kind of rice, rice and fish culture? First of all the topography and the contours of the land will make the difference in preparation of rice field. Because suppose, you have a rice field which has very like not regular slope, but rather irregular slope and also because of it what happened when suppose you want to drain the whole water, drain from the system and all. Like you have a you need to drain the water you cannot, it will keep on accumulating in certain places inside the rice field and all.

So, what you need to do you need to prepare the proper bottom, I mean like the rice soil, that the soil, the soil that which you are preparing. So that has to be properly prepared, and this may, that slope has to be maintained in such a way that it will connected it, once it will you wish you can directly connect it to the proper canal systems and it will take the water to a particular destination.

There are different types of rice field, identified for these kinds of activities. I mean like this kind of rice-cum-fish culture. Suppose we have a rice field which is like this type of, it looks like this. So, the middle part is actually the most elevated one, and then all the other parts are like the slope is towards the perimeter, what will happen because of that?

The water, it will stagnant and the moment you want it to be drained the water it is much easier because you can drain the whole water without even letting any like amount of water inside the rice field. So, this type of field is normally prepared with a moderate elevation and round sloping all the sides towards the perimeter fringe, and this middle of this land is very much perfect area for growing the rice.

Second type of field is central pond-type. In case of central pond-type, what happened it is like suppose you have a rectangular field, in between you have another small rectangle, so in this small rectangle is actually the place where it is the pond where rice is, the aquatic species is growing. And it is along with ring like structure.

So there, the peripheral structure actually the rice is growing, and those rice fields that they are like their water, their like, their slope is it would be better if it is towards the field, or outward the field, outward towards the perimeter of the field. So, based on your design and your destination, your outlet design and all these things. Another type of field is called lateral trench-type field. You will design, you will prepared different type of trench, it can be in one side, it can be other side like basically it has to be a continuous system, like a canal like structure where the fishes will be normally dwelling.

So, suppose you have, I will show you some figure. So, first of all this first figure if you see is the perimeter-type. In the perimeter-type as I mentioned I told you like in the middle it has to be the rice field, and it has to be going towards the outer wards like perimeter area. So, this perimeter trench will be utilised as a fish, or the aquatic, any aquatic species that you are targeting. In case of perimeter-type, in case of this central-pond if you see this in case of see the central-pond, this inside this like as I told you it is like one rectangular structure, another

rectangle in between or square. So, there the central-pond will be there, the fish will be grown there, and the paddy filed will be surrounding to it.

So, this slope you can make it towards the central-pond, outside outwards the central-pond whatever it is, and this central-pond also has to be a underwater drainage line. So that if you want to get it under water or in open drain line, so, if you want to get rid of the water it has to be as easy as that. So, that line should be prepared, to be better to have this kind of lines ready with you, in case of emergency.

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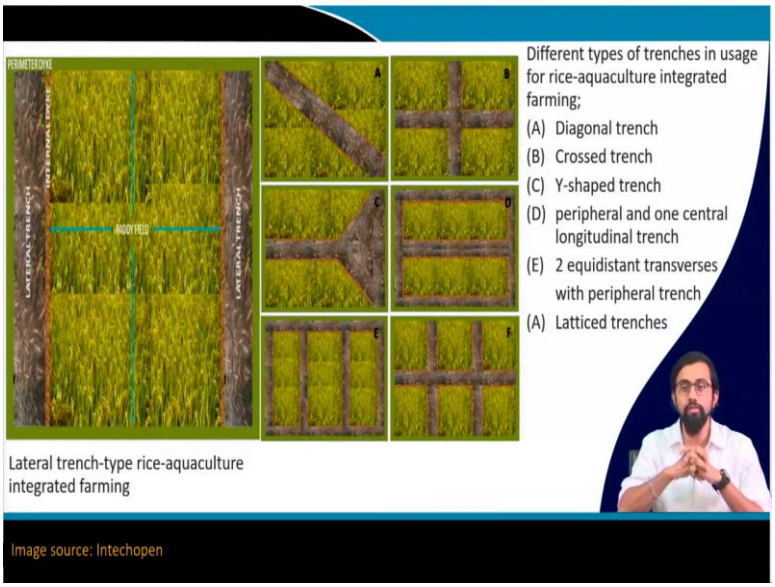

This is the one that I was talking about the trench-type. In case of lateral trench-type see the lateral trench is the most regular one that you find very commonly in case of this rice fish like integrated culture systems. In case of rice-cum-fish culture, you see this paddy field is in between and there is this lateral trench in the both of the sides. So, this lateral trench is actually used for growing the fish or aquatic species, and in the middle we have this paddy fields.

