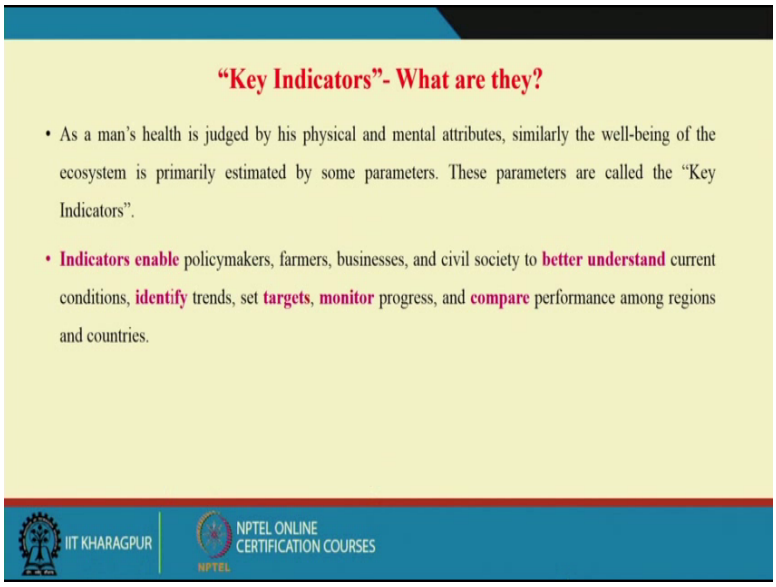
Organic Farming for Sustainable Agricultural Production

Prof. Dilip Kumar Swain
Department of Agricultural and Food Engineering
Indian Institute of Technology, Kharagpur

Lecture - 08
Key Indicators of Sustainable Agriculture

So, welcome for lecture 8, it is a Key Indicators of Sustainable Agriculture. So, last lecture we have discussed and discussed about to what is sustainable agriculture. So, this lecture we will be focusing what are the key indicators of sustainable agricultures and how we can evaluate the sustainability based on the key indicators.

(Refer Slide Time: 00:47)



So, coming to this one key indicator, what are the key indicators? If you see so this is the as a man's health is judged by his a physical and mental attributes, similarly the well being of the ecosystem is primarily estimated by some parameters.

These parameters are called key indicators or knowing the indicators what happens once you know the indicators, then this enables the policy makers, farmers, business and civil society to better understand the current conditions, identify trends, set targets, monitor progress and compare performances among regions and countries what you say. So the key indicators of sustainable agriculture once we know we want to achieve sustainability, we must know what are the indicator sustainability.

And if you know the indicators, then we look forward how to achieve the sustainability knowing the indicators; that means, we have to know the indicators and we have to work accordingly how we can achieve and how we can increase the efficiency of our production systems, so that this sustainability is maintained.

(Refer Slide Time: 02:09)

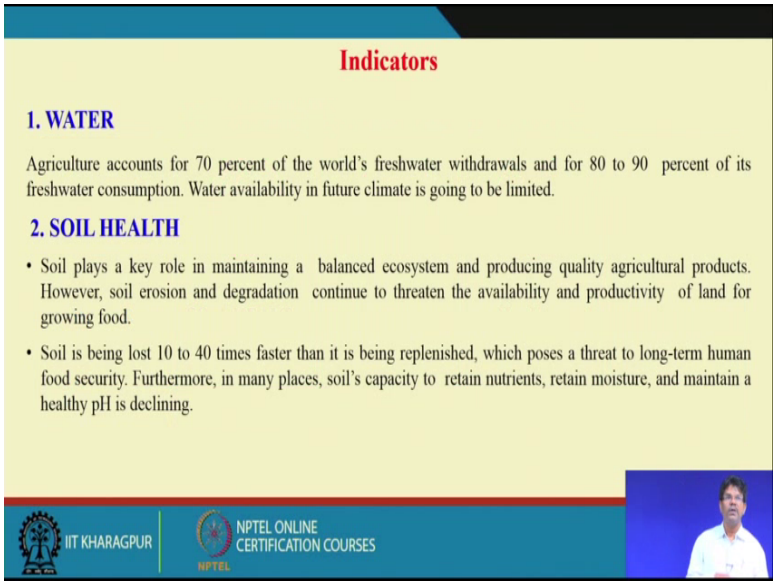
So, coming to the indicators; these are the 5 main indictors for agricultural sustainability; so water, soil health, land conversion, pollution and climate change. So, if you look at the 5 indicators, once you know the indicators and they are used their importance in agricultural production systems; so we should know how to protect them, how to protect water, how to economize the use of water and how to maintain and improve the soil health. And land conversion how to minimize land conversions; that means, the deforestations how to check the deforestations.

