Watershed Management

Prof. T. I. Eldho

Department of Civil Engineering

Indian Institute of Technology, Bombay

Module No. # 02

Lecture No. # 05

Agricultural Practices and Watershed Management

Namaste and welcome to the video course on Watershed Management. Today in module two on sustainable Watershed approach and Watershed management Practices Lecture number 5, we will discuss about the Agricultural practices and Watershed Management.

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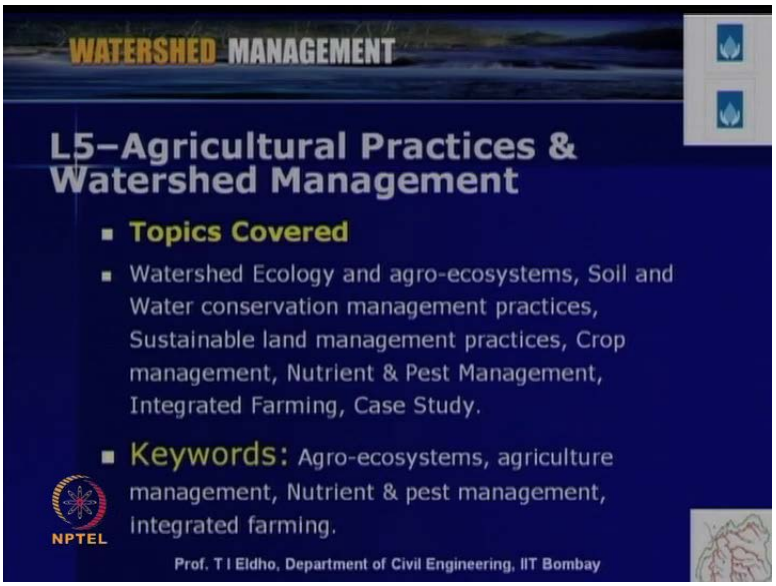

So, the topics to be covered in today's lecture include Watershed Ecology and Agro-eco systems, Soil and Water conservation Management Practices, Sustainable Land Management Practices, Crop Management, Nutrient and Pest Management, Integrated Farming and finally, a Case Study. Some of the important key words in today's lecture include Agro-ecosystems, Agriculture management, Nutrient and pest management and Integrated Farming.

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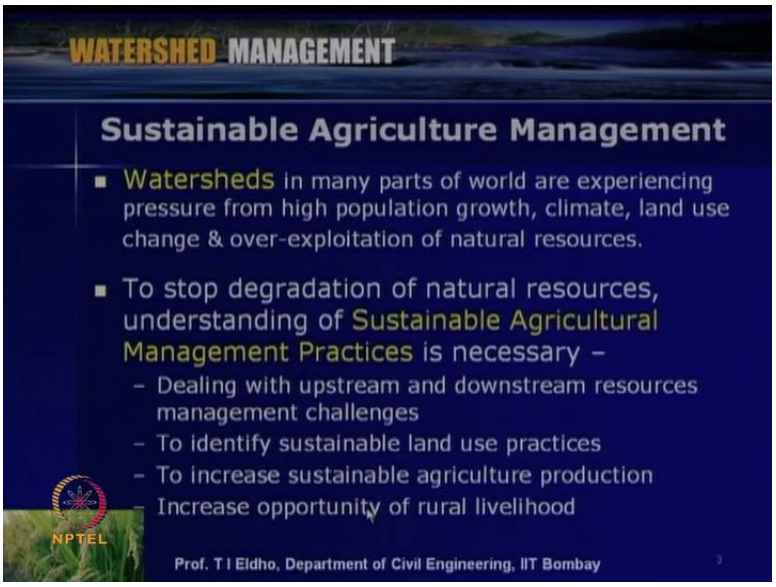

So, as we discussed in earlier lectures like a sustainable water management or sustainable land management or the sustainability issues are all very important in watershed management; so, in any of the watershed which we consider as one of the important land uses is agriculture. So, we have to see what the important issues are, as far as the agricultural management is concerned. What are the important issues in sustainable agricultural management?

So, as far as watershed in many parts of the world are concerned, watersheds are experiencing pressure from high population growth, climate, and land use change and over exploitations of natural resources. So, we can see the effect of population growth and then the land use change. All these are directly influencing the agricultural practices within the watershed. So, as we have discussed earlier to stop the degradation of natural resources and to understand the sustainable agricultural management practices, we need to deal with upstream and downstream resources, management challenges.

So, what are the major challenges within the watershed, as far as various resources are concerned? How we deal with the management of those resources? Then, if the sustainable agricultural management is concerned, we have to deal with the, to identify sustainable land use practices to increase sustainable agricultural production and to increase opportunity of rural livelihood.

So, we can see that in most of the areas, the rural people are living mainly based upon the agricultural or the farm outputs. So, we have to improve this farm output in a sustainable way. So, for that, on a watershed basis we have to see that the agriculture is sustaining and then the land use is sustainable and water use is sustainable. So, within that, we have to see that how we can have better agricultural or agriculture water management or agricultural practices.

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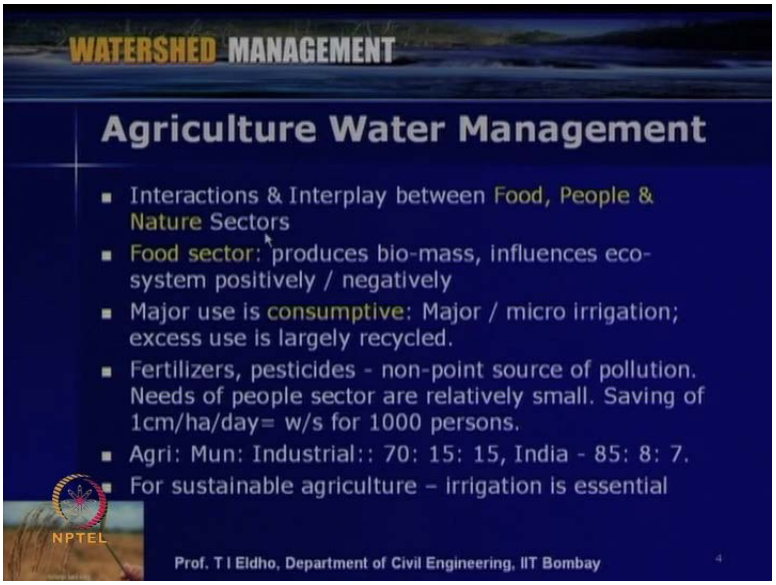

So, let us see some of the issues, as far as water management in agriculture are concerned. So, these deals with the interactions and interplay between food, people and nature sectors, so we have already seen earlier, when we discussed about the sustainability issues. So, very important sectors are food, people and nature. So, out of these, the food sector produces a bio-mass and influences eco-system most of the time positively and sometimes negatively.

So, we can see that as far as agriculture is concerned and the water is concerned, the major use is consumptive. So, this can be directly through irrigation or otherwise. So, as far as irrigation is concerned there can be major or micro irrigation. And many times, farmers use excessive irrigation and so, this irrigated water are largely recycled. Then, some of the other issues like the use of fertilizers and pesticides and then corresponding problems like non-point source of pollution in the water either surface or ground water, so like this, we can see that water use is concerned. A larger number of issues are there,

which we have to deal, as far as the particular watershed is concerned or watershed management is concerned.

So, you can see that, when we consider the three sectors like food, people and nature, so the requirement of water for the people is relatively small. So, we can see that, say for example, if you can see 1 centimeter per hectare per day for as far as the irrigation water is concerned, that much water is sufficient for thousand people; domestic or other usages.

So, if you consider, say the well average as far as agricultural, municipal and industrial water usage is concerned, the ratio is 70:15:15 percentages. But, say for example in developing country like India, this usage is 85 percentages for agriculture, only 8 percentages for municipal use and 7 percentages for industrial sector.

So that, we can see, that is say for example in a county like India, major portion of the water is used for agricultural purposes. So, if we can save the available water by doing appropriate agriculture management practices, effective water use in agriculture, then we can save lot of water.

So, but you can see that in most of the time, whenever we consider the farming sector for a sustainable agriculture, we need irrigation. Since, as we discussed earlier, the rainfall is distributed only for four or five months. So, time wise variation is there; then spatial wise variation is there. So, that way we need irrigation for sustainable agriculture.

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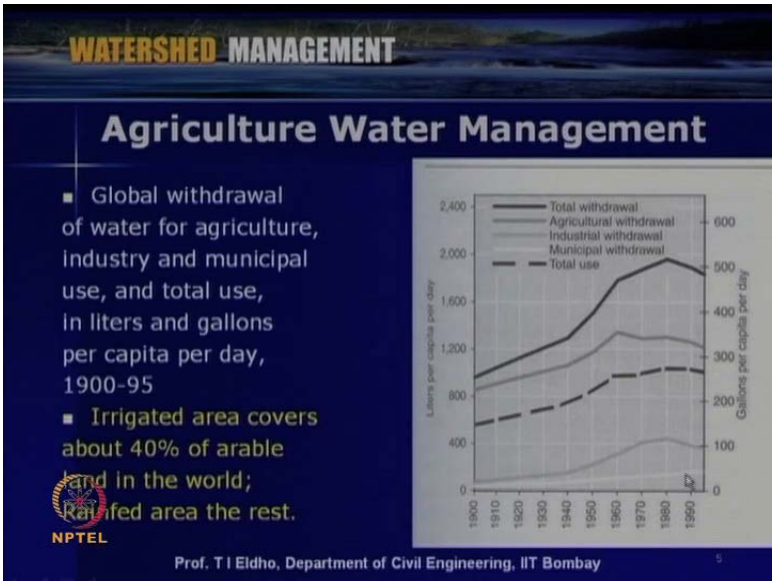

So, that way if we consider, say for example, the Global withdrawal of water for agriculture, industry and municipal use and then its total use in liters, say for example, the data from 1900-1995 for about ninety five years, you can see that this curve shows the total withdrawal. And then, you can see that this, just below this curve, shows the agricultural withdrawal. And, the municipal usage is much smaller. This white line shows the municipal usage and then this is a gray line, show the industrial usage, but where especially in agriculture, lot of water is lost in different ways. So, that way with respect to the total withdrawal, we can see that the effective water or the total water usage is much less compared to the total withdrawal.