So, the water it is it can be locked there, it can the fish can be easily dwell over the latter trench, if they want they can come inside the paddy field also, if you want to design it, like that way or simply water can go directly towards the lateral trench, and it will go out from the paddy filed, the moment you will take it, moment you will open the drainage canal.

It can be other types also, the trench is not necessary to be like lateral trench, based on your design and based on your area like the system, the typography and all you can design it differently, it can be diagonal trench, you can see the first one, this is like the this cross one is

the cross trench, you can see the Y shaped trench, you can see this peripheral and one central longitudinal trench, you can have it two equidistance traverses with peripheral trench, you can see the bottom left.

The bottom right is the latest trench, you can know since like H like structure, extended H like structure and all. So, these are the type of trenches that you can prepare, you can, it is actually entirely up to you that how, what is your target, like is it like a rice is your main product, main crop or I mean like main yield for your main economic return is giving rice or the fish? In either way you have to design it in such a way that your expectation will be fulfilled. And based on that you have to design it either it is a trench, or this central-pond tank or whatever. So, based on that you have to choose the fish also.

So, fish is also important factor here because you cannot choose only the type of fish which cannot which do not, like it is like a say like, it is not a larvivores one, or say like not a proper carnivorous one, or just a herbivorous one, or something. So, for them to sustain you have to, they need to it needs to be provided with the phytoplankton, enough amount of phytoplankton, so that also something that you need to worry about that you need to think about before starting your business, before starting your farm, that you have you study enough and you get to know about all the things enough that before starting your farm. Because of the it is a risky business, if it is a living organisms that you are culturing, you have to be very much cautious about that.

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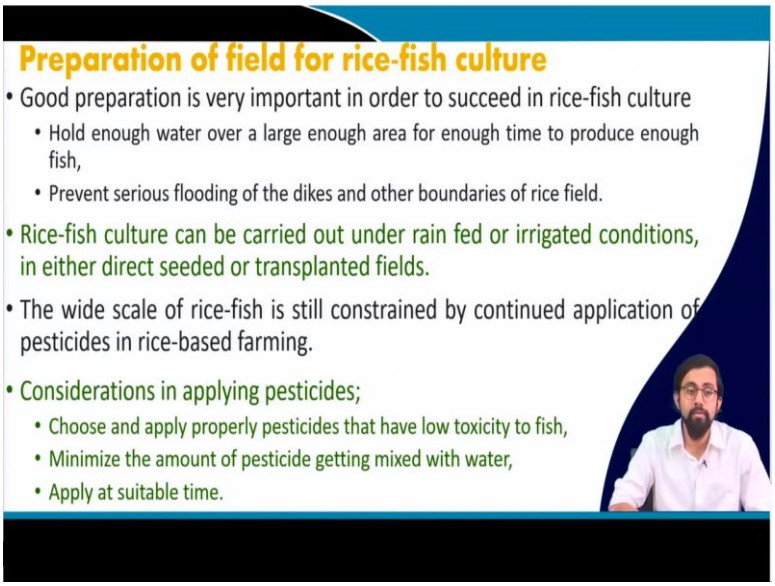