And the pollutions mean the agricultural activity that is say fertilizers and pesticides, how we can increase the efficiency of inputs. So, that the fertilizer or the application methods so that the pollutions due to the input managements. These are fertilizers and pesticides should be kept as minimum as possibles or no.

Then finally, climate change as you as you are discussing just last previous class, so how the agricultural activity doing the management practices. They can minimize the climate then (Refer Time: 03:54) activity as you say that can minimize the climate change means

minimize the greenhouse gas emission to the atmosphere. So, we will we will discuss the indicator one by one.

(Refer Slide Time: 03:46)



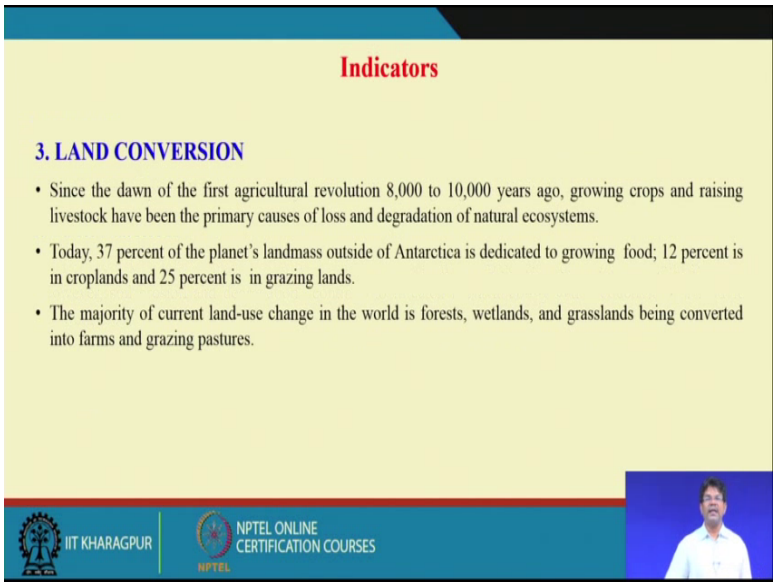
So, let us come to the water. If you see the water the agriculture accounts for 70 percent of world's freshwater withdrawal and for 80 to 90 percent of its freshwater consumptions.

Moreover the water availability in future climate is going to be limited. So it should be very careful in using water and we should think of the technologies; how we can improve the production of the crops with less and less water.

Then this is soil health second indictors. Soil plays a key role in maintaining a balanced ecosystems and producing quality agricultural products. However, say soil erosion and degradations continue to threaten the availability and productivity of land. So the soil which say play a key roles and the soil productive to maintain the soil productivities. So, our activity likewise the minimum tillage or conservation tillage or the soil comes in practices should be focused how to minimize the soil erosions or the soil degradations.

Also soil is being lost 10 to 40 times faster than it is being replenished, so which pose a threat to long term human food security. In that case, so, in a many places soils capacity to retain nutrients, retain moistures and maintain a healthy ph is also declining. So that is a question so how to maintain the soil health long term as an indicator.

