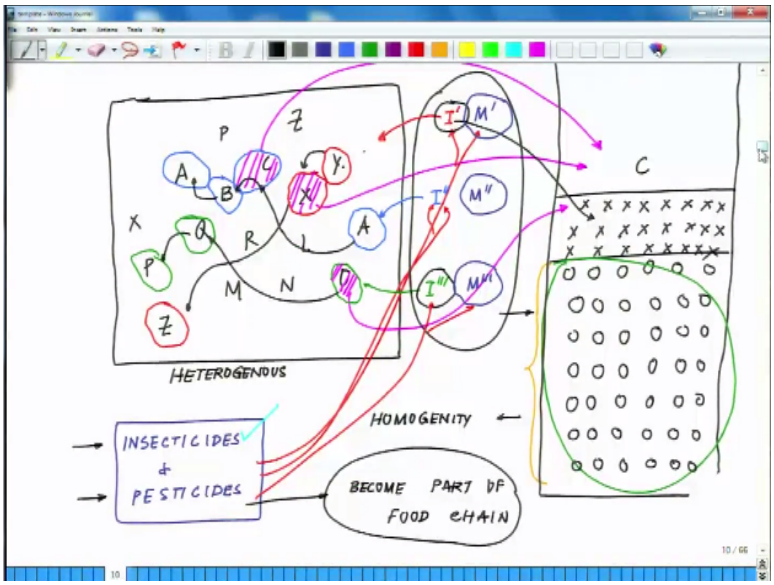
Nanotechnology in Agriculture
Prof. Mainak Das
Biological Sciences and Bioengineering and Design Programme
Indian Institute of Technology-Kanpur

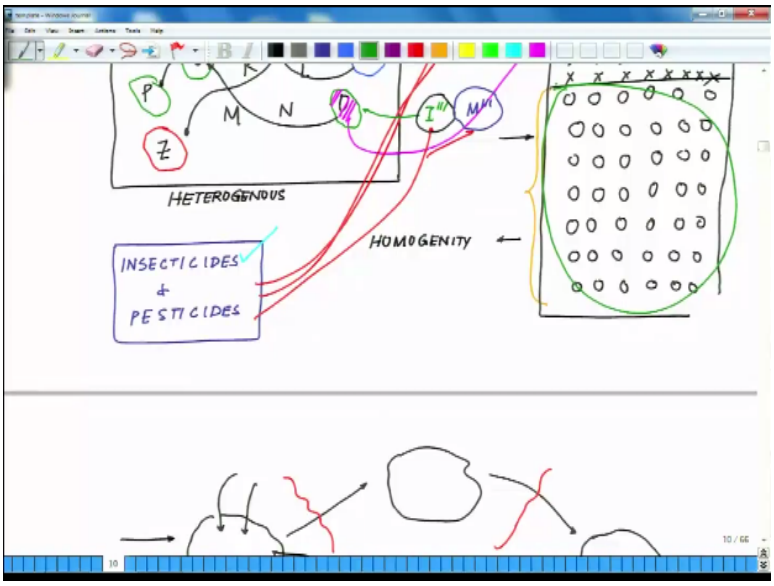
Lecture-05
Modern Agriculture_controlled or out of control

(Refer Slide Time: 00:13)



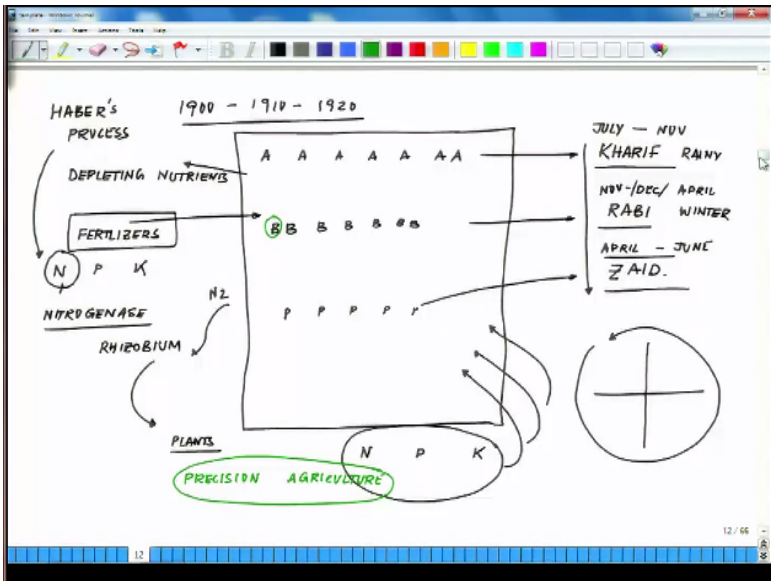
Now, let us think what is happening in a piece of land.

