

Episode -39

Climate Change & Global Warming

IMPACT ON SOIL SALINITY AND AGRICULTURE

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ANCHOR: Good morning listeners. Scientists revealed that during the twentieth century the earth's average temperature increased by about 10F, with half of that rise taking place during 1970 and 2000. The last few decades have seen the warmest summers in the Northern Hemisphere. In addition, globally the sea level has already risen considerably during the 20th century largely due to thermal expansion. All these symptoms indicate a warming trend, just as a high thermometer reading indicate that a patient has a fever. There is little doubt the earth is getting warmer triggering climate change. The sea level rise and precipitation changes will have impact on soil salinity and agricultural production leading to issues of water and food security in coastal areas. This episode deals with impact of climate change on soil salinity, vulnerability and mitigation.

CHARACTERS;

Chandrayya (50): Farmer

Vijay (34): Tahsildar

Simhadri (48): Farmer

Dr. Pavan (54) :Soil Scientist

Mutyalu (52):Farmer

Avani (35): Agriculture officer

SCENE-1

Chandrayya: Good evening friends. We are all small and marginal farmers. All our families are dependent on agriculture for livelihood. Today we all gathered here to discuss our common problems and to take collective decisions.

Simhadri: Chandrayya ji. Thank you for convening the meeting of the taluk rythu sangham. Many farmers and farm workers are present. Nobody is happy.

Chandrayya: I know the seriousness of the problem we are all facing. I talked to many farmers from various villages. Nobody is happy. Already they took huge loans from banks and also from private money lenders in the town.

Simhadri: It's true Chandrayya ji. Most of us are sunk neck-deep in debts. We all invested large amount on farming with the hope of getting good returns at least this year. All our hopes are shattered. Crop yield are being reduced year after year. We cannot continue agriculture any longer.

Mutyalu: What Simhadri anna said is correct. He explained our plight. I think it is foolish to invest in farming and incur losses. I used good quality seeds of rice and excess fertiliser this year but the yields are very poor. I am planning to give up agriculture and migrate to the town. I will search for at least a part time employment as a construction worker or a vegetable vendor.

Simhadri: You are right, Mutyalu bhayya. It is foolish to invest so much on seeds, fertiliser and pesticides. Even then there are no returns. It may be better to declare a crop holiday for a year and wait for proper investigations and adaptation strategies by experts.

Chandrayya: Oh! It is a serious problem. Crop holiday is not a good idea. Next week our Agriculture Minister is visiting our taluk. We shall meet him and submit a memorandum to bring all our problems to the notice of the government. I think you all agree to my proposal.

Simhadri: It's a good idea, Chandrayya Ji. Some of us from various villages will go and meet the minister. We shall tell him that the crops withered and soil lost its fertility.

All farmers: Ok sir. Our minister understands our problems. . He will certainly help us.

Chandrayya: Thank you

(SCENE ENDS)

SCENE -2

Village Panchayat Office. Chandrayya, sarpanch; simhadri, Mutyalu and some others present.

Simhadri: Good morning Chandrayya Ji. Our friends are also here. You asked us to meet you at the panchayat office today. Any important news?

Chandrayya: yes. Simhadri garu.. This is important information for all farmers in our Taluk. You know, we submitted a memorandum to our Agriculture Minister four days back.

Simhadri(anxiously): Any action taken?

Mutyalu: Our Minister knows the problems of farmers. He is kind and helpful.

Chandrayya: Yes. You are right. Our Minister responded positively. He instructed the officials of the agriculture department to study our problems and submit a detailed report to the government within a week for suitable action to help us

Mutyalu: What is the department doing?

Chandrayya: Yesterday, our Tahsildar sent a message to me. The agriculture officer, Avani is coming with two lab assistants. They will collect soil samples from our fields and send for testing. They will collect soil samples from neighbouring villages also.

Simhadri: It's good. We must find out why we are getting low yields despite using good quality seeds and high quantities of fertilisers. We should ask them to test the irrigation water also.

Chandrayya: Oh yes. They said they would collect water samples also. Let us cooperate with them.