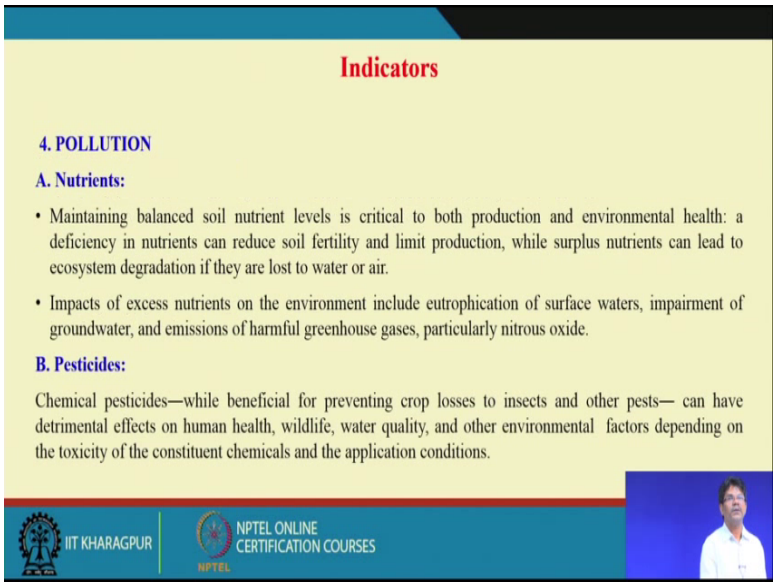
(Refer Slide Time: 05:34)



So, next one is a land conversion. Since, the dawn of the 1st agricultural revolutions 8000 to 10000 years ago, going crops and rising livestocks have been the primary cause of loss and degradation of natural ecosystems. That means, today around 37 percent of the planets landmass is dedicated to growing food of which 12 percent is for the crop lands and rest 25 percent for the grazing lands.

The majority of current land use change in the world is forest, wetland, grassland are being converted into farms and grazing pastures. So, in that way the land conversation are the deforestations that is also contributes to climate change how can check the deforestation maintain the natural ecosystems.

(Refer Slide Time: 06:34)



And the 4th one the pollution: the nutrient pollutions and the pesticides pollutions. Nutrients means maintain a balanced soil nutrient levels is critical to both production and environmental health. If you there is a deficiency of nutrients can reduce the soil fertility and limit productions while excess nutrients can lead to ecosystem degradations, if they are lost either to water and air. So that that causes the pollutions air pollutions and water pollutions your (Refer Time: 07:11).

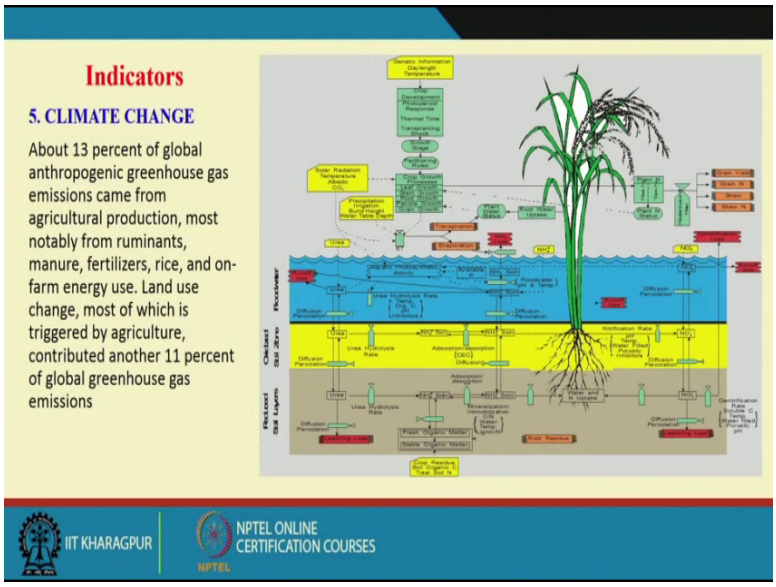
And impacts of excess nutrients on the environments in include the eutrophications of surface water, impairment of groundwater, and emission of a harmful greenhouse gases particularly nitrous oxide I will discuss. So, the nutrient management is very very important and scientific and efficient nutrient management is very very important for sustainable agricultural production. If there is less inputs, less input application, less nutrient that reduces the crop field which you do not want, which we do not want to sacrifices the yield of the crop.

And if you applying excess, so the surplus the nutrients either they are lost to the as a lichening loss goes the groundwater contaminations or they go to reverse and they may eutrophication of the surface waters or they may release the atmospheres as a greenhouse gas emission- as a nitrous oxides and cause as a contribute to the global warming.