(Refer Slide Time: 00:19)



Now here say for example you are growing these crops here and you are exposing them.

(Refer Slide Time: 00:29)



So, here you have a piece of land and through 3 different seasons by the way in Indian subcontinent we grow crops thrice in a year which we call as a kharif crop which is the rainy season where the sewing will be happening by the end of July somewhere. In some places have slightly earlier depending on when the monsoon is arriving and this last for next 90 days to 120 days August, September, October, by November the harvest takes place.

Then comes the next season which is called the rabi season which is the winter crop where we grow wheat. So in the kharif season we grow the rice, paddy mostly across the country, then we have the wheat crop which is during the cold months, winter months January, February, March and then of course we harvested. Then comes as spell across the country which is kind of a tri spell that is what is called the zaid or the summer crop zaid.

So you have kharif, rabi and zaid, so which is around April, May, June that is the kind of where very few really go crops which rather depend on vegetables during that time. And here you have the rainy season and this is the winter which is mostly dry in India. So these are the 3 cropping seasons we follow mostly across the country. So now here you have a piece of land some hectare or something and you are growing a crop say A in 1 season.

Say for example in kharif if we are growing A, in the rabi you are growing B and say in the zaid you are growing P fine and this cycle continues. So if I see so this is somewhere from July to November, then you have from say November or December to April or March somewhere around March or April. And here from April till June, so round the year if you see it we are growing crops, now as we are continuously growing crop as I told you we are depleting the nutrients.

So now while you are depleting the nutrients we are applying fertilizers and the story of fertilizer if I have to say modern days agriculture, major ones which are use Nitrogen, Phosphorus, potash. And if you look at it nitrogen the critical one, nitrogen is synthesized by an enzyme called nitrogenase by the biological world. There is enormous amount of nitrogen in the year but we really cannot trap it varying aside rhizobium or symbiotic microbes.

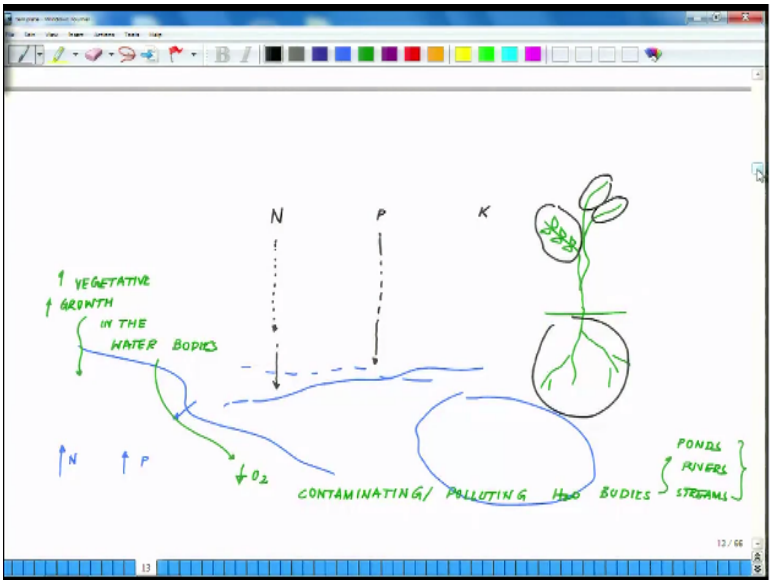
We will talk later about it okay, they are the ones who can fix the nitrogen from the environment and convert it into a nitrogenase compound, nitrogenous form which could be made available by the plants. Now that is not really sufficient when we are talking about growing crops round the year, so you have to add more nitrogen and historically the breakthrough happen in the very early part of 1900.

This is the time major breakthrough was Haber's process who change the concept of growing crops, this is where we could synthesize different nitrogenous compounds. Haber process is a landmark discovery earlier part of 19th century Bosch Haber process, that changed the way to agriculture for last almost now 100 years. We had sufficient amount of sources to produce ammonia, urea the source of nitrogen followed by potash, phosphorus.