So, that way if we can save the water, which we are using for agriculture by appropriate management practices, optimal irrigation management practices, we can save lot of water. And, that can be utilized for many other purposes. And then, also we can use say for example, for further irrigation and other purposes.

So, if you consider the world average for irrigation, the irrigated area covers about 40 percentage of arable land in the world and the rain fed is the rest; that means about 60 percentage of the arable land in the world, say the water is obtained through rain and only 40 percentages is obtained through irrigation.

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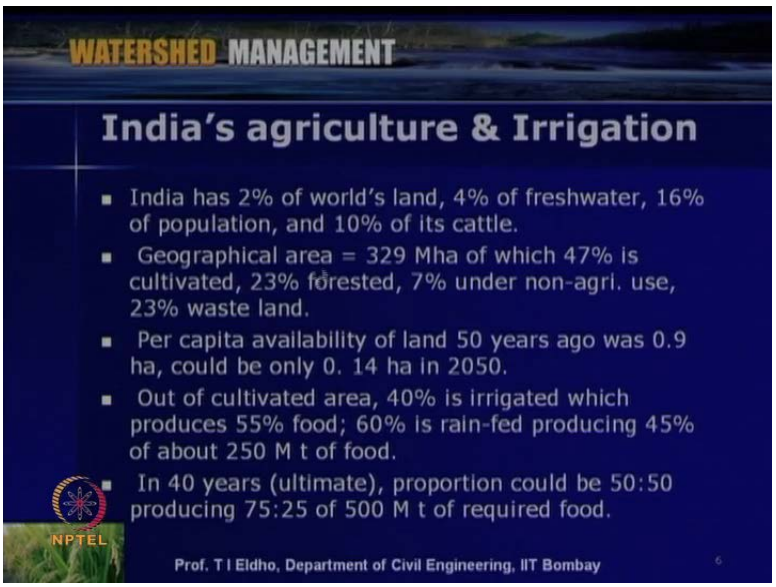

Say for example, now if we consider India's agricultural scenario and irrigation, so India has about 2 percentage of world's land, 4 percentage of freshwater, 16 percentage of population and then only 10 percentages of its cattle. So, this is of the major issue, as far as a developing country like India is concerned. We have water only in 2 percentage of world's land. But, we have 16 percentages of population and then 10 percentages of cattle and only, hardly 4 percentages of freshwater.

And, geographic area is concerned, say India covers 329 million hectare of area of which only 47 percentages is cultivated, 23 percentages is forested, 7 percentages under nonagricultural usage and above 23 percentages of the land is waste land.

And, if you consider with respect to the population, the land availability is concerned per capita availability of land fifty years ago; that means, in about 1950s, it was about 0.90 hectares. But, now, due to the population explosion, this will be reducing to about 0.14 hectare by 2050.

So, that way the land availability compared to any other country, it is much smaller. So, that way India has major problem, as far as the sustainable practices, as far as land, water and agriculture is concerned. So, whatever available, we have to do it in a better way.

And, out of the cultivated area in India, about 40 percentage is irrigated, which produces about 55 percentage of the food requirement of the country and 60 percentage is rain-fed producing about 45 percentage of about 250 metric ton of food required presently.

So, we can see that 40 percentage of the irrigated area produces 55 percentage of the food. And, 60 percentage of rain-fed area only produces 45 percentage of about the 250 metric ton of food produced.

So, in forty years, say for example by 2050, say Government of India wants to increase the irrigation level such that, we can have more food production. So, the irrigation we want to increase may be at least up to 50 percentages. So, that 50 percentage is irrigated area and 50 percentage of the arable land is the rain-fed area.

So that, ratio of food production 75 percentage can be produced from irrigated land and 25 percentage from the rain-fed land, out of the 500 metric ton of food is required by

2050. So, this is the Indian scenario, as far as the agriculture and irrigation requirement is concerned.

So, now let us see, what are some of the agriculture related issues, as far as, especially India is concerned. So, India after independence in 1947, there is large increase in agricultural growth rate.

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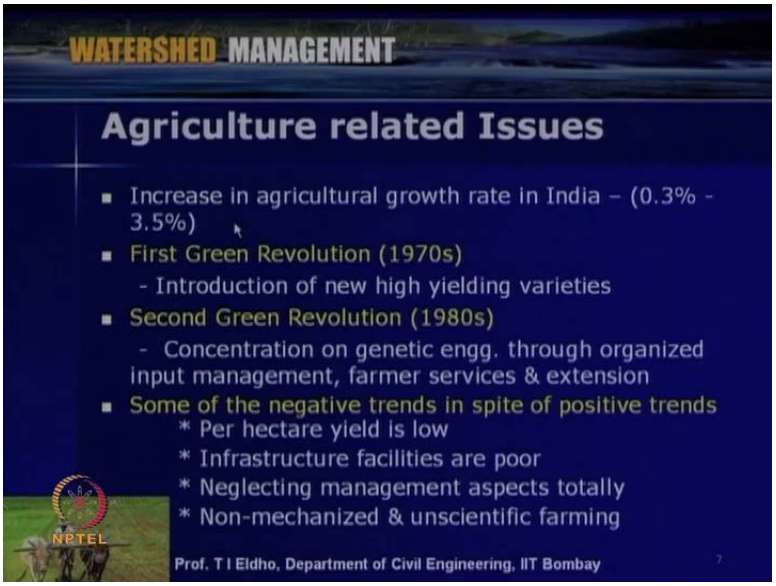

Say for example in 1950s, if it was about 0.30 percentages; in 1960s or 1970s or 1980s it has increased to 03.50 percentages. So, this has mainly happened due to a large number of irrigation or reservoir projects implemented in the earlier five year plans. So, that way the irrigation capacity has increased and that way the agricultural growth was increased.

So, then, another important issue is, say in the first few five year plans, say in 1970s and 1980s, Government of India put a lot of efforts to improve the agriculture sector through introduction of new high yielding varieties that is, say we can call it as, " First Green Revolution" in 1970s.

And then, in "Second Green Revolution" say in 1980s, Government of India through its agriculture and other ministries concentrated on the Genetic Engineering through organized input management and farmer services and extension. And, then also, better seed varieties where implemented in the agriculture sector.

So, that way we can call this say 1980s as, “Second Green Revolution”. So, that way, lots of improvements were taken place in the agriculture sector. But, of course lots of issues are still there in the agriculture sector; so some of the negative trends in spite of the positive trends, we have discussed here.

The negative trends are, say per hectare yield is low. So, compared to other countries like USA and China, per hectare yield is much low. Then, infrastructure facilities in the farming sector is concerned, are poor.

Then, say the total management aspect is neglected in most of the farming sector. And, then also you can see that, still in rural area the farming is not mechanized. So, people are using different types of traditional equipments for farming. And then, say most of the time the rural farmers are not adopting scientific farming. So, that way, say lots of issues are there, as far as the agriculture in India is concerned.

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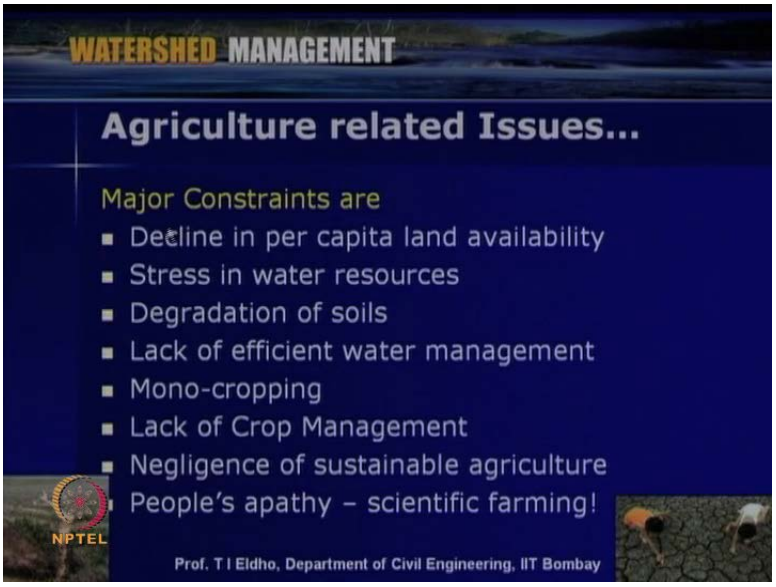

So, some of the important constraint, as far as sustainable agriculture in India are concerned are listed here. So, these are decline in per capita land availability. So, as we have already discussed that, per capita land availability is decreasing due to population explosion, then stress in water resources. So, available water is not sufficient for irrigation due to lack of better agriculture management practices, water management practices or a lack of availability of sufficient water, then degradation of soils, then lack

of efficient water management, mono-cropping in many areas. Farmers are continuing with the same crop. So, that way there are lots of problems, as far as nutrient management and then other soil related issues are concerned.

Then, lack of crop management, negligence of sustainable agriculture, so, say as far as, especially most of the farmers are concerned, they are not bothered about the sustainability issues, as far as agriculture is concerned. And then, of course people's apathy; that means, the farmers are indifference to various, say the scientific farming or mechanization. And, other issues due to, of course various other constraints due to lack of availability of resources or due to lack of education and other issues.