So, nutrient management that should be very scientific and very efficient way to minimize the pollutions levels. And next is pesticides. If we are discussing also a lot our

pesticides because of the insect chemical pesticides while beneficial may be for the protecting the crops from the insects pest or the diseases, but can have the detrimental effects on human healthy. That is how wildlifes or the water quality due to the pesticide contamination. So that is say that is say environmental impacts toxicity of the constituent chemicals. So, the pollutions that is say either the nutrients or the pesticide pollutions that should be kept in mind while attuning your sustainable agricultural productions.

(Refer Slide Time: 09:25)



So, last one indicator that is the climate change: this is the climate change say the un through the agricultural activity that contributes to greenhouse gas emissions. About 13 percent of global anthropogenic greenhouse gas emission come came from agricultural productions.

And they are from ruminants, of the livestocks, manures, fertilizer, rice and energy use. And land use changes, mostly which triggered by agriculture, contributes to because conversion of the deforestation forest lands to agricultural land so that contribute to another 11 percent of global greenhouse gas emission.

And if you keep example of right hand sides how the nutrient management practices; that can cause greenhouse gas emissions. So the nitrous especially nitrous oxide emissions from the rice field; so as you know the rice a laps standing water you can say we go on their water allowed condition sometimes though the production wise rice does not require the standing water to have a higher productions and because of the rice grows

under standing water conditions none of the other crops may fail to grow under the water alert conditions.

So, under that when there is standing water, when you go for the fertilizer applications especially the nitrogen fertilizers where should apply n fertilizers. If you apply in the surface water, so there is a less efficiency because most of the fertilizers that is converter that is a lost as a soil able in water and zerona plus.

If you apply in the oxidized zones that are the surface soils, the what will happen the urea as a nitrogen's fertilizer discussed this under hydrolysis, converted to ammonium and the oxidized layers as oxygen is presents that is oxidize to nitrate. And nitrate because of the concentration gradient that goes to the bottom layer that the reduced layer.

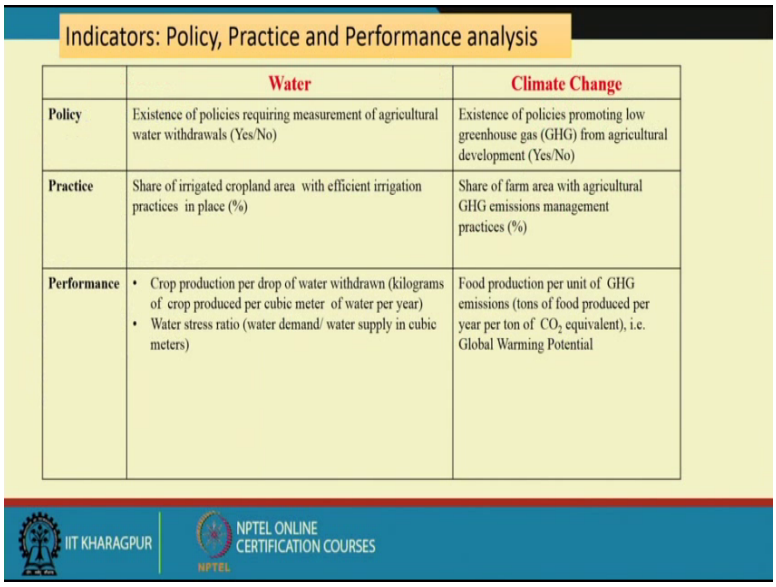
And in the reduced layers as there is no oxygen and the nitrogen gets lost as a denitrification loss as a nitrous gets reduced, the nitrate gets reduced to nitrous oxide in the reduced layers as there is no oxygens and this N 2 O nitrous oxide lost the atmosphere as nitrous oxide emission.

On the other hand if you go on applying fertilizer at the reduced layers to the bottom layer you can say, where there is no oxygen the fertilizer remain their because urea under hydrolysis that is converted to a mmonium. And as there is no oxygens so ammonium may not be converted to nitrate. So, as ammonium the it is a form which that is a rice can take as a ammonium form for the nitrogen fertilizers and you can have a better productions and you can have better efficiency.