So these compounds in the form of salt now started to dominate the modern agricultures since 1900 early part of 1900. Now these are manmade chemicals and they had a turnaround time do you know mix up with the soil, you know get acclimatize with the soil. But of course the plants are pulling them through plants are but now think of it is think of a situation in the very first part of my lecture I told you that we need organic matter to trap these things.

So, they could be slowly release, so while we were adding all these kind of things many soils in many parts of the world where not being sufficiently supported with organic matter. And what happen is because of not supplementing sufficient amount of organic matter.

(Refer Slide Time: 07:36)



These excess nitrogen or phosphorus or even potash is started going down the soil and try to get mixed with the water table. And eventually they cut at the water table in such a way that the nearby rivers or ponds or the water bodies had excess nitrogen, excess phosphorus much higher than their tolerable limits, that let to lot of unnecessary growth, excess growth of excess vegetative growth in the water bodies, thus creating a lack of oxygen situation.

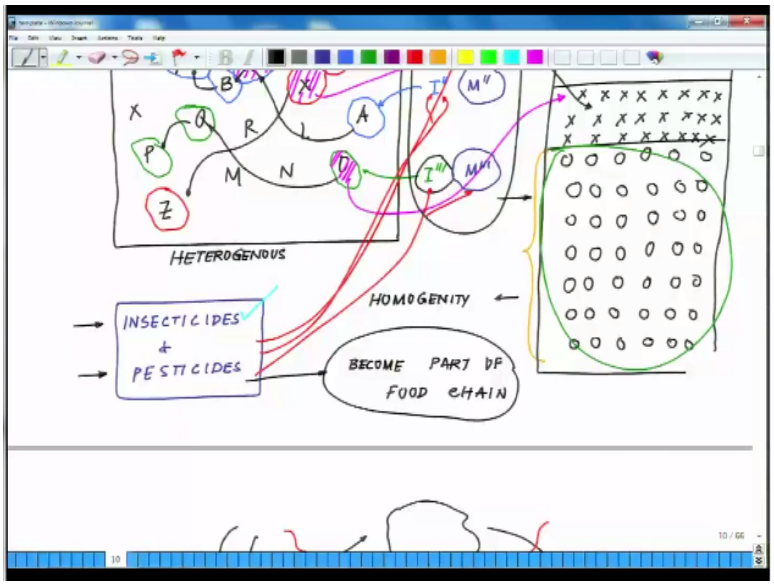
Apart from contaminating or polluting the water bodies which includes your ponds, rivers, streams. So you realize that though we have no other option, we have to depend on all these. But how much a individual plant needed, are we using them in excess, that is a very big question which is now being posed in front of agriculturist and plant biologist, are we really really putting way more.

And this is where there is a question which is coming a concept which is evolving in the horizon of futuristic agriculture called which I have mention what today in a different context I am coming precision agriculture. I told you the problem that we are applying these compounds in excess, you have to find out a way to reduce that excess, how we can do it, could we ensure say

for example somewhere other, could we ensure suppose here I have a plant which is growing okay.

These are the shoots and could I ensure that my required compound or chemical remain concentrated in this region or I do a foliar spray or somewhere other it works, so lesser concentration. Second thing what happen because of this kind of situation many of these plants started to grow much more than their limits which eventually attracted more infestation from this part of the game, insecticide insects and microbes.

(Refer Slide Time: 11:43)



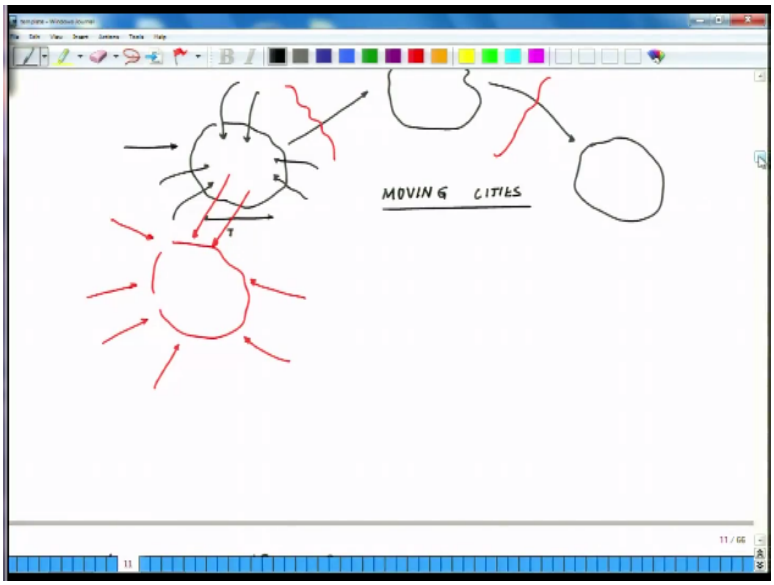
So, this leads to a excess use of insecticides and pesticides, now the problem of using excess insecticide and pesticides is they become part of food chain. Because when you are putting them unless otherwise they are metabolized by the plant, they will remain either in the fruits or in the stem or in the leaf or in the roots and we consume all of that. We consume the root of some plant, we consume the shoot of some plant, we consume the underground fruits of some plant, we consume the fruits of some plant, we consume the leafs of certain plants.