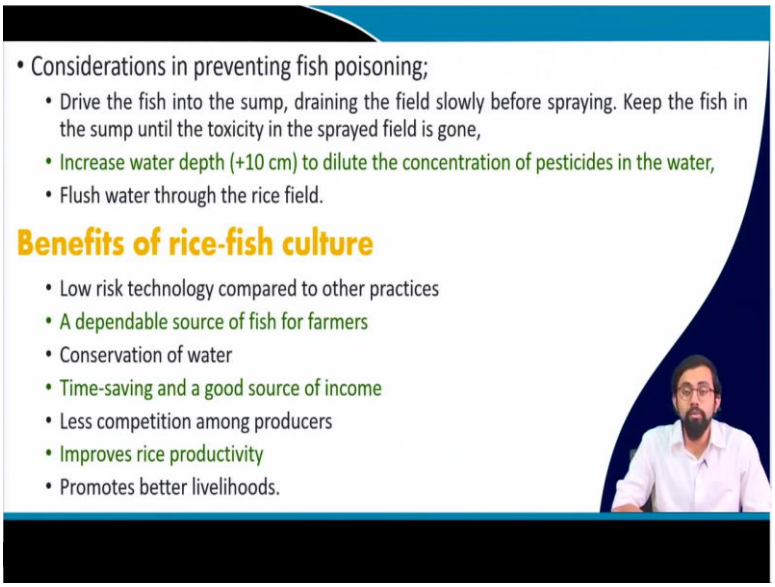

So, what are the preparation procedure of field for this kind of rice fish culture? So, first of all, it is definitely it is mandatory to have a good preparation, and it should hold enough water over a large enough area, for enough time to produce enough fish, it should prevent a serious flooding of the dikes and the boundaries of the rice field, because we will lose a lot of produce, lot of your fish and all.

Rice fish culture it can be carried out under rain fed or irrigated conditions in either direct seeded or transplanted fields. The wide scale of rice field is still constrained by continued application of pesticides in rice based farming and which is the major drawback of this kind of systems. Because there are still people like farmers who use, and it is like kind and sometimes necessary for higher yield for specific regions where they need to produce, they need to provide it, they need to apply the pesticides and all, which is not good.

Which is not good in terms of what like first of all it is harmful chemical, there are a lot of harmful chemicals involved with it, this pesticide and all. It can kill your living, any living system associated with it specifically if you culturing fish, it will not sustain. Because specific mostly we the amount of pesticide that we supply, it is good enough for fish to be in stress condition and a long enough exposure can even kill them, it can be lethal for them.

Moreover, that is not good for our consumption as well. So, the there are a lot of way by we can, you can still provide pesticides but you can help get rid of any harmful effects in a fish. You, what you can do you can choose and apply properly pesticides that have very low toxicity to fish, you can minimize the pesticide getting mixed with water. So, you can it is very difficult though like you have to have provide the pesticide in such a way that it will not get mixed to the water or because of its specific pellet like structure, specific packaging or

like, even like it is not even like, it is like you just cannot do that, because it is a liquid most of the cases it is liquid and it is liquid. And most of the cases the pesticides are actually they are prone to they are mostly water soluble.

So, you can try for it, like try to make it dry and use the pesticide and once you see that pesticide action is done and all. And then you get back to action again so it is still risky. And apply at suitable times, you have if you can do that it is good like what I am giving some example, what how we can help your fish to survive in this kind of scenario.

First of all, you drive the fish into the sump, and drain the field slowly before spraying, and keep the fish in the sump until the toxicity of this sprayed field is gone. You can increase the water depth to dilute the concentration of pesticide in the water for the time being. And also, you can flush the water through the rice field. What will happen in all the cases, the fish will get less exposure to the pesticides but still it is dangerous, I am telling you.

So, because there are different types of compounds there which can be bio accumulated, and there is a high chance it will kill your living any living means, like little as for fish for sure. And in case of bioconversion, it can be dangerous for the higher trophic level animals, like whoever is eating them like, this case specifically it is for human consumption, it is hard, it is not good for our health also. So, what are the benefits of so, first of all, like we need to get rid of pesticides, we try to get rid of as much as possible from the pesticides and whatever we will go the rice and fish culture and all.

So, what are the benefits of rice fish culture? It is a low risk technology compared to the other practices, a dependable source of fish for farmers. And conservation of water is possible, time saving and good source of income definitely, it is less competitive among producers, and improves the rice productivity and also promotes a better livelihood. Rice productivity is definitely it increases most of the cases it is witnessed it can increase a lot, the production capacity and all. And not only that, it is like they are kind of it is a kind of symbiotic relationship.

So, fish is helping like, all these plants to get rid of all that pest attack and all these things. And that other way, whatever the stubbles when they get degrade at this micro-organism, which degrading micro-organism are actually the feed for the fish. So, this both way they are actually helping each other to grow in this way it is this rice and fish culture is very much helpful and very much it turned out to be economically very successful process.

