Environmental Science

Introduction to Environmental Studies and Natural resources

Lecture 6

Modern Farming Technology

Now we'll move onto **Modern Farming Technology**:- Crop production and Management plays a very important role. If you look at the different Macro nutrients and Micro nutrients, you can see in a typical crop how it works. Oxygen, Carbon dioxide, Sunlight, and is the inputs that are required along with water. And the soil nutrients that go in are nitrogen, potassium and phosphorous. And then you have carbohydrates, proteins, vitamins and oils depending on the type of crop that it is. It could either be a sunflower plant, it could be lentils, it could be rice, wheat, whatever. So whatever the crop it's going to be, the basic input that goes in, is going to be the same. But the output could be varied products.

Manure is actually prepared by decomposition of animal excreta and plant waste. Manure increases soil fertility and its organic material improves soil structure. Based on biological materials used, manures can be classified as **Compost and Vermicompost**. You have **Green Manure** that is economically friendly as well as ecologically friendly. It's not harmful pesticides that is going to affect the quality of the soil.

The **pros and cons** or the **Differences between using Manure and Fertilizers** – Manures are prepared by the decomposition of animal excreta and plant waste. These are commercially produced plant nutrients. It is not nutrient specific. Fertilizers are nutrient specific. Now if you do a soil analysis for a particular agriculture land, you will realize what is the nitrogen content, what is the phosphorous content, all of that. So if suppose one is completely lacking you can get a fertilizer that is that particularly nutrient specific. Manure is bulky and difficult to transport. Fertilizers are in powder form and very easy to transport. Manures improve the soil structure. Fertilizers do not do that. Some cases they actually decompose or change the soil structure. It is not water soluble and hence takes time to be absorbed by the plants. Fertilizers are water soluble and that's how they are applied. It's in powder form, they are dissolved in water and it is applied to the soil or the plant and it is readily absorbed. Manures do not cause water pollution or any kind of pollution. Fertilizers cause water pollution and in the longer run they do cause soil pollution as well, because as a soil specific nutrient is added it could become excess after a certain point of time. And farmers usually do not tend to keep doing soil analysis. So say for example say you put a nitrogen specific fertilizer and then you keep adding it thinking that soil needs it , that soil needs it , it will saturate, over saturate and it will come poisonous to the soil and plants eventually. Manures are cheap and can be made at site by the farmer under his own control. It is costly. Another very important advantage of using the manure is that usually farmers also have cows to plough the fields and for their other ancillary activities. So the excreta of the cows instead of wasting it can be actually used for the farms and the fields. But this cow the excreta of cow, the plant waste, the compost anything that is there needs land to be decomposed in. That is a major disadvantage of manures. Now Fertilizers are manufactured in some spots and the entire land can be utilized for agriculture and farming. Versus when it is going to be manure, to actually have or produced manure for a particular say an acre of land you will need quite a bit of land to just store that manure. That could lead to a lot ,if it is

not done properly that is. If the manure is not stored properly or composted properly it could lead to a lot of diseases because of insect infestation, a lot of unhygienic sanitation activities happening nearby. Or even if there is a nearby water stream or something it could be leaching into that. So it has to be done properly. Versus fertilizers, even if it is done properly does pose certain disadvantages.

Moving **onto Irrigation**:- The supply of water to the crops is called irrigation. Water is necessary for proper growth of plants and it helps to increase crop yield. **Mixed Cropping** actually refers to growing two or more crops simultaneously on the same piece of land. So when this happens the nutrients of the soil gets automatically distributed. If you actually plant the same crop say throughout the entire acre, the crop, the soil is completely depleted of one particular resource. For example groundnuts need nitrogen specific soil because they need a lot of nitrogen to grow. So if an entire acre is going to be put with just groundnuts the nitrogen of the soil will completely get depleted for the next circulation of crops. So to avoid this from happening, you could circulate having groundnuts with say bananas or any other plant, that will make sure there is a balanced maintained with the nutrient level of the soil.

Intercropping; - Intercropping refers to growing two or more crops on the same piece of land in one particular definite pattern, like the image shows. One row of lettuce and one row of cabbage or whatever plant that needs to be grown in a particular pattern. This ensures a particular growth frame, also the type of sunlight that is required a particular pattern could emerge so all of these are dependent for inter cropping.