So, that way these are some of the important issues especially in a country like India, as far as sustainable agricultural management practices are concerned. So, now, let us see the agricultural management practices within the perspective of watershed. So, we have already seen that agricultural practices are very important in any of the watershed management plans. So, the agriculture practices following within a watershed, whatever watershed plans or management issues we are making. So, that would definitely affect.

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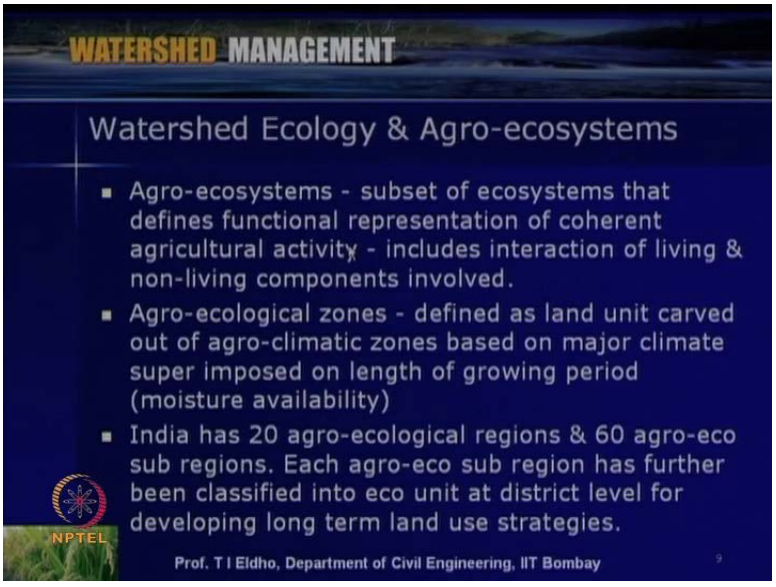

So, that way let us discuss about the watershed ecology and agro-ecosystems. So, these agro-ecosystems, we can define as a subset of ecosystems that defines functional

representation of coherent agricultural activity including interaction of living and non-living components involved within the watershed.

So, we are considering a subset of the ecosystems as agro-ecosystems, and then we can do various zones according to the Ecology, according to agricultural practices and the climate system. So, that way we can call these zones are agro-ecological zones, which are defined as land unit carved out of agro-climatic zones based on major climate super imposed on length of a growing period.

So, if some particular crop is concerned or particular climate season is concerned, so accordingly we can say, define this agro-ecological zones. So, this mainly depends upon the moisture availability. Say for example if India is concerned, we can classify India in to twenty agro-ecological regions and sixty agro-eco sub regions. So, as we have defined here, agro-ecological zones indicate the various issues, as far as the agriculture is concerned with respect to land, with respect to climate and other issues.

So, each agro-eco sub region has further been classified into eco unit at district level for developing long term land used strategies. So, when we have discussed about the sustainable agriculture practices, these agro-eco system or agro-ecological zones are very important. Since, we can implement or we can sort out many issues by considering this agro-ecological zones or agro-ecological sub regions as we discussed.

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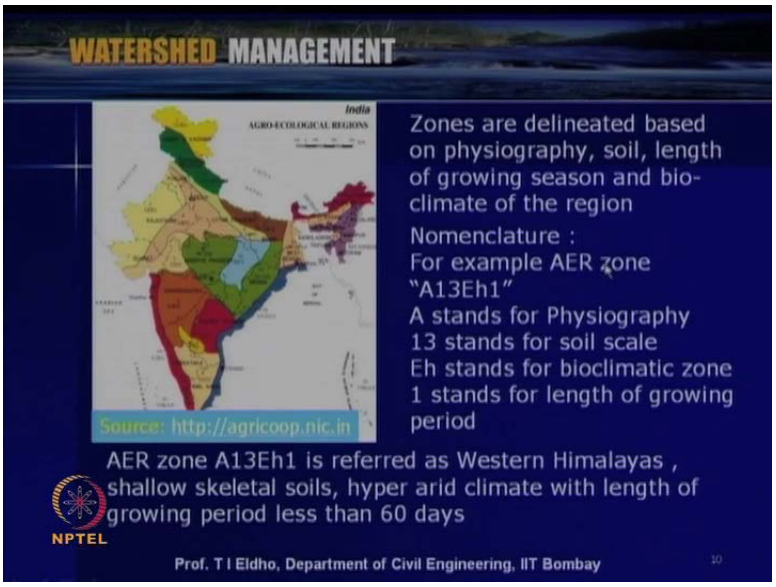

So, here in this slide, you can see the agro-ecological regions of India. So, these various colors indicate various zones. So, these zones are delineated based on physiography, soil length of growing season and bio-climate of the region. Say for example, we can say the agriculture ministry has put various nomenclatures also. So, for example, AER zone means a zone is called AER zone. So, there it is numbered as “A 13 Eh 1”; where “A” stands for physiography, “13” stands for soil scale, “Eh” stands for bio-climatic zone and “1” stands for length of growing period.

So, that way we can put various agro-ecological zones. So, AER zone, A 13 Eh 1 is referred as western Himalayas here. So, some of the important characteristics of the zone is shallow skeletal soils and hyper arid climate with a length of growing period less than sixty days.

So, that way by considering this agro-ecological zone, we can look into various sustainable agricultural practices or issues. And then, we can go for planning and management. It can be watershed based planning and management, but by considering this type of zones, we can implement or we can have various plans, as we discussed.

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So, what are the necessities? Or what are the needs of agro-ecology classification? So, the needs are listed here to assess yield potentialities of different crops, crop combination in agro-ecological regions or zones. Then, to formulate future plan of action involving

crop diversification to disseminate agricultural research and agro-technology to other homogenous areas and then to determine the crop suitability for optimization of land used in different agro-ecological regions or zones. So, as we discussed, this agro-ecological region or zones, say indicates what kind of crops, what kind of climatic region or what kind of soil pattern is there.

Then, we can put plans like, what kind of crops can be grown there, what should be the crop period length. So, like that, various issues can be put according to the agro-ecological classification or agro-ecological zones or regions. And, then we can come up with plans, as far as sustainable agriculture practices are concerned. So, now as far as sustainable agriculture practices are concerned, soil conservation and water conservations are two important issues.

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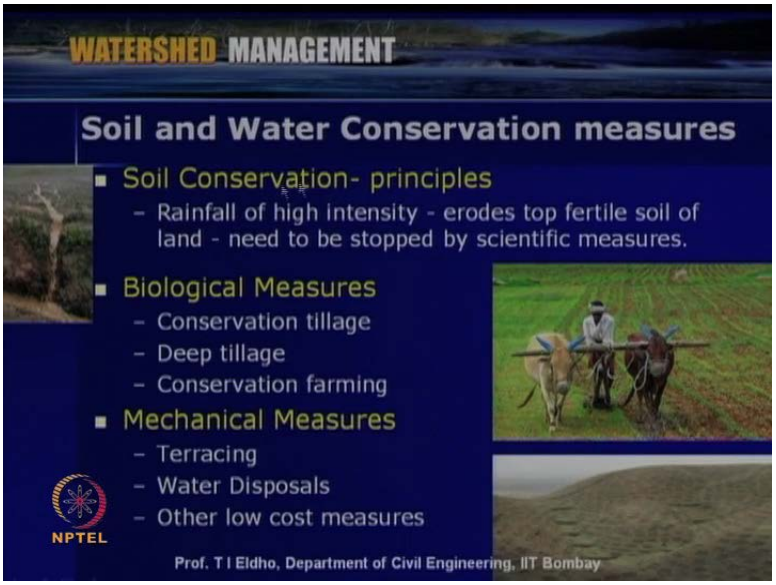

So, let us look into some of the important principles and issues, as far as soil and water conservations are concerned. So, in soil conservation, important principles are based upon high intensity rainfall that erodes the top fertile soil of land. So, we have to stop this soil erosion. So, by various practices we can reduce the soil erosion. So, that is called as soil conservation.

So, we can have various measures like contour farming, and then we can plant trees or grass to reduce the soil erosion. So, various measures are possible like biological

measures like conservation tillage, deep tillage and conservation farming. And, we can go for mechanical measures like terracing, water disposal and other low cost measures. So, like shown here, we can reduce the soil erosion and we can go for soil conservation using various techniques.

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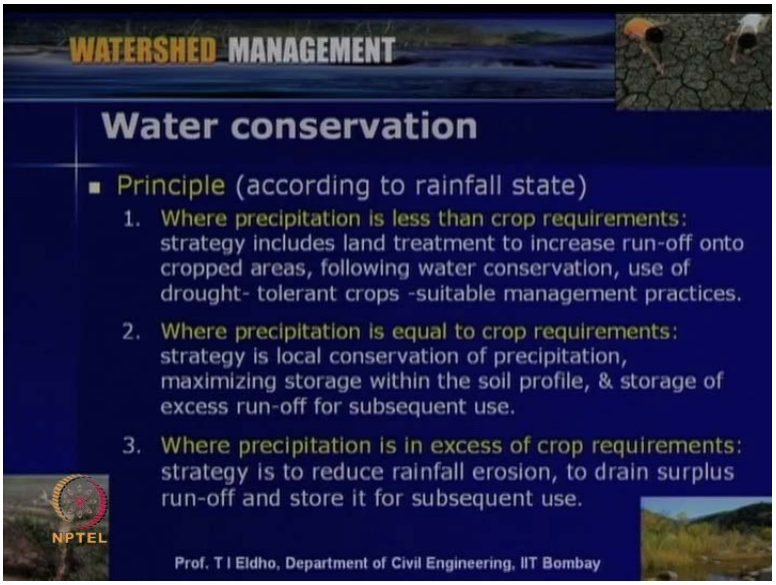

So, then, as far as water conservation is concerned, the principle of the water conservation is where precipitation is less than crop requirement, what we have to do? So, then, where precipitation is equal to crop requirement or where precipitation is in excess of crop requirements. So, accordingly in these three cases, we can have a particular strategy according to the climatic or rainfall conditions.