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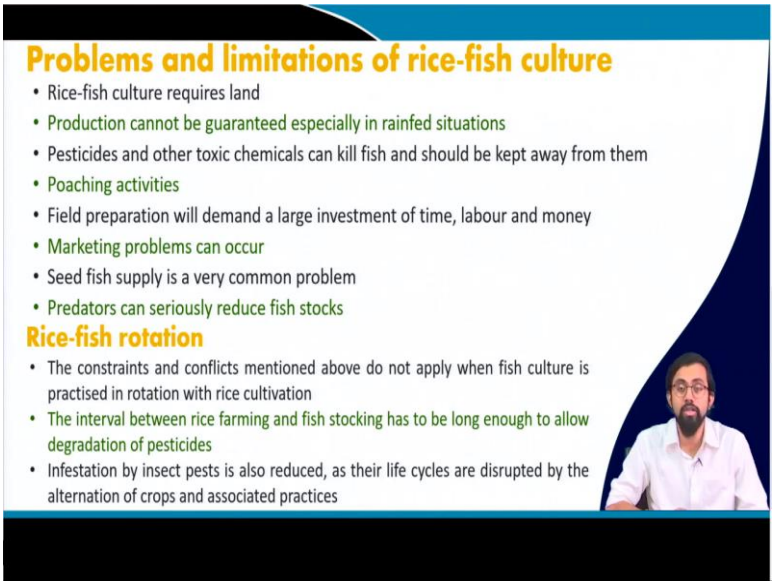

What are the problems other than the pesticides which relates to which is there with the rice fish culture? It requires the land, definitely anywhere you want to go for rice culture or fish culture you need a land. Production cannot be guaranteed especially in rain fed situation, it is very important when there is a like rain fed situation, it is really risky. And first of all, there is a risk of flooding and all that though if you can somehow manage to put a bandh or something. So, it will increase the water level, it can cause problem to your crop or to aquatic species whatever. So, it is like there is a lot of possibilities and lot of. So, especially rain fed situations is not so good.

Pesticide and other toxic chemicals can kill the fish. Definitely, you should be kept away from them. Poaching activities major in phenomena that major thing that happened like people go and steal other's fish, other's animal. Field preparation will demand a large investment of time, labour, and money. Marketing problem is there sometimes.

Seed fish supply is very common problem actually, that is there for any culture, not only for this, but any culture, seed supply is one of the major problems specifically in Indian scenario, one of the sector that is going to bloom in near future, but at this moment, it is really very, it is in very beginning stage, weak stage. Predators can seriously reduce the fish stock definitely. So, all these problems are there with this kind of rice fish culture.

So, the third one that is there is the rice fish rotation. The constraints and the conflicts as we discussed in the other issues like the other ())(23:22) situations, it do not apply when fish culture is practice in rotation with rice cultivation, the interval between rice farming and fish

stocking has to be long enough to allow the degradation of pesticide. So, you do not have to worry about this pesticides and all, application is fish, rice. Infestation by insect, pests can also be reduced as their lifecycle are disrupted by the alternation of crop and associated practices.

So, they cannot grow properly. Suppose the moment they normally is their breeding time and all say all this pest, you do not grow, we just do not go for a rice, you just grow fish at that time. So, they will not be able to fed their generation and it will completely evolution, it will not be able to attack the rice at that particular moment of time. So, it actually somehow changed the cycle a little bit but how however this rice fish rotation is much, much more beneficial.

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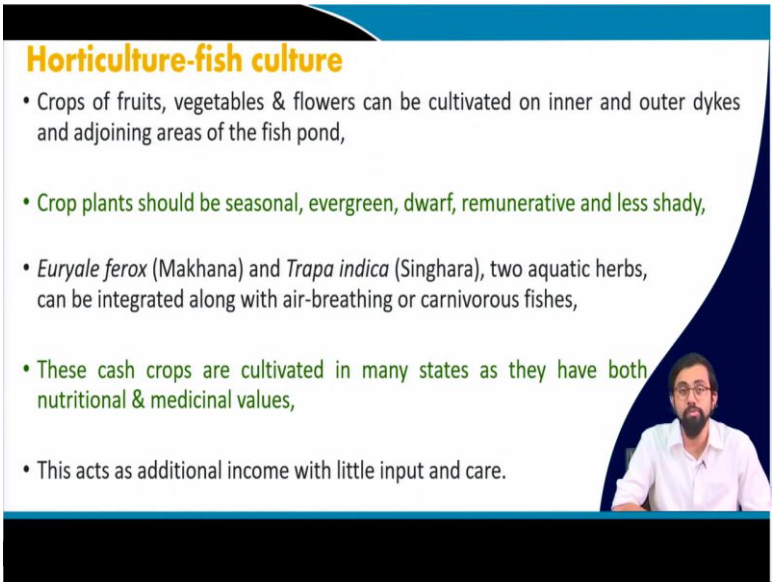

The horticulture fish culture the crop of fruits, vegetables and flowers can be cultivated in on inner or the outer dyke and adjoining areas of the fish pond, which is very good. It will not only give you economic return, it will also give you some aesthetic, it will it looks also very good, it can have a park nearby, it will increase the aesthetic, we call them aesthetic enhancement and all, that is also possible. Crop plants like most of them those should be provided in this kind of structure, in this kind of culture system, horticulture fish culture, it should be seasonal, evergreen, or seasonal, or like dwarf, remunerative, or and less shady.