Crop Rotation is the growing of different crops on the same piece of land in a pre planned succession. So first you will have a legume that is beans , peas, lima beans, or potatoes. If you are going to have legumes in the first cycle, then you need to have roots. Root would be onions, garlic, turnips, beetroot, carrots, radishes. Then you will have fruits. Fruits are the usual tomatoes, cucumbers, peppers, eggplants, squash melons. Then from fruits you move onto leafy vegetables, like lettuces, greens, herbs, spinach, breccias and corns. So then you can go back to legume if required. So you need to have this rotation of crops to ensure your soil remains fertile and healthy.

So **what are the advantages of cropping patterns**?:- **Reduces risks and gives some insurance against failure of crop.** So say you have groundnut and banana. Groundnut gets infestation from one particular pests. At least you will get some amount of money from the banana. So and vice versa. **Ensures maximum utilization of the nutrients supplied: Prevents pests and diseases from spreading to all plants; In crop rotation, according to the availability of moisture and climate, crop can be selected after one harvest. It allows cultivation of two or more crops resulting in a good harvest.**

Food comes from three sources. You have **croplands** that provide nearly 76% of the total so that's basically grains. Then you have **range lands**. They produce meat mostly from grazing livestock. This accounts for only about 17% of our total food. **Fisherie**s gets the last 7%.

What are the impacts of overgrazing:- India leads in livestock population in the entire world. Huge population of livestock needs to be fed and the grazing lands or pastures areas definitely not adequate. Because of **Overgrazing soil erosion** happens, because the cover of vegetation gets completely removed from the land. So when cows and goats and all such creatures are left to graze, they don't have a

mentality OK I've eaten my share and that's it. Overgrazing happens because of continuous chewing the grass and they take the grass from the root which loosens the top soil. So when grasses are removed the soil becomes loose and susceptible to aviation of water and wind.

Land degradation:-Overgrazing leads to multiple actions resulting in loss of soil structure, hydraulic conductivity and soil fertility. So how does soil fertility get affected is there is humus content of the soil. That is the fertile part gets decreased. Overgrazing leads to organically poor, dry ,compacted soil. Overgrazing removes the vegetal cover of the soil and the exposed soil gets compacted due to which operate soil depth decline. Due to trampling by cattle the soil loses infiltration capacity, which reduces percolation of water into the soil and more water is left to go.

Organic recycling also declines in the eco system because not enough detritus or litter remains in the soil to be decomposed.

Loss of useful species. ;-Overgrazing adversely affects the composition of plant population and their regeneration capacity. When the livestock gaze upon them heavily even the root stock which carry the reserved food for regeneration gets destroyed. Example:- as a result of overgrazing vast areas in Arunachal Pradesh and Meghalaya they are getting invaded by thorny bushes, weeds etc. which actually have low fodder value. Thorny plants like Lantana, Xanthium etc**.**

Floods:- Soil erosion leads to floods. The soil cannot check the flow of rainwater that causes floods.

Reduction in plant diversity:- The cattle like to eat certain types of plants and leave the others which result in destruction of that particular type.

Now looking at the **impact of agriculture**;-Changes brought about by agriculture in the environment can be broadly divided as 3 classes. You have local changes, Regional Changes.

Local Changes:- are soil erosion, pollution at that particular area, poisoning of a fish in a particular pond, depletion of nutrients in that particular field.

Regional changes are a little more higher level where you have deforestation, desertification, soil infertility, and large pollution caused either in the water body or in the soil.

Global changes are world at large like global warming, climatic changes, change in the carbon and nitrogen cycle. All of these are changes caused in a global scale.

Effects of Modern Agriculture

Effects of Modern Agriculture impacts related due to high yielding varieties;-High yielding varieties cause a lot of problems, actually preferred in the shorter run because you get a better yield, more money and more population to feed. But what actually happens is, it encourages monoculture. That is the same geno type is grown over vast areas. So then if attack of pathogen leads to total devastation of a crop by disease due to uniform condition. This results to a greater spread of the disease.

Next is **water logging**;-in Punjab and Haryana extensive areas have become water logged, where adequate canal water supply or tube well water supply encouraged the farmers to use it over enthusiastically leading to water logging problem. That is what happens in many places. If you give them an inch they take a mile concept happens. They do not know where to stop. If something is abundance we have a tendency to utilize it, not thinking of the future or not thinking of let's keep it now let's use it at a later date.

Then **Salinity problem**:- At present 1/3rd of the total cultivable land is affected by different kinds of salts. In India about 7 million hectares of land are estimated to be salt affected which may be actually saline or sodic. Salinization of soil is caused by excessive irrigation and sodic soils have carbonate and bicarbonate of sodium and the pH level actually exceeds 8.