So, in the first case, where precipitation is less than crop requirement, the strategy includes land treatment to increase run-off onto cropped areas following water conservation, use of drought-tolerant crops and useful suitable management practices. So, this is, when the precipitation is less than crop requirement.

Then, in second case, where the precipitation is equal to crop requirement; so, the strategies are local conservation of precipitation, maximizing storage within the soil profile, and storage of excess run-off for subsequent use. So, this is, when the precipitation is almost equal to what is required, as far as crop requirements are concerned.

Then, in the third case, where the precipitation is in excess of crop requirement; the strategies are to reduce rainfall erosion, to drain surplus run-off and to store the surplus water for subsequent use in summer season.

So, this way, as far as water conservation is concerned, we can make particular strategy depending upon the region and depending upon the case. We can have either whenever precipitation is less than crop requirement or whenever precipitation is almost equal to crop requirement or when precipitation is in excess of crop requirement. So, accordingly, we can go for particular strategy, as far as water conservation is concerned.

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So, now based upon these issues, now let us discuss the sustainable land management practices. So, we have seen that, to achieve sustainable agricultural practices, we need to go for sustainable land management practices.

So, sustainable land management practices that gives, it is a knowledge based system which helps to integrate land, water, bio-diversity and environmental management to meet rising food and fiber demand while sustaining eco-system services and livelihood to meet requirement for the growing population. So, we can define the sustainable land management like this. So, it is a holistic way of sustainable approach, as far as land, water, bio-diversity, and environmental management and then the requirement, as far as the growing population is concerned.

So, this sustainable land management or SLM enhances the productive capabilities of a land in cropped and grazed area. So, if we consider the various issues appropriately, we can increase the productivity of the crop yield and then forest tree can be improved or the grass land or grazed area can be improved.

So, through sustainable land management, we can have actions to stop reverse degradation or at least to mitigate adverse effects of earlier misuses. So, whenever we discussed about the watershed deterioration issues and related problems, we have seen that, say here the watershed will be degraded by various problems, various issues as we discussed earlier.

So, through sustainable land management practices, we can at least reduce what is happening and then also, we can reverse the trend; so that, we can, however say overall sustainable development.

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So, now, let us look into what are the objectives, as far as sustainable land management practices are concerned. Some of the important objectives are listed here to increase land productivity. So, that means, replenish soil nutrient by limiting organic inputs and then maintain soil cover. So, like a cover we can use cover crops and residue recycling.

And, second objective is to provide adequate quantity of water. So, there is no scarcity of water. So, we can use crop, forage or tree species with higher water use efficiency. So

that, depending upon the available water, we can go for water resource management. If we are using particular crop, then we should maintain water quality. So, water quality is also an issue. So, here we can protect vegetative filter areas in the riparian zone to remove excess sediments and nutrients. And then, also the nonpoint source of pollutions, all those we can reduce.

And then, third objective is to reduce flooding and flood damage. So, as we discussed earlier, flooding is always a problem. So, through sustainable agricultural management practices or sustainable land management practices, we can plant a deep rooted vegetation to enhance in filtration and water consumption by the plants. And, this also may decrease the soil erosion problems. So, these are some of the important objectives, as far as sustainable land management practices are concerned.

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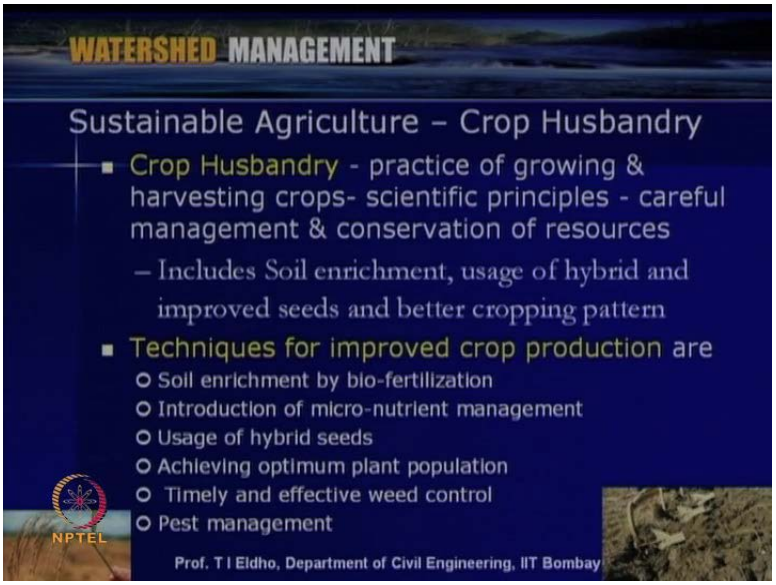

So, now let us look into the sustainable agriculture issues. So, first one is the crop husbandry. So, crop husbandry means the practices of growing and harvesting crops based upon scientific principles, careful management and conservations of resources.

So, whatever the cropping pattern, so we have to concern the cropping pattern, what type of crop is to be used. Then, the various issues as far as soil is concerned, water is concerned and then the health of the crop is concerned, so, here the crop husbandry

includes soil enrichment usage of hybrid and improved seeds and also better cropping pattern.

So, some of the techniques used for improved crop productions includes soil enrichment by bio-fertilization, introduction of micro-nutrient management, usage of hybrid seeds, achieving optimum plant population; so that, better production will be there. Then timely and effective weed control. So, we say in agricultural practices weed control is very important. So, we have to do the weed control timely and effectively. Then, here comes the pest management. So, these are some of the important techniques, which we can utilize in crop husbandry. So that, we can achieve sustainable agricultural practices, as far as various crop managements or crop husbandry is concerned.

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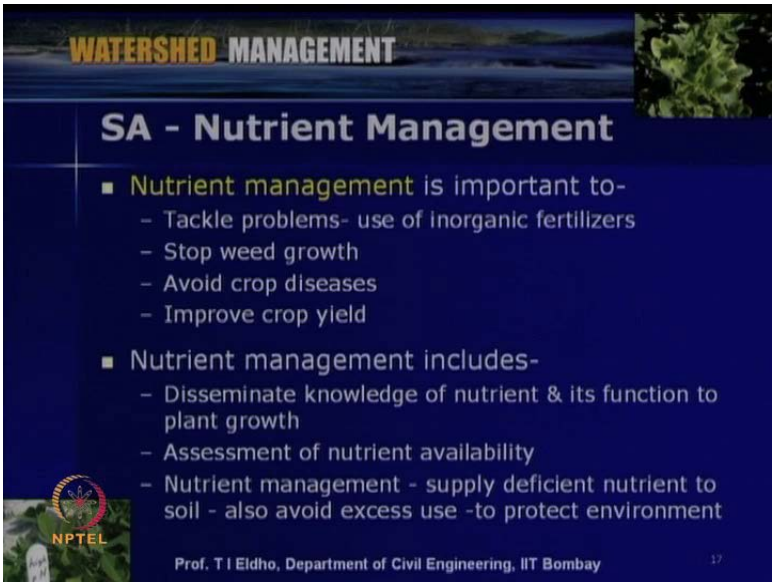

Then, the next issue in sustainable agriculture is nutrient management. So, as far as nutrient management is concerned, it is important to tackle problems like use of inorganic fertilizers. So, in the last few decades, farmers are using lot of inorganic fertilizers like urea, then phosphates, like that. So, whenever we use without optimal use or without scientific knowledge, then what happens is that, it decreases the soil fertility. And then, also it becomes a pollution source, as far as soil and water is concerned. So, the other issues of nutrient management are to stop weed growth, to avoid crop diseases and improve crop yield. So, these are the main issues, as far as nutrient management is concerned.

Then, as far as nutrient management is concerned, it includes disseminate knowledge of nutrient and its function to plant growth. So, most of the time, say in a country like India, the farmers are not well educated. So, we can disseminate the knowledge, say why we have to study a nutrient analysis as far as particular area, particular watershed is concerned and then how to improve the nutrients in the Soil. So, we can disseminate the knowledge and then its functions in plant growth, as far as nutrient management is concerned. Then, assessment of nutrient availability, as far as the watershed is concerned. Then, nutrient management supplies deficient nutrients to the soil, also avoid excess use to protect the environment.

So, as I discussed, say for example, the Nitrogen, Phosphorous and Potassium; N, P, K is concerned. So, you can see that in the last few decades, in many areas, farmers are using these important nutrients like N, P and K. So, what happens, when it is over used, it becomes an environmental problem. And, whenever it is underused it becomes deficient nutrient, as far as the particular area is concerned. So, that way we should look into an effective nutrient management, as far as the particular area or particular watershed is concerned.