The Makhana, or the Singhara are two aquatic herbs that can be integrated along with air-breathing on carnivorous species. These cash crops are cultivated in many states as they have both nutritional and the medicinal values. And this acts as an additional income with very little input and care, because they get all that essential nutrients from the nearby vicinity and

that is okay for them. And so, they can easily grow, aquatic herbs can easily grow on the inner and outer dikes of the, or the adjoining area the fishpond and also it will increase it will reduce the soil erosion as well from this dykes and all. So, that is also possible. Additionally, you will get income, like maximum income from this type of systems.

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Fruits with the fish culture, banana, mango, papaya, lime, coconut plants can be cultivated on the pond embankment in rows, and by making ditches between the rows, and its ditches have continuous supply of water so for them it is like a very perfect place to grow, and simultaneously you can grow the air breathing and live this larvivorous species like Channa marulius, this Channa striatus and Tilapia etcetera. And that can be cultured in these ditches, and which have a rich population of insect larva.

Vegetables with fish culture like seasonal, or fast growing or market ready crops should be preferred brinjal, tomato, gourds, cucumber, chilli, carrot, radish, turnips, spinach, cabbage, cauliflower, ladies finger, etcetera maybe the choice that you can grow on the side of it of your culture pond. It will give you additional economic benefits. So, this way we can do this kind of multi crop culture, or we can go for this kind of integrated farming and it will it is very important it is very helpful for higher economic return and maximum utilization of the land footprint.

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The flowering plants like Rose, Jasmine, Marigold, Gladiolus, Poppy etcetera, chrysanthemum, so etcetera can be successfully cultivated along the ponding management as you can see in the bottom picture, it is done on the inner side of the embankment, and the outer side, even in the on the width of the embankment as well. They have ready market and this culture provides 20 to 25 percent more return in terms of the aquaculture alone.

High value crops like you can just you can go for turmeric culture, which will give you additional medicinal value, and that can be cultured very easily in this kind of scenario, and you will get more return from your system, from your farm.

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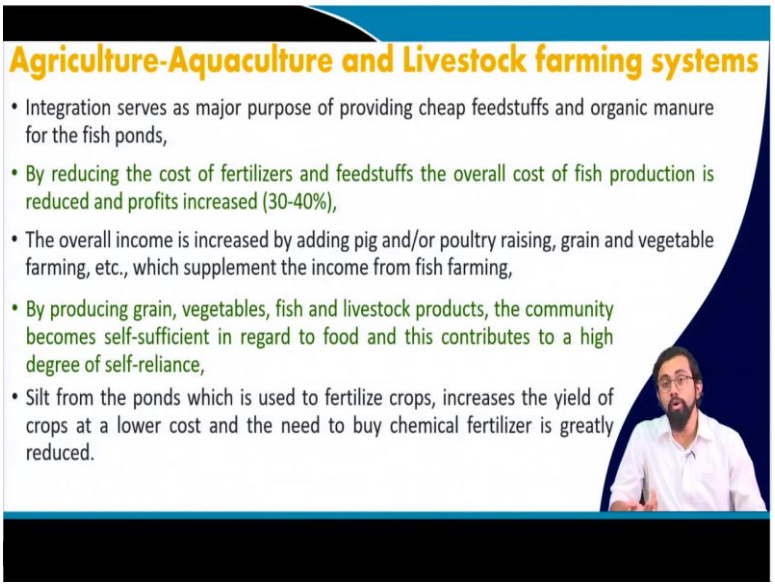

So, agriculture-aquaculture livestock farming systems where agriculture, aquaculture plus livestock is done at the same time three of them, or we sometimes call them ALS system, AALS. So, in this kind of cases, we its major purpose is to provide cheap feedstuffs and organic manure for the fish pond. By reducing the cost of fertilizer and feedstock the overall cost of fish production is reduced and profits increased up to 30 to 40 percentage. The overall income is also increased by adding pig or poultry raising or grain or vegetable farming and etcetera, and which can supplement the income from the fish farming, by producing this grain, vegetables, fish, or livestock the community becomes self sufficient in regard to food and those contributes to a high degree of self reliance.