Fertilizers related Problems:- So you have a **micro nutrient imbalance**. We saw in the initial part of the lecture were you have certain kinds of macro nutrients and micro nutrients. So most of the chemical fertilizers used in modern agriculture have nitrogen, phosphorous, potassium which are essential macro nutrients. So if you use excess of these, there is obviously a micro nutrient balance. Excessive fertilizers have been used in Punjab and Haryana, which has caused a serious deficiency in the micro nutrient Zinc in the soil which is actually affecting the productivity of the soil.

Nitrate Pollution:- Nitrogenous fertilizers applied in the field often leach deep into the soil, contaminating the ground water. If it exceeds 25mg / litre, it causes 'Blue Baby Syndrome' which even leads to the death of an infant. Example- these cases have been recorded in India, France, Germany as well as Netherlands.

Eutrophication;- is a large proportion of nitrogen and phosphorous used in crop fields which is washed off along with runoff water which reach the water bodies causing over nourishment of lakes and this is called Eutrophication. Due to this excessive nutrients, the lakes actually get invaded by algae blooms and often produce toxins and badly affect the food chain.

Moving onto **Pesticide Related Problems**:-Although DDT and chemicals such as Sulphur, arsenic, etc. pesticides have gone a long way in protecting our crops from huge losses due to pests, yet they do have a lot of side effects.

No.1 they end up **creating resistance** in pests producing new pests. About 20 species of pests are known are now known which have become immune to all types of pesticides and these are referred to as 'Super Pests'.

Then you have **Biological Magnification**;-Many of the pesticides are non bio- degradable and keep on accumulating in the food chain, a process that is called Biological Magnification'. As human beings occupy a high tropic level in the food chain, that is we are up in the pyramid, they get pesticides in a bio-magnified form which is actually quite harmful.

Death of Non Target Organisms;-Many insecticides are broad spectrum poisons which not only kill the target species but also non target species which are actually quite useful to us .For example the

earthworm is considered the friend of a farmer. But certain pesticides actually kill the earth worms which results in compacting of the soil and other resulting issues. It can even affect certain birds which help in pollination. It can affect bees, it can effect even say the random cow or goats that could end up eating the fodder.

Renewable and Non-Renewable Resources

Now moving **onto Renewable and Non renewable Resources**:-What does **Energy** actually mean? Energy is the amount of force or power when applied that can move one object from one position to another. It also defines the capacity of a system to do work, it exists in everybody whether they are human beings or animals or even non living things. Energy is intermittently related to power. According to the law of conservation of energy, any form of energy can be converted to another form and the total energy will remain the same. For example- when you charge your mobile phone, the electrical energy is converted into chemical energy which then gets stored inside the battery for our consumption.

Now we look into the **relationship between energy and environment**;- Energy and the environment have a strong relationship. The production and consumption of energy is one of the biggest causes of environmental damage on earth. It leads to large amounts of destruction of natural landscapes and habitants through the process of fuel extraction, pollution of soil, climate change. Energy is in the heart of many of the world's current environmental problems and possess many problems for the sustainable development. If you actually look about energy can have many forms. You have kinetic, potential , light, sound, gravitational, elastic, electromagnetic, or nuclear. So you have basically two types of major classifications. You have renewable energy, something that can be reused again or can be re-brought back again. Non- renewable is once that it gets consumed; it gets transferred to another form it cannot be brought back to its original form. So the types of renewable energy you have are solar, bio-mass, wind, geo thermal and hydro power. And non renewable you have coal, natural gas, nuclear to a certain extent, and fossil fuel oil.

If you look at the **Conventional sources** you have, **Non Conventional sources**, otherwise referred to as how we can go about calling it as renewable or non renewable. If you look at non- conventional sources, you have solar energy, wind, tidal, geothermal, atomic, bio-gas. And conventional you have cattle dung cake, coal, firewood, petroleum, natural gas, Hydel and thermal energy. 70% of the energy requirement in rural India is met by firewood and cattle dung cakes. Continuation of the two is becoming difficult as forest area is decreasing and dung cakes are being discouraged as it consumes most valuable manure that is required for agriculture and plus it gets quite polluted as well, the air.

Renewable energy is energy which is generated from natural resources that is sun, wind, rain, tides and can be generated again and again as and when required. They are available in plenty and by far are the most cleanest sources of energy available on this planet. Renewable technologies are suited to large scale production, small off grid applications. Main forms of renewable energy will be discussing are wind energy, hydro energy, solar energy, bio-fuel, geothermal energy.

If you look at **wind energy or wind power**, air flows can be used to run wind turbines, areas where winds are stronger, more constant such as off shore, high altitude sites are preferred for wind farms.