So, if you see the 3 layers if you apply a cloud water so that is say the fertilizer is a lost thrown off and that contaminants your reverse flows reverse and that effect the peace population in the river and make the eutrophication of the surface water. If you apply in the oxidize zone, so there is a less efficiency because no the nitrate the after the nitrification process the nitrate as a concentration variants or the lichening come to the reduced layer and there is a less efficiency and that is lost to the atmosphere as that causes global warming. And if you apply the reduced layers so, there is a efficiency is the higher the; that means, the crop gets this nutrients and the production gets increased that is what the example of the yield management improper application of the fertilizer can cause the global warming and can cause the greenhouse gas emissions from the agricultural field. And management practices should be proper, we should change the

management practices we should know the scientific management practices to apply fertilizer and right type of fertilizer. So that we can minimize the emission of greenhouse gases and minimize the climate change.

(Refer Slide Time: 13:52)



And if you see the indicators; that are: policy, practice and performance. When you go for the performance evaluation of indicators, then there should be policy government let us say this comes from the government label policy and somebody should the see and observe and whether there is a policy comes in practice one there is a practice policy, then practice policy comes practice and then there is performance evaluations.

So, if you take up indicator water, climate change and we will go for the others. So, water so the policy level you say whether there is a existence of policy requiring the measurement of agricultural water withdrawal. So, if you want the farmer should make efficient use of water and economic use of water as one of the indicator of sustainable agriculture.

So, they has been policy once policy is in force, then farmer should be very causes to withdraw ground water. If there is only measurement nothing to say only there is a measurement how much water the farmers to drink to drink. If that system that mechanism is there, then farmers will be very causes and he can only withdraw the amount of water that is required for his productions.

And the practice at the same time we should know, the share of the agricultural land that is under a fishnet water management practices. If that practice the if you know the percent is how much percentage of agricultural land is under the efficient water management that efficient means we are talking about the limited irrigations as your drip irrigations, sprinklers or obvert irrigations or we can say as a not exactly flood irrigations of the region for alternate for irrigations.

So, those things so the share of land area under the efficient water management practices in percentage that has to be accounted. Then we can go for the performance evaluations. So, if you have the policy, then there is a practice you have economic or the efficient use of water; then you can for the performance evaluation of water use that means the water productivity or the water use efficiency and water stress ratio. Water product means the amount of crops per unit drop of water per unit amount of water that can be calculated and also water stress ratio water demand and water supply. So, we can compare region to regions the performance evaluations can be done.

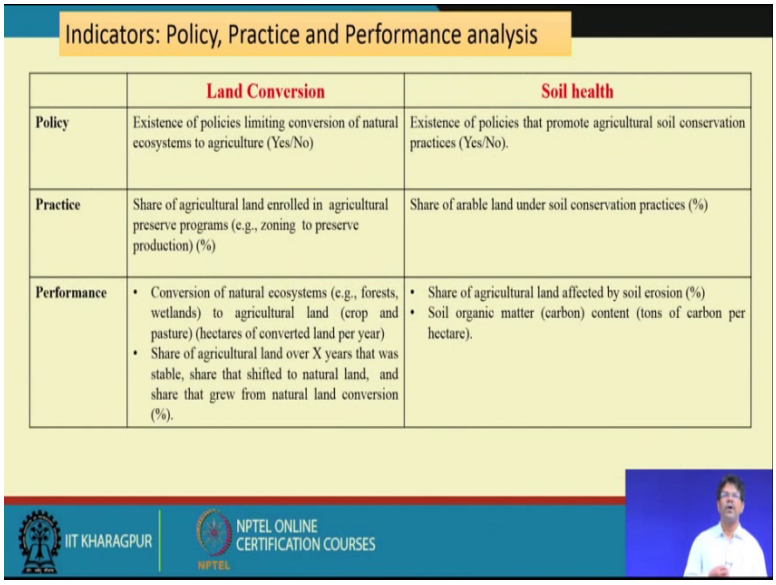
Similarly, if you go for the climate change indicators so the policy for the climate change to know the where there is a greenhouse gas emission from the agricultural operations. So, whether there is a existence of policy promoting low greenhouse gas emission from agricultural activities or agricultural development.

If there is a policy yes, then farmers should do know the then we should know the share of farm land of the farm area with agricultural greenhouse gas emission management practice percentages of land under greenhouse gas emission management. That means, the percent a land that is taken care to minimize greenhouse gas emission as we know the activities, they can the management practices; that ensures less greenhouse gas emission like minimum (Refer Time: 11:17) or the stubble Marcellus practice. Or we can say the organic farming, organic nutrient management say crop rotations with legumes less use of synthetic fertilizers.