Silt from the pond which is used for to fertilize the crops increases the yield of the crops at a lower cost, and the need to buy chemical fertilizer is greatly reduced. So, that is how you are having your agriculture field, aquaculture product, livestock at the same ground at the same place which will definitely give you all the possible nutrient, that is that it requires in your community. So, it can be done in community bases in a small land you can convert it into aquaculture pond plus small agricultural land, that has to be practiced very like it is a time, it is really it is a need of the hour right now.

So, because although if you see the skyscrapers and all the things that is happening in the municipality areas, and all there, they can somehow arrange some area on the back of their, their how to say building and all, some area they can provide and they can start growing some fruits, small fruits, or vegetables, or say like flowering plants, they can have a small aquaculture pond.

And by the side of it, you can put some seating area so it will be nice seating place for your people like for the recreation purposes also you can use it, and you can have the livestock in rearing, you can simply just you just put some duck there and ducklings there and they will grow. And this duck can also be like this kind of stuff, this kind of culturing practices has to be more intense more like more popular.

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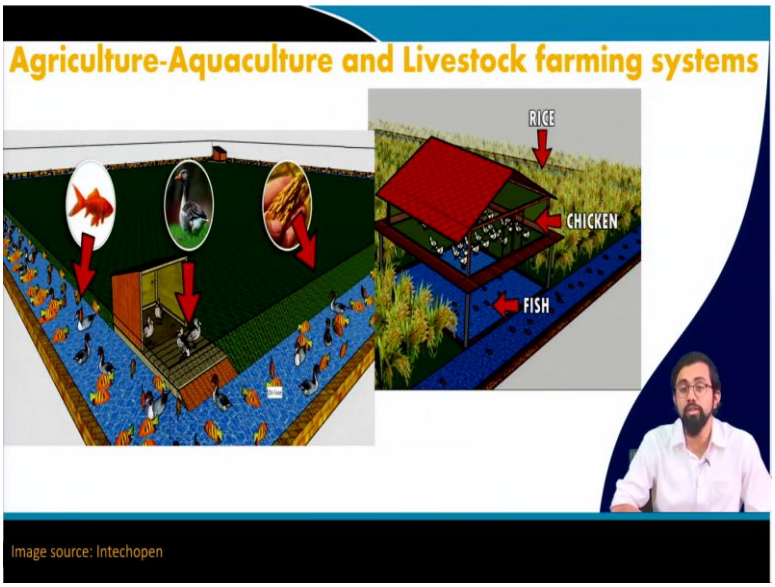

So, you can see this is one example of how agricultural-aquaculture and livestock farming works like. So, you if you see in the picture, in the right, this is a rice field where the chickens are there, and also in chickens are there in their farm and this poultry and just below them there is like a fish it is dwelling. So, because of that this fish can get enough food from the chicken, because they have their excreta are actually they are droppings are there in the fish. And that is a very rich source of nutrients for the fish and all.

And also they can grow here and there, and the chickens can feed all the pest from the nearby areas and all, from the pest or the insects from the nearby areas and all by which you can, it can also help in making a very nice symbiotic relationship between all of them. So, this AALS is very important, that is a agriculture, aquaculture and livestock farming systems and this there is lot of future, there is lot of possibilities in Indian scenario.

Anyone can grow anywhere like almost anywhere you can just replicate it, replicate the optimum scenario, you can just go ahead with it. And it will give you, not only benefit, but it will give a lot of employability, help with employability with the nearby people, and also help with the country in general to increase the GDD there, to increase the self reliance, and all these things so.