Wind energy is believed to be 5 times total current global energy production or 40 times the current electricity demand. This could require large amounts of land to be used for wind turbines particularly in areas of higher wind resources. Off shore resources experience wind speeds of 90% or greater than of land. Wind power produces no green houses gases during operation and power is growing at the rate of 30 % annually with a worldwide installed capacity of 157,900 megawatts.

Moving onto **Hydro power**. : - Hydro electric energy is a termed usually reserved for large scale hydro electric dams. Micro hydro systems are hydro electric power installations that typically produce up to 100 KW of power. They are of usually used in water rich areas such as remote area power supply. Dam less hydro systems derive kinetic energy from rivers and oceans without using a dam. Ocean energy describes all the technologies to harness energy from the ocean and the sea. This includes marine current power, ocean thermal energy conversion, and tidal power.

Solar Energy is the energy derived from the sun through the form of solar radiation. Solar powered electrical generation relies on photo volatile cells and heat engines. A partial list of other solar applications include day lighting solar hot water systems, solar cooking, high temperature process, heat for industrial purposes. Solar technologies are broadly characterized as either passive solar or active solar depending on the way they capture, convert and distribute the energy from the sun. Active solar techniques include the use of photo volatile panels or cells and solar thermal collectors to harness this energy. Passive solar techniques include orienting a building to the sun, selecting materials which are favorable for thermal mass or light dispensing properties and designing spaces such that it naturally circulates air or light.

Bio-fuel;- Liquid bio-fuel is usually either bio-alcohol such as bio–ethanol or an oil such as bio-diesel. Bio-ethanol is an alcohol made mostly from sugar and starch crops. With advanced technology being developed celluloid bio-mass such as trees and grasses are also being used as feed stocks for ethanol production. Ethanol can be used as a fuel for vehicles in its purest form, but it is usually used as a gasoline additive to increase the octane and improve vehicle emissions. Bio-ethanol is widely used in United States and in Brazil. Bio-diesel is made from vegetable oils, animal fats, or recycled greases. Bio-diesel can be used as a fuel for vehicles in its purest form but it is usually used as a diesel additive, to reduce levels of particulates, carbon monoxide and hydro carbons from diesel powered vehicles. Bio-diesels is produced from oils or fats and is the most common bio-fuel in Europe. Bio-fuels provide for 1.8 of the world's transport fuel in 2008.

Advantages;-Wide availability; Lower running costs; Decentralized power production; Low pollution; Available for the foreseeable future.

Disadvantages of using these sources.:-**Unreliable supply**, for example if it is wind or even sun for that matter it could be really cloudy one day. So that day the energy you cannot say that you will get so many Kilo Watts that day .Wind again it's the same way. The wind that day need not be at one particular speed, so many Kilo metres per hour. Because of that again energy generated from the wind turbine could be less. It is **usually produced in small quantities, often very difficult to store, currently per unit**

cost of energy is more when compared to the other types. And that is because it is not being used widely. And once it is starts getting used widely I think the cost of production would also come down.

These are **Non Renewable Resources**;- a non- renewable resource is a natural resource that cannot be remade or re grown at a scale comparable to its consumption. You have nuclear, oil, coal, and natural gas.

Coal, petroleum and gas are considered non-renewable because they cannot be replenished in a short period of time. These are called fossil fuels. Natural resources such as coal, petroleum, oil and natural gas take 1000 of years to form naturally and cannot be replaced as fast as they are being consumed. Extraction of fuel is by mining, drilling and quarrying.

Coal:- India accounts for about 0.8 of the total geological reserves and 5.7% of the total proven reserves of coal in the world. The bulk of the coal produced is inferior grade, non-cooking coal used to meet the demands of the power sector.

How is coal made?:- Before the dinosaurs many giant plants died in the swamps. 100 million years, 300 million year ago that happened. 100 million years ago the plants were buried under the water and the dirt. So you had dead plants, dirt and different kinds of animals on top. Then heat and pressure has turned all these dead plants and animals into coal. So it has taken so many 1000 and 1000 of years for it to get made. The formation process again is a very slow process. It is under intense heat and pressure that peat comes to lignite. Lignite becomes bituminous coal or soft coal and then finally under a lot of heat and pressure again it becomes anthracite or the hard coal that we finally use.

The **disadvantage**s:- when coal is burnt it produces carbon di oxide that cause global warming. Since coal contains impurities like sulphur and nitrogen, it produces toxic gases while burning which causes acid rain and air pollution. Traces of mercury and radio active compounds are also released when coal is burnt. Severe human health threat especially lung related diseases.