So, unless otherwise the insecticides or pesticides or microbicides whatever you call it or the kind that a plant is the ability to degrade it during its life's span of mostly if the crops are of like you know unless it is sugarcane which is 9 months or 10 months crop most of these grain crops

are like you know 90 days to 120 days and so forth, unless they can metabolize all these things degrade of these compounds they will remain within the plant system.

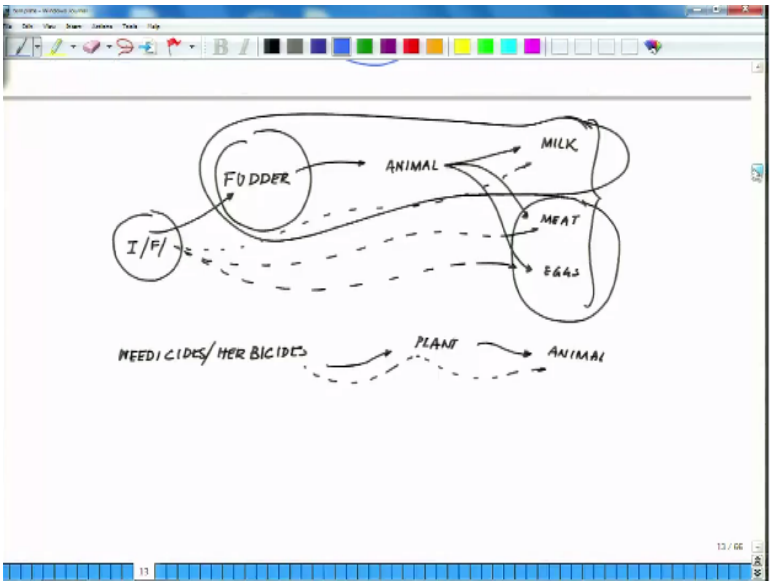
And this is the serious concern for several hormonal disbalances, which affects the female population big time because of the complex hormonal milieu and of course mailer too. So there are several diseases which are of because of the residues of these compounds which are found in the full products. Similarly if these are used for the fodder crops, a lot of it goes into the animal side and which eventually becomes very interesting.

(Refer Slide Time: 14:07)



Like if you think that you know there is always at the bait among the vegetarian and a non vegetarian or the thing is that the whole gamete of agriculture. If it both of them equally, say for example there is a like example of a say fodder crop okay.

(Refer Slide Time: 14:22)

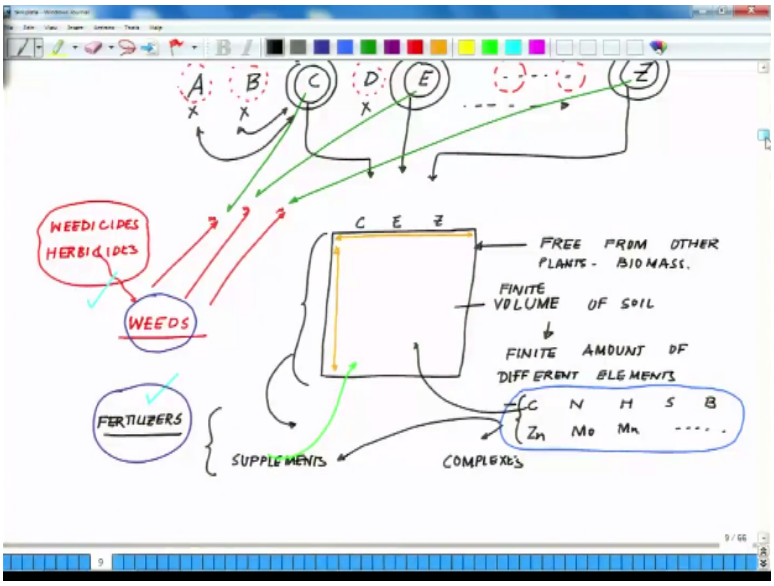


Now a fodder is getting say some form of insecticide or fungicide or you know something, so now this is consumed by an animal, say a cattle. Now we are deriving milk out of it say, so milk will have the residues of this travelling or you using it for say meat okay or even say eggs okay. So, these residues are travelling along unless otherwise the fodder metabolizes it or the animal metabolizes it and most of these compounds are not easy to metabolize.