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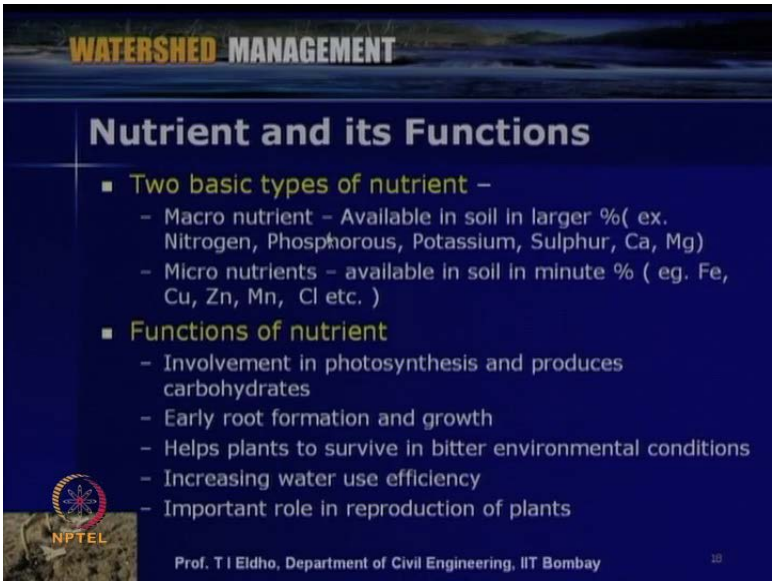

Then, let us further look into the nutrient and its functions. So, there are two basic types of nutrients. One is called a macro nutrient. So, these macro nutrients are available in soil in larger percentage. Say for example, Nitrogen, Phosphorous, Potassium, Sulphur,

Calcium, Magnesium, etcetera. So, then the other one is called micro nutrients. So, these are available in soil in minute percentage. So, like Iron, Copper, Zinc, Manganese etcetera.

So, that way this is depending upon the requirement for the particular crop, say depending upon the availability of that particular nutrient for the particular area. We have to provide that particular nutrients to the soil. So that, the crops can grow in a healthy way and it can give better yields. So, appropriate nutrient management is very important.

Then, let us look in to what are the important functions of nutrient. So, some of the important functions are listed here. These are, it includes an involvement in photosynthesis and produces carbohydrates.

Then, in early root formation and growth, the nutrient helps plants to survive in bitter environmental conditions like drought area or the increased saline area. So, like that, so the nutrients help plants to survive in this particular areas and then increasing water use efficiency. So, if you give appropriate nutrients at appropriate levels to the plants or to the soil, then we can even increase the water use efficiency and then it also plays an important role in the reproduction of plants.

So, these are some of the important functions, as far as nutrient is concerned. So, we should have a better nutrient management plans, as far as the particular area or particular watershed is concerned.

So, then, say particular area is concerned, we should assess the nutrient availability and then we have to provide nutrients to the soil, as far as the particular crop is concerned. So, the various tests are possible, as far as the assessment of nutrients is concerned.

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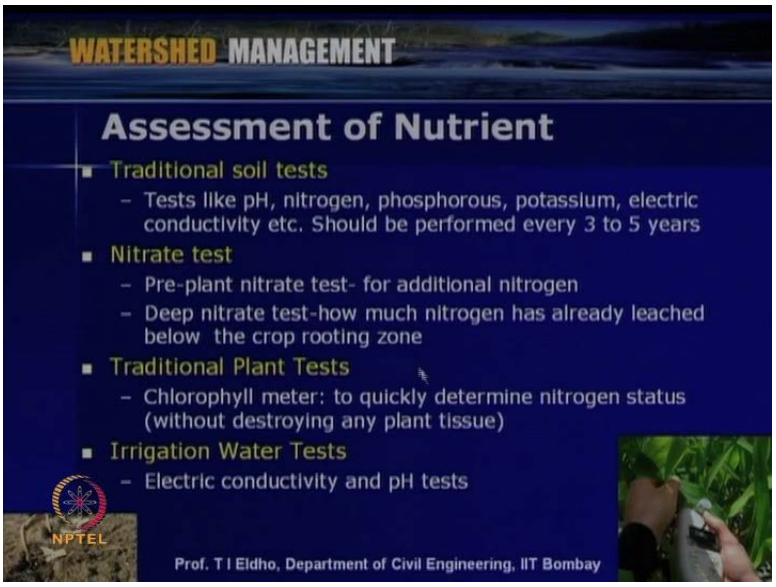

So, some of the important tests are listed here, like your traditional soil test. Traditional soil test involves tests like pH, Nitrogen, Phosphorous, Potassium, electric conductivity etcetera. So, these types of traditional soil test, we should perform in every three to five years. So that, depending upon the non-availability of these particular nutrients, we can provide these nutrients according to the requirement.

Then, another important test is Nitrate test. So, this includes the pre-plant nitrate test for additional nitrogen. Deep nitrate test, tests how much Nitrogen has already leached below the crop rooting zone. So, these tests we can do, and then accordingly we can provide appropriate Nitrate treatment, as far as the soil is concerned. Then, next one is traditional plant tests. Traditional plant tests like chlorophyll meter are used to quickly determine the Nitrogen status without destroying any plant tissues.

Then, also we can go for irrigation water tests and then electric conductivity and pH tests. So, these are some of the tests used to assess the nutrients available for the particular area, particular Soil and for particular crop growth. So, then accordingly, we can go for nutrient management by supplying appropriate nutrients on appropriate levels or appropriate measures to particular area for the given crop. So, now, another important issue in sustainable agriculture management is pest management.

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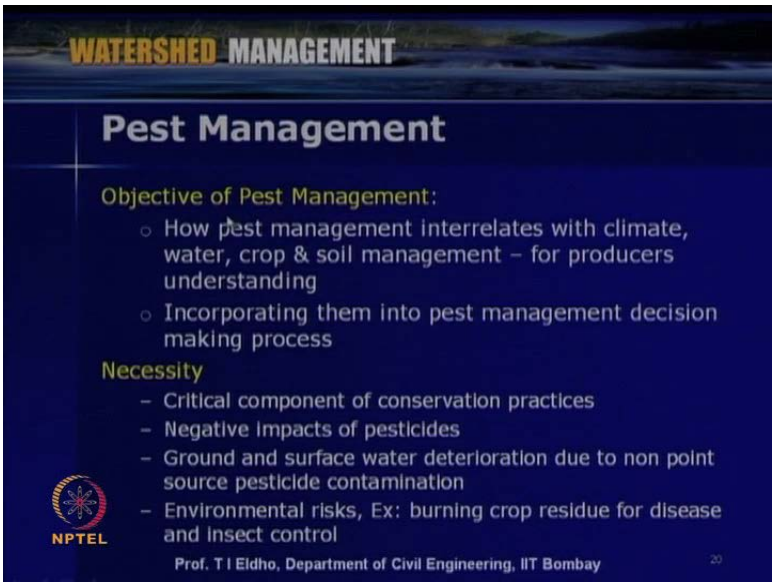

So, for the pest management, the main objective is to say how pest management interrelates with climate, water, and crop and soil management. So, the farmers should understand. So, the farmers should understand how the pest management will help them to incorporate these pest management techniques for the decision making process, as far as the farming is concerned.

So, this is another important issue. So, some of the important necessities as far as pest management is concerned, that includes critical component of conservation practices. So, it is very important in the pest management. Then, next is the negative impact of pesticides. So, if over use is there, then lot of issues can be there. Then, ground and surface water deterioration is due to nonpoint source like pesticide contamination. So, this is very important issue, as far as water and soil is concerned.

Then, environmental risks like, say for example, burning crop residue for disease and then insect control. So, these are the necessities, as far as the pest management is concerned. So, then for the considered area, considered crop, we have to go for appropriate pest management, as far as the sustainable agriculture management is concerned.

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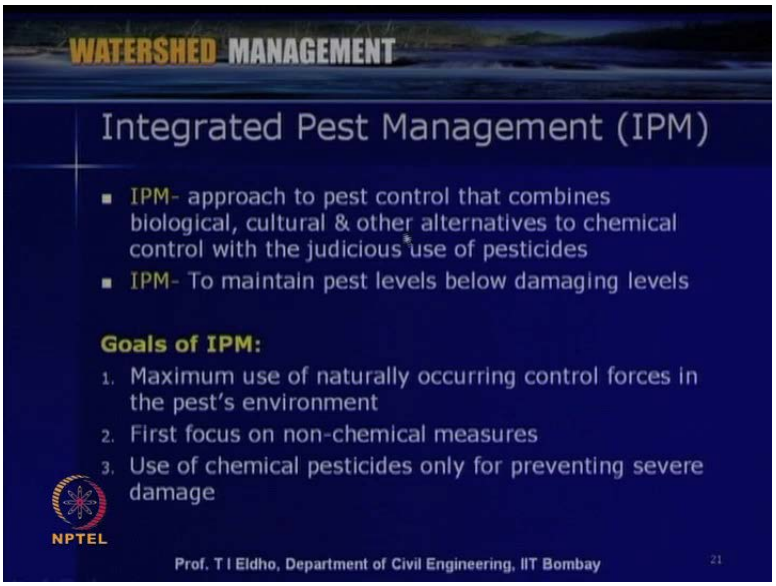

Then, generally, we use a term called integrated pest management. So, IPM is an approach practiced for pest control that combines biological, cultural and other alternatives to chemical control with the judicious use of pesticides. So, instead of overuse or underuse of pesticides, we have to judicially use the pesticides by considering the various biological, cultural and other chemical issues. So, the important goals of integrated pest management include maximum use of naturally occurring control forces in the pest's environment.

So, when particular area or particular crop is concerned, we have to consider, whether we can control the pest naturally. So, if it is not possible only, we have to go for chemicals. So, first focus on non-chemical measures. So, either biologically or with natural control, we can reduce the pest. So, first focus on non-chemical measures. Only, then chemical pesticides are used for preventing severe damage. So, as far as particular farm is concerned or particular agriculture is concerned, we go for integrated pest management; so that, to reduce, of course the damages due to the pest.

But, we have to see that whether without non-chemical measures, we can reduce the pest problem. Else, if chemical measures to be adopted, then it should be in a controlled way; so that, there are very less environmental problems. So, we can achieve sustainable agricultural management, as for as the particular area is concerned.