So, share of the agricultural land under greenhouse gas emission management and the water management; if you go for the flooding like rice, if you go for the flooded rice, there will be more emission or mittens and aerobic decomposition of carbon organic carbon compounds that cause methane emissions. On the other hand, if you go for the saturations, there will be less or no methane emissions.

So, if you know the there is a policy whether there is a greenhouse gas emissions management practices are followed then farmers will because of then we shown a how much farm area that is under the greenhouse gas emissions managements. And then we can we can calculate there is a performance evaluations: that is say food productions for unit greenhouse gas emissions; that means, the global warming potential of agricultural productions amount of greenhouse gas emitted per ton of the agricultural per unit weight of the agricultural produced tons of the food per ton of the C O 2 equivalent that is a global warming potential can be calculated.

(Refer Slide Time: 18:33)



This is for the water climate change. Similarly, if we evaluate the policy practice and performance analysis for other indicators like land conversion and soil health. In land conversions, we can have the existence of policy limiting conversion of natural ecosystem to agriculture Yes or No. If so then share of agricultural land enrolled in agricultural preserve program, then we can have the performance evaluations like the conversion of natural ecosystems like the forest lands to agricultural land and or you can sub share of agricultural land over the X years that was table and share that shifted to natural land and share that grew from natural land conversions.

So, this type of performance analysis that indicates to check the how can check the conversions of the forest lands to agricultural lands or the deforestation can come in to you can check the activities of deforestations.

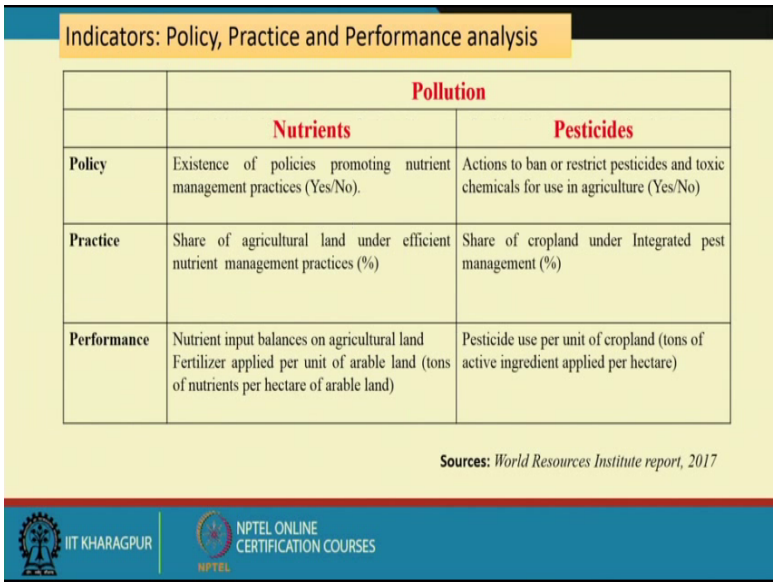
Then you see the other indicator, the soil health. So as a discussing if there is a policy existence of policy that promote agricultural soil conversation practice; if there is a so yes or no. So, the practice means the soil conservation practices so you have you have discuss the earlier classes say control planting how we can do the control planting, the growing the crops across this loss and the minimum clays operations and we have the broad bed and the forosystem of cultivations. So that the erosion soil erosion can be checked.

So, this type of the practice are the soil erosions or the stubble merge tillage how can minimize the water and wind erosions, whether there is a policy that is say existence of the policy to promote the agricultural soil conservations practice. If so, then share of arable land under soil conservation practices that should be in percentage. This is a so 1st one is a qualitative measure that is a yes or no. The 2nd one is a percentage, this is a quantity. We can quantify how much area under the soil conservation practices any type of conservation we can say either the management to ergonomic managements or as a engineering approaches, ergonomic approaches or the biological approaches, what the soil conservation practices are followed. So it is a percentage of area under soil conservations.