So you whether you are a vegetable eater or you are a non vegetarian or you are something like this only a milk and plant, no one is peered in this game. Third thing when we talk about weedicide or herbicides, these weedicides or herbicides are again having the same fate, same problem because they become part of the plant and which moves into animal and whereas they travel alone, well the situation is not grim.

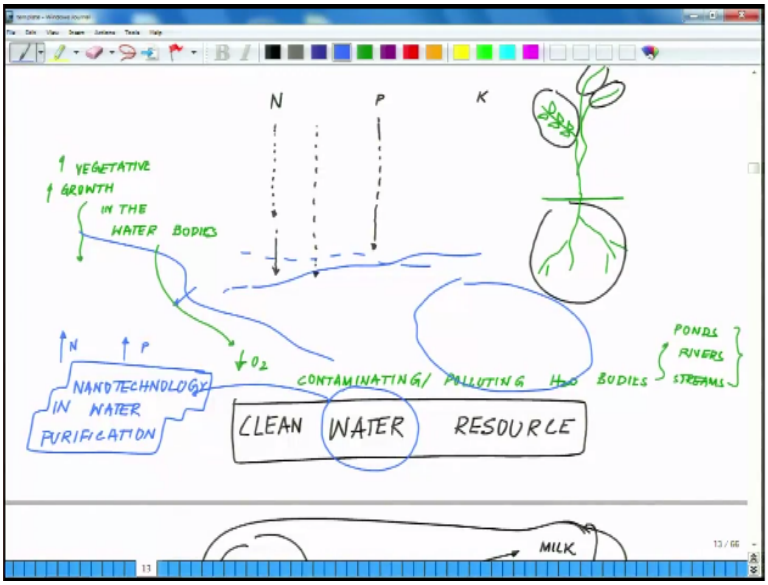
It is just we have to realize what is that amount which is precisely we can put which we can tolerate or which will go away. If we do it in excess there are always possibilities that we may hit the wrong chord and eventually will have to follow other problems which are much more relevant to the medical world okay. Now if you look at it out here, so we talked about the challenges what is there with the insecticide and pesticide, we talked about the challenges of having fertilizers.

(Refer Slide Time: 16:49)



We talked about the challenges of weeds.

(Refer Slide Time: 16:59)



Now think of this situation because of peculation along of different compounds or chemicals used in agriculture. We now land up with another problem which is clean water resource and agriculture cannot be done without water. So, that is why you will see there is a section in this course where we talked about nanotechnology in water purification, the world where we are continuously contaminating the water, so cause of these compounds needed to be clean.

Because this is one resource which unless otherwise we were technology to convert sea water or saline water into fresh water. We have a finite resource of fresh water and you have to work with

the fresh finite resource for generations to come unless otherwise we make breakthroughs in water purification which is happening. But scaling up is equally slow like if you visit places like Israel they do tremendous amount of water purification.

Because they do not have much resources they have to do it, similarly there are other places where water is one of the most challenging community or even if you go to places like you know Bombay and other places where we have limited supply of water that is not that you will get water all throughout the day. There is a rationing of water but that is just to at this stage to counter or to ensure everybody gets it.

But that is not who as human race we are where to find out technologies, where to find out ways to counter these kind of challenges. So, that you know our generations to come have ample resources to think bigger stuff not to depend on these simple things right. So on one hand we realize that we do not have an option, we cannot go back, we cannot put the clock back but you know will become something like you know.

We started as nomads will became, become nomads or you know we will burn piece of land I will move onto the next one, those options are not there, those are impractical situations. Instead what we have to think is how precisely we can use these chemicals in agriculture which includes crop production, vegetable production, fruit production, fodder production, all the way to animal production, poultry, dairy, meat.

And even leather as a matter of fact get ensuring the assisting resources like land, water, environment is being conserved, is being be use it but we replenish it with our scientific technical now how.