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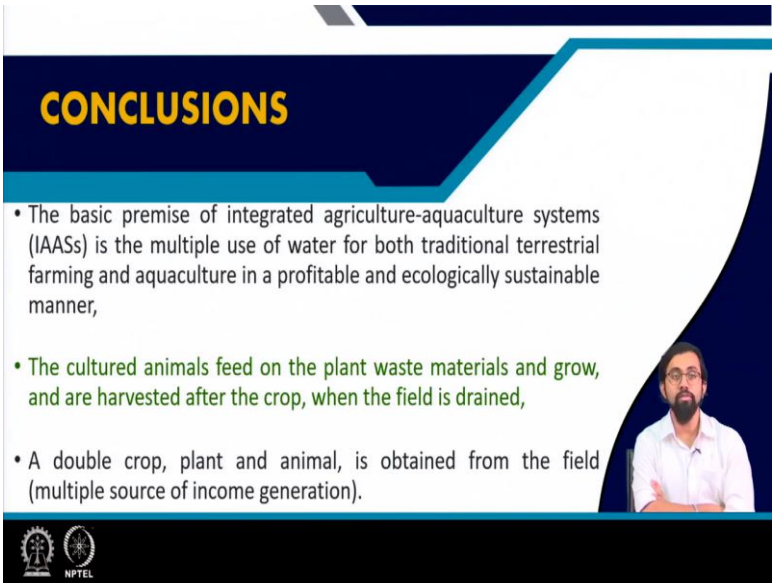

In conclusion, this IAAS, or this integrated agriculture aquaculture systems is the multiple use of water for both traditional and traditional terrestrial farming, plus aquaculture and which turns out to be a profitable and ecologically sustainable business. Cultured animal feed on the plant waste materials and grow and harvested after the crop and when the field is drained, a double crop plant and animal is obtained from the field.

So multiple sources of income generation is possible. And as a takeaway message, we can say that water is like the most precious and inefficient utilize natural resources. If we can efficiently utilize it, it can give us a lot of fruit. In real sense, it will it can give us a lot of fruit.

Integration of farming practices to enhance the productivity and water use efficiency it will contribute to the ecologically sustainable development of the natural resources. Also, this integrated agriculture aquaculture systems, it allows the irrigated farming systems and multiple use of same water typically the fish production first, and then for irrigation so this way they can reduce the overall consumption of water and it can be helpful for our for, like, our income purpose all these things. So, that is why I really want.

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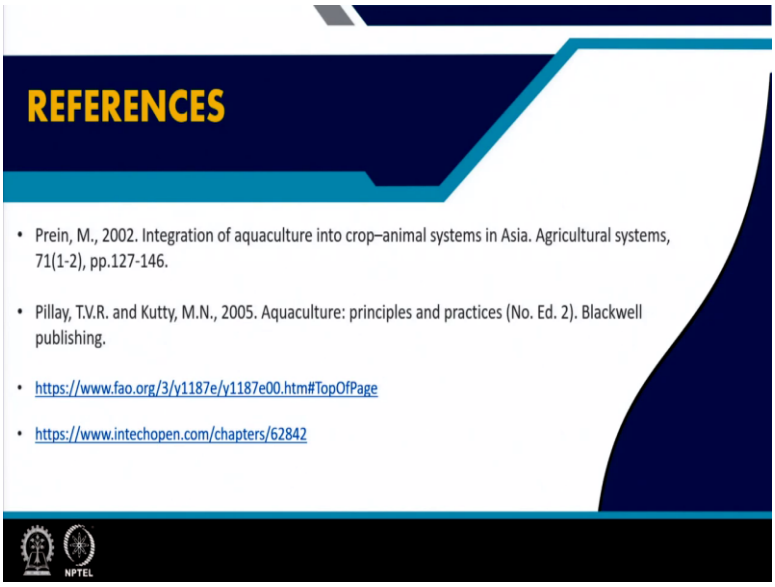

This is the references that you can follow and you can take a picture and you can go ahead with Google and you can search for it. And so in general, if I talk about different types of like the structure, different type of agriculture system, aquaculture systems that we have understood we have gone through in this lecture material, in the other last lecture material, I really appreciate it like even like 10 percent of you people go and find it as their employability, employing opportunity, they can go and they have their land definitely they have their own land or their land in their village area they can utilize it, it can be a very good business it can be a it can employ it will give you most more self sufficient nature, it will, you do not have to worry about anything there will be no loss.

You just go and have your own business start your own start-up and it will give you every other way it is a win win situation for you, for nature, for the production, or for the production of those things and they can be easily sell and the more the production that will give more availability in the market, and it will definitely and then if it is exceeding the availability you can go for exporting and all these things. That is also that will also help in the overall condition, the country's GDP and all this thing.

So anyway, so that is it for this lecture. And in next lecture we will be discussing about the bio-floc technology. And we will see how bio-floc technology helps us this kind of organic treatment help us to have organic treatment of aquaculture and it will give us both the function, treatment of wastewater plus the feed for the aquaculture at the same one. Thank you so much. See you.