Then we can have performance evaluations like the share of agricultural land affected by soil erosions and also we can have this soil organic matter content; if there is a conservation practices over the years, then that helps in buildup of soil organic carbon.

If you compare the lands where the conservation practices are not followed and the land where the conservation agricultural practices are followed so we can evaluate change in soil organic carbon over the years. So that give indications of the sustainability.

(Refer Slide Time: 21:46)



And the other one we can saw the pollution this indicator as a policy, practice and performance analysis for pollutions so policy for the nutrients. Existence of policy, promoting nutrient, management practices yes or no. So as we discuss, so, nutrient means what type of nutrients we are using that is say the type of fertilizers and the source of fertilizers the application method.

So, just discuss now the N fertilizer management, if you apply nitrogen fertilizer at the oxidized one; that means, surface layer so that will give that that will in decrease the efficiency of N fertilizer for the crop use and also that can cause the global warming, that cause the groundwater pollutions by lichening the nitrate to the groundwater, contamination of groundwater, nitrate contaminations. And also that can cause global warming through denitrification through reduction of the nitrate to nitrous oxides and release the atmosphere.

So, that is say existence of policy promoting the efficient nutrient management whether the proper nutrient management; whether if nitrogen fertilizer is applied whether applied as a proper depth special in case of rice or we are using organics. So, the in case of if we are using the synthetic fertilizer special in case of the aerobic crops also, so that is the so because ammonium the nitrate fertilizer so that that gets converted to nitrous oxide too to through some soil. There is some denitrifying bacteria present in the soil even though there is a aerobic conditions.

If you are applying synthetic fertilizer that is see first release of nutrient, it is converted to nitrate and this nitrate is denitrified by the bacteria they are present in soil under aerobic conditions.

If you are using the organic fertilizers, just slow release and the as release is slow, then loss will be less. It is taken by the crops and there will be whatever last loss is very low as compared to the chemical fertilizers.

So, that is what the policy. If there is a policy promoting nutrient management and the practice, then we can have the share of agricultural land under efficient nutrient management practices the percentage. Then we evaluate the performance; performance means the nutrient input balance on agricultural land.

And fertilizer applied per unit of arable land input balance means how much fertilizers are so nitrogen or prosperous how much in nutrients applied to the crops, then last the output the crop removals the loss; loss may be to the groundwater contaminations or loss to the atmospheres the emissions to the greenhouse gases or the amount remaining the soil how much.

So, that input balance per the nutrient input balance and the fertilizer applied per unit of arable land. So that type performance evaluations for the nutrients if you go for pesticides, so the policy action to ban or restrict pesticide and toxic chemicals for use in agriculture. So, like there in India we have we have so there is a B H C Benzene Hexa Chloride D D T Dichloro Diphenyl Trichloroethane.

So, those pesticides are banned, we have the policy. So, there is so; that means, the policy is there so, it is action to ban the pesticides use. The practice that means, we have to say share of crop land under integrated pest managements; that means, the portion of land they use less and less pesticides.

So, if you have the policy, the farmers campunses and you have a practice there is a monitoring amount of land under the less insecticides or minimum insecticides and pest management, then you can go for the performance evaluations that is pesticide used for unit of the crop lands that is say tons of active ingredients applied per hectare.

So, these are the indicators they if you go to indicators then I have the policy; the policy from the government sites and the practice and the performance analysis can minimize and can make economic use of the resources natural resources like the water. So water or we can say soil health or the pollutions as you say fertilizer pollutions or the pesticide pollution pollutions as you say.

So, this can be controlled by the policy and looking at the practice and the performance evaluations. So for this lecture as you say, so this is a approaches to achieve sustainable agricultural productions; that means, so this indicators this is the 5 measure indicators (Refer Time: 27:11) water or the climate change or the soil health at the pollutions either though through nutrients or the pesticides and the land conversions.

So, if you consider the 5 key indicators and if you go for the real evaluations performance evaluations, then we will be able to achieve sustainability in agricultural productions; that means, so our practice should be done to maintain the food productions as per the need to meet the requirement high amount of productions. At the same time we should see the less water use of the less water, less energy, and less inputs like fertilizers or in integrated way. So, that we can achieve sustainability in agricultural productions looking at the indicators and making the best use of the resources in integrated manner ok.

Thank you all.