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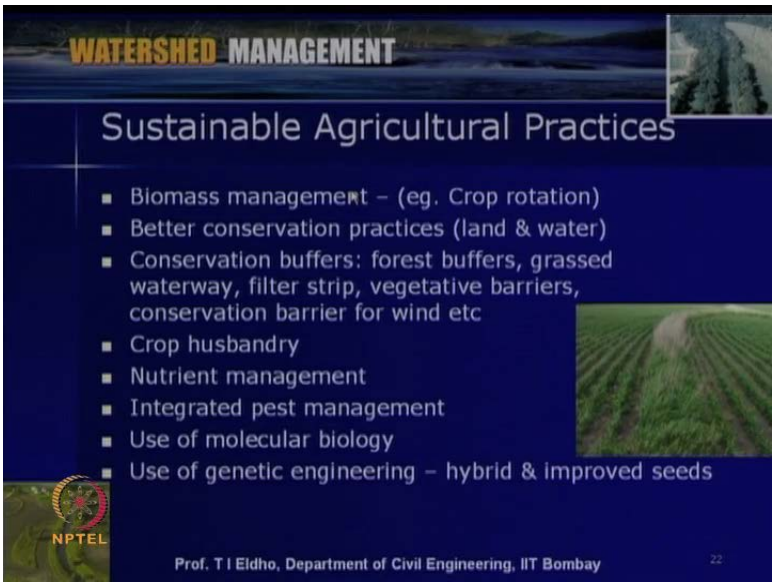

So, now finally, let us look in to what are the important issues, as far as sustainable agricultural management practices are concerned. So, some of the important issues are listed here. First one is biomass management. So, for the particular area, what kind of crop is to be considered for the particular region, particular area; depending upon the soil, depending upon the water availability and also like crop rotation.

Then, second issue is better conservation practices, as far as land and water is concerned. When land and water are concerned, we have to go for better conservation practices, then for conservation buffers. So, to achieve sustainable agricultural management, we can consider conservation buffers like forest buffers at particular area, then a grassed waterway, then we can go for filter strip, then vegetative barriers, then conservation barrier for wind, etcetera. So, we can consider various conservations for the particular watershed or particular area to achieve sustainable agricultural management. Then, as we discussed earlier, we can go for crop husbandry by considering the various crop management practices. Then, we can go for nutrient management. So, as we discussed in the previous slides, nutrient is very important. So, we should not overuse and we should provide sufficient nutrients, as far as the particular area or particular crop is concerned. So, nutrient management is very important in sustainable agricultural practices.

Next is integrated pest management. So, first we have to see, whether we can go for pest control without chemical use. And, if chemical use is required, then we should go for a

scientific way, controlled way. Then, of course, as far as sustainable agriculture practices are concerned, we can go for modern technology like Molecular Biology and Genetic Engineering.

So, now these two branches of Science like Molecular Biology and Genetic Engineering have been grown considerably in the last few decades. So, availability of this Molecular Biology and Genetic Engineering are its practices. Through its practices, we can have better sustainable agricultural management. We can go for, say for example seeds are concerned, we can go for hybrid and improved seeds and then we can go for tissue culture. We can go for, say hybrid varieties. So, like that, various things are due to the development in Molecular Biology and Genetic Engineering. We can use the various available techniques for sustainable agricultural or agricultural management is concerned.

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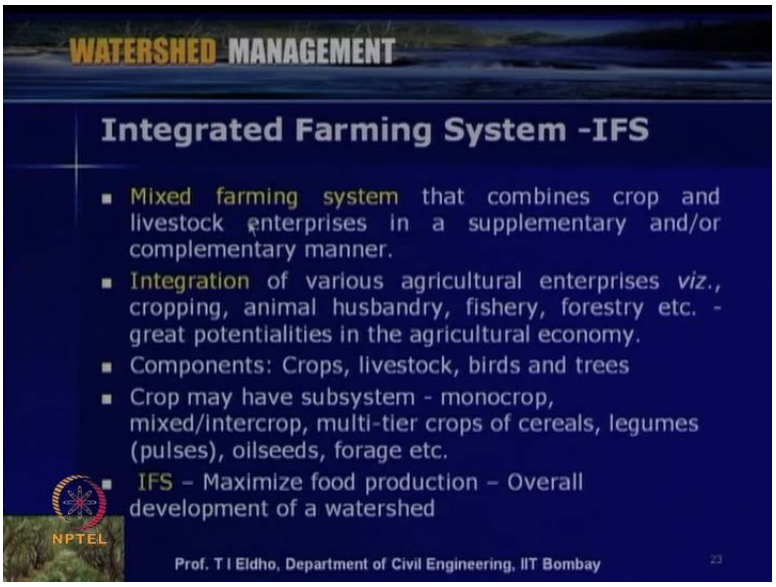

So, now another important issue in sustainable agricultural management is, whether we can go for integrated farming system. So, say, integrated farming system or IFS, some of the issues are listed here in this slide. So, say for example, mixed farming system. We can go for mixed farming system, so mixed farming system combines crop and livestock enterprises in a supplementary and are in a complementary manner. So, for a particular watershed or particular area is concerned, it is not only a crop. We can have an integrated

way of say mixed farming, as far as crop is concerned and as far as live stocks are concerned.

So, we can combine together; so that, we can have better economic achievements, as far as the watershed is concerned. So, integrated farming system means integration of various agricultural enterprises like cropping, animal husbandry, fisheries, forestry, and etcetera. So that, we can have better economic achievements, as far as the particular area is concerned. And this, gives great potentialities in the agricultural economy.

So, some of the important components of integrated farming system includes crops, livestock, birds and trees. So, depending upon the area, say for example crop is concerned, we can have a monocrop; that means only one type of crop or a mixed or intercrops. Then, we can have multi-tier crops of cereals, legumes or pulses and oilseeds forage etcetera.

So, when crop is concerned, we can have not only monocropping, we can have different crops together. Say for example, wherever coconut farming is there with coconut, we can grow, say we can grow pepper. So, like that, various crops can be combined within the given area. So, those farmers can have more products and better benefits from their particular farms.

So, the main motto of integrated farming system is to maximize food production and then overall development of a watershed. So, say by integrated farming, we can achieve overall development of the area, since the farmers will have better profits through various crops in the same area; so that, we can maximize the food production and maximize the benefits.

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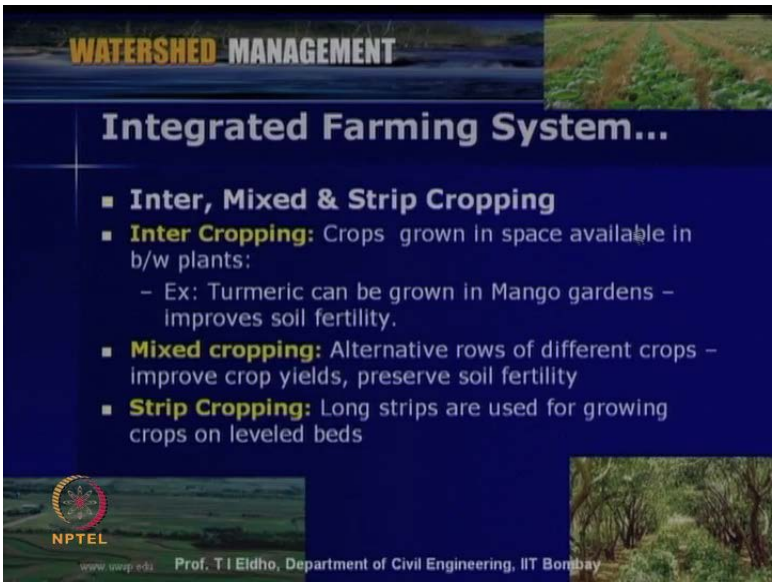

When, integrated farming system is concerned, there are some other issues like inter cropping, mixed cropping and strip cropping. So, as far as crops are concerned, we can have a three ways of integrated farming. First one is inter cropping. So, here crops are grown in available space in between the plants. Say for example, Turmeric can be grown in Mango gardens. So, like that, some crops will be already growing like this. You can see that here in the Mango gardens, the Mangoes are growing and then, here other types of crops are also growing. So, this is called inter cropping.

Then, second one is mixed cropping. So, here we can use different crops in alternative rows. So, we can improve the crop yields and then preserve soil fertility. Then, the third one is strip cropping. Where, long strips are used for growing crops on leveled beds. So, like this, as far as integrated farming is concerned, cropping is concerned and we can have inter cropping, mixed cropping and strip cropping. So, like this, say by using integrated farming system, we can achieve sustainable agricultural practices or sustainable agricultural management for the given watershed. So, within the perspective of what we discussed today, sustainable agricultural management practices are concerned. Let us look in to a case study.

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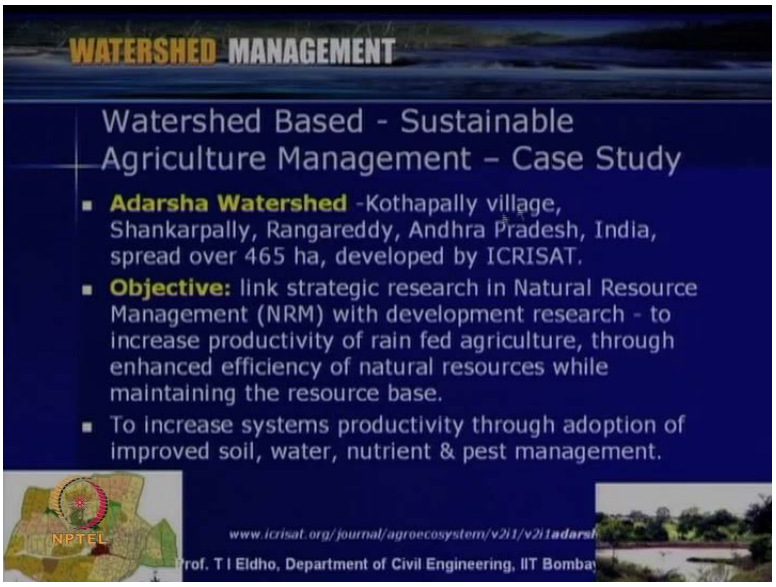

So, the case study is Adarsha Watershed is in Kothapally village in Rangareddy district in Andhra Pradesh. It covers 465 hectares. And, an integrated watershed management plan based upon sustainable agriculture has been developed by ICRISAT in this area. So, the details are taken from the ICRISAT website. Details about ICRISAT website are available in this website.

So, the main objective of this watershed intervention was, to link strategic research in Natural Resource Management (NRM) with development research to increase productivity of rain-fed agriculture through enhanced efficiency of natural resources while maintaining the resource base.

So, these are the main objective, as far as the watershed intervention in Adarsha Watershed. So, finally through this, the aim was to increase the productivity through adoption of improved soil, water, nutrients and pest management, as far as the area is concerned. So, the area is shown here. It is taken from this website.

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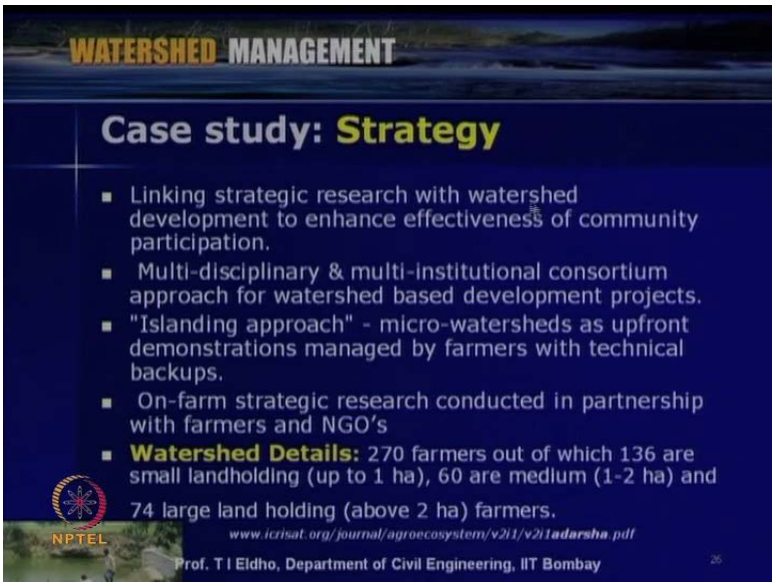

So, the important strategy in this watershed was to link the research with the watershed development schemes to enhance the effectiveness of community participation. And, a multi-disciplinary and multi-institutional consortium approach for watershed has been utilized and various developmental projects were implemented by ICRISAT in this area.

So, they used an "Islanding approach" through micro watershed as upfront demonstrations, managed by farmers with technical backups. So, a technical advice is given by ICRISAT in this area. And then, say the farmers implemented these projects. Then, the on-farm strategic research was conducted by ICRISAT in partnership with the farmers.

So, some of the important watershed details are, say out of 270 farmers in this area, 136 are small land holders (up to 1 hectare), 60 are medium land holders (1-2 hectares) and 74 are large land holders (above two hectares). So, these were the details, as far as the distribution of land holders, as far as farmers are concerned in the Adarsha watershed.

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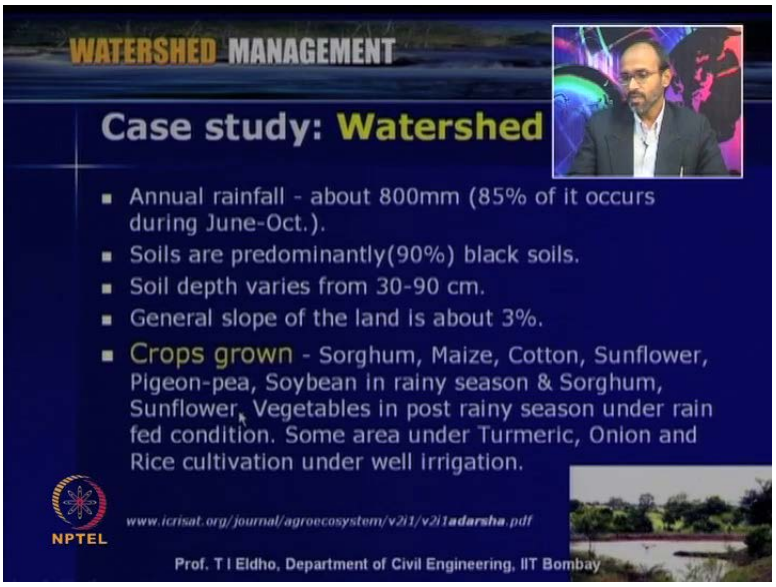

Then, some of the other watershed details like annual rainfall is about 800 millimeters say 85 percentage of it occurs during June to October. So, soil is predominantly black soils in this area. Soil depth, varies from 30 to 90 centimeter. The general slope of the land is hardly, about 3 percentages.

And, some of the important crops grown include Sorghum, Maize, Cotton, Sunflower, Pigeon-pea and Soybean in rainy season; where Sorghum, Sunflower and the vegetables are grown in post rainy season under rain-fed condition. And then, in some areas, say the farmers grow Turmeric, Onion and Rice. The cultivation depends upon the water availability and then well irrigation. So, all these details were taken from the ICRISAT website.

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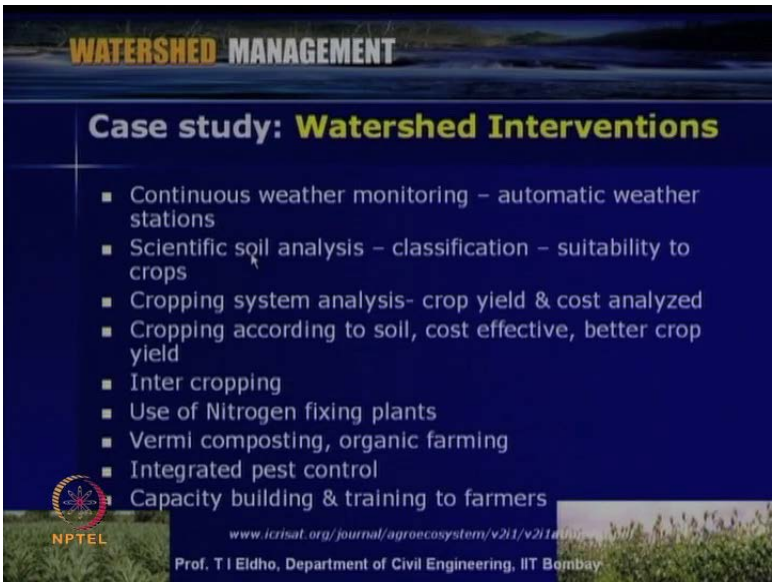

So, let us look into what are the important interventions done by the ICRISAT authorities. So, here, say they conducted a complete resource mapping as the first step and then they identified the various problems, as far as the watershed is concerned. They discussed the various issues with the farmers.

So, some of the interventions did by ICRISAT include continuous weather monitoring. They implemented a number of automatic weather stations in the regions and then conducted scientific soil analysis. So, that soil, according to the soil analysis, the soil has been classified and then, they identified which type of soil is suitable for particular crops.

Then, also cropping system analysis has been carried out. So that, how much crop yield is possible, then what is the cost for the farming and then, what will be the benefits from the particular crop, in that particular area. Then, the cropping has been done according to soil and then the cost effectiveness of particular cropping has been also analyzed. So that, better crop yield can be achieved through various measures. Then, another aspect, which has been implemented in this watershed, is inter cropping.

So, we have already seen, what is inter cropping? It is not only one crop, various crops where, say done in the same area. Then, use of nitrogen fixing plants; so that, the Nitrogen fixing plants, give Nitrogen to the soil, instead of providing Nitrogen through artificial fertilizers. So, this has been implemented. Then, Vermi compositing and then

organic farming; so, all those things where done in this particular watershed. So, also integrated pest control through natural control measures were implemented in this watershed. So, that was a one, another important aspect of the success in this watershed.

So, then finally, the ICRISAT or the NGOs carried out capacity building and then they gave training to farmers. So that, farmers know what kind of cropping to be done in what particular area and then, say scientific way of farming, then by using soil testing, then nutrient management and then, integrated pest management. So, these are some of the important watershed interventions done in this watershed. So, then, now let us look what are the important impacts of these measures, interventions done by the ICRISAT in this Adarsha Watershed.

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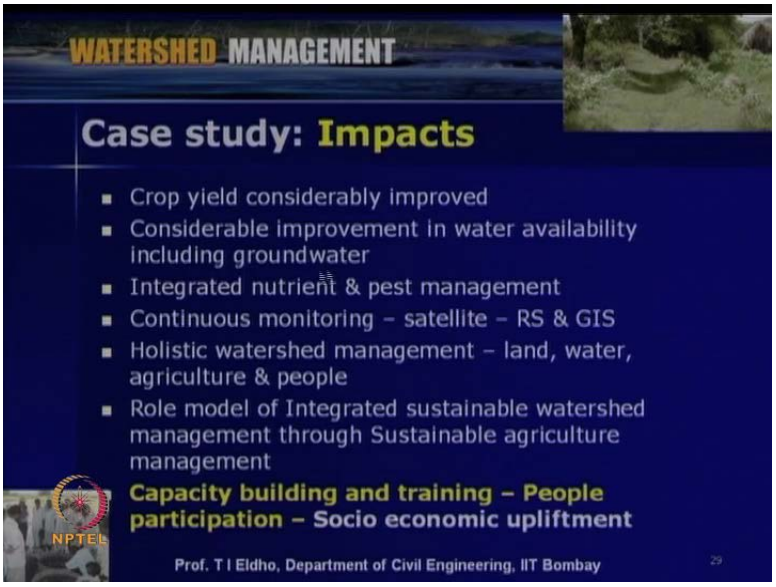

So, the analysis showed that, crop yield considerably improved in many of the areas. Then, there is a considerable improvement in water availability including ground water. So, they implemented rain water harvesting also in this area. So, that improved the water availability for the area. And then, integrated nutrient and pest management were carried out.

So, that way the farmers are using very less artificial fertilizers. But, they go for organic fertilizers, then for better nutrient management and then they go for better scientific pest control and natural pest control, instead of using chemicals for pest management.

Then, is the continuous monitoring; so, as far as the watershed is concerned, it was monitored using remote sensing and then GIS platform has been also used for overall better management.

Then, is the holistic watershed management, the holistic approach as far as land, water, agriculture and people are concerned, so that way, a holistic development approach has been done in this particular watershed.

Then, this watershed has been declared as a role model of integrated sustainable watershed management. Through sustainable agriculture management by various agencies, this has been replicated in many villages in India and abroad.

So, another important aspect in this watershed is capacity building and training has been given by the NGOs to the people. So, people participation was another important aspect. And then, overall socio-economic upliftment has been taken place in this watershed through various interventions. So, as far as this today's lecture is concerned, some of the important references are listed here, including various websites.

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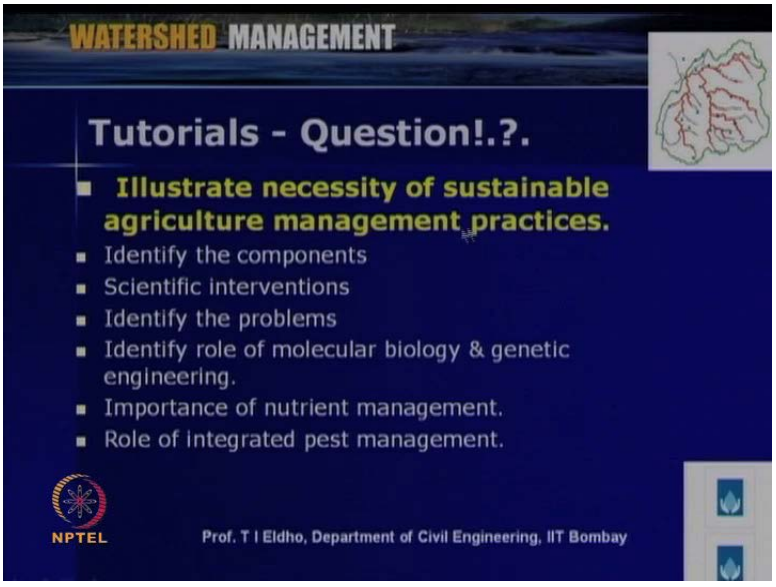

Then, based upon today's lecture, here I have listed one tutorial question. So, the question is "Illustrate necessity of sustainable agriculture management practices", as far as overall watershed management plans are concerned. So, you can do through a systematic approach. Some of the steps are mentioned here.

So, the steps are as follows. Identify the components, then the possible scientific interventions, as far as the agriculture management practice is concerned. Then, identify the problems, then identify the role of the modern techniques like a Molecular Biology and Genetic Engineering, then importance of nutrient management, then finally, the role of integrated pest management. So, most of these issues, we have discussed in the lecture.

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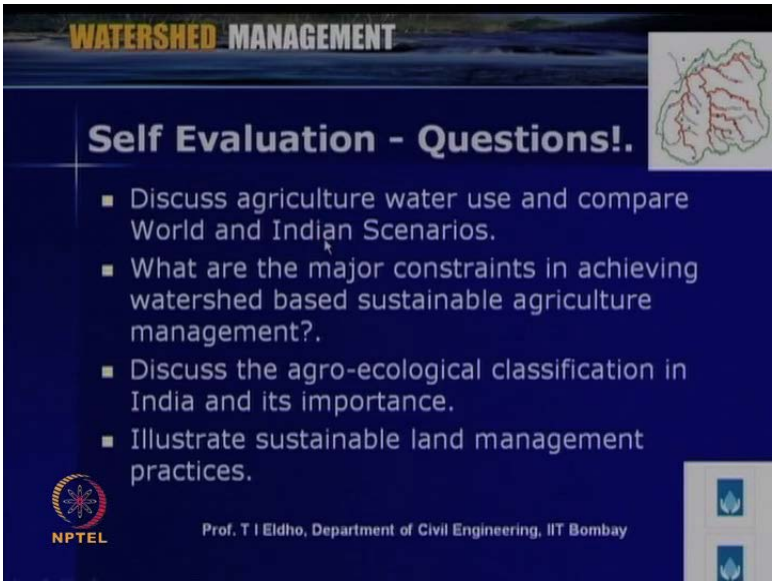

Then, some of the self-evaluation questions from today's lecture are listed here. First one is, "Discuss agriculture water use and compare world and Indian scenarios". Second question is, "What are the major constraints in achieving watershed based sustainable agriculture management?" Then, "Discuss the agro-ecological classifications in India and its importance". Then," Illustrate sustainable land management practices. So, for most of these questions, the details are available in today's lecture.

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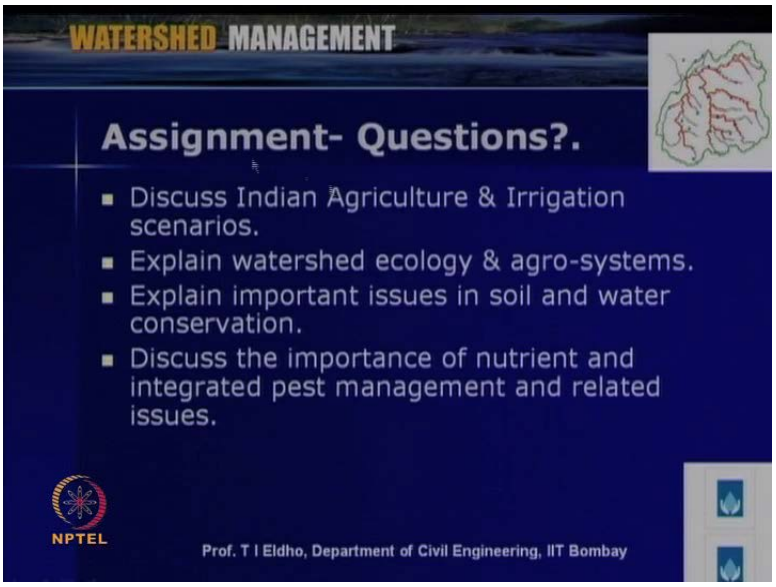

Then, few assignment questions are there. They are, “Discuss Indian agriculture and irrigation scenarios”. Then, “Explain watershed ecology and agro-systems”. Then, “Explain important issues in soil and water conservation”. Then, “Discuss importance of nutrient and integrated pest management and its related issues”.

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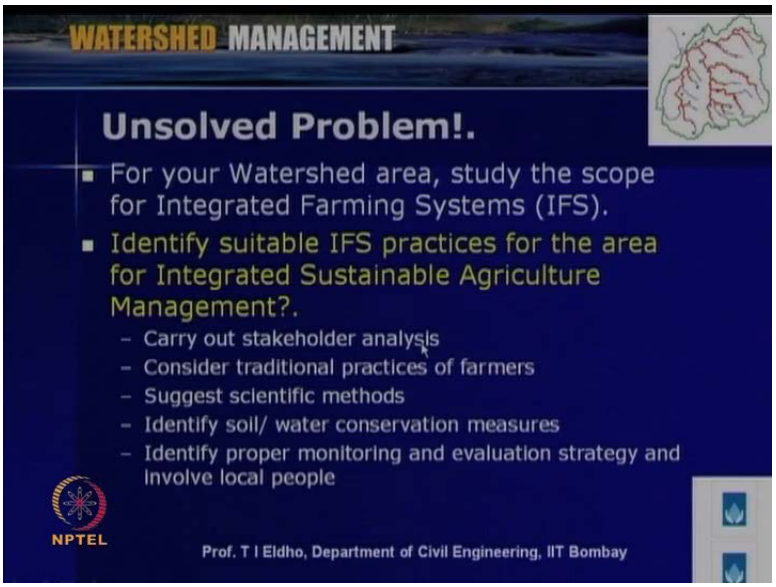

So, most of these questions can be answered based on today’s lecture. So, finally, one unsolved problem is listed here. For your watershed area, study the scope for integrated farming systems in your area. So, this, we can do in a step by step procedure. So, first,

we can identify the suitable Indian farming system practices for the area for integrated sustainable agriculture management. Then, carry out stakeholder analysis. Consider traditional practices of the farmers. You can go to the field and discuss with the farmers and identify it.

Then, suggest scientific methods, various methodologies, how we can go for integrated farming systems, then identify soil and water conservation measures for the area, then identify proper monitoring and evaluation strategies for the area. And, how we can involve the local people to achieve integrated farming systems for the given watershed? So, this is, you can do it, it as an unsolved problem.

So, this is today's lecture. We discussed about the sustainable agriculture management practices and then its importance in watershed management. So, we will discuss further the various issues, as far as sustainable water management or sustainable watershed management issues are concerned in the next lecture.

Thank you.