Mutyalu: Oh, certainly. All our farmers will cooperate. It's all for our good.

Simhadri: We should learn how to collect soil sample to be sent for testing in future also.

Chandrayya: It's a good idea. I will ask the Agriculture Officer, Avani garu, to demonstrate the procedure for sample collection.

(Sounds of a jeep approaching)

Chandrayya: Welcome Avani madam. Our farmers are waiting to receive you.

Avani: It's alright. We shall collect soil samples and water samples. Let's move.

Chandrayya: We are already madam. We shall take a cup of coffee and move.

SCENE ENDS

SCENE-3

Mike announcement: Farmers' meeting will be held today evening at the panchayat office to discuss agricultural issues and related problems of farmers. Agriculture scientists and government officials will attend and give important suggestions. All farmers are requested to attend.

Simhadri: Hi Mutyalu bhai. I am a bit late. Has the meeting started?

Mutyalu: I also came just 5 minutes back. The meeting has not yet started. All our friends are in the meeting hall. Look.. Our Tahsildar and others are also coming. Let us go inside.

Simhadri: Ok. Let's go.

Chandrayya: Good morning everybody. We brought the problems of our farmers to the notice of our Minister. He responded immediately and ordered detailed study of the problems. Agriculture department collected samples of Soil and irrigation water in our area for testing. The test reports are with them. Today we have with us our Tahsildar, Vijay Ji, Agriculture officer, Avani madam and Agriculture scientist, Dr Pavan . They will discuss with us and give some suggestions to overcome our problems.

Tahsildar: Good morning friends. Farmers are the backbone of our society. We know that agriculture is the major occupation of the people here. But you are all in distress as you are incurring losses. We must know the reasons and find solutions. Government stands by you.

Avani: Dear friends. As you know, we collected soil and irrigation water samples from your area. The lab reports show that the salinity levels of the soil and the water have increased. This is the main reason for crop failure. Dr Pavan is a soil scientist. He will explain the importance of soil and the reasons why the salinity increased in this area. He will also give some suggestions.

- Dr Pavan:** Good morning friends. You are all farmers. It is necessary to have awareness about soil health and steps to make agriculture sustainable.
- Mutyalu:** Yes sir. Healthy soil is very important for crops. Please tell us a few things about it.
- Dr Pavan:** Many of us think of soil as simply dirt. But soil is actually a complex ancient material teeming with living organisms. It is often said that a handful of soil has more living organisms than there are people on planet earth! Soils are the stomach of the earth, consuming, digesting and cycling nutrients and organisms.
- Simhadri:** There are earthworms in the soil. Are there any more living organisms sir?
- Dr Pavan:** Simhadri ji, the living organisms include spiders, insects, ants, bacteria etc.
- Mutyalu:** There is non-living matter also in soil .Isn't it sir?
- Dr Pavan:** Yes.About one half of the volume of soil is made up of mineral material and organic matter. Humus is an important part of soil. It contains much of what plants need to grow. It is made up of remains of plants and animals that once lived. Top soil contains most humus. The pores in soil are filled with air or water.
- Avani:** Plants take up essential elements from the soil through their roots and from the air (mainly consisting of nitrogen and oxygen) through their leaves .Nutrient uptake in the soil is achieved by cation exchange.
- Mutyalu:** Plants require water. How do they get it, madam?
- Avani:** water is made available to plants by gradients arising from capillary and gravitational forces. It is the important medium for transporting essential plant nutrients from soil particles into plant roots and then into the farther tips of the plant leaf structure.
- Dr Pavan:** Mutyalu ji. Soil has changed a lot in these areas. Don't you notice any change in its physical appearance?
- Mutyalu:** Yes sir. Soil colour has somewhat changed. It appears white at many places in my field and neighbouring areas.
- Simhadri:** Soil in my field has become light brown in colour.
- Avani:** Our lab reports show that the electrical conductivity of the soil extracts and alkalinity (PH value) have increased. Irrigation water is also salt-affected.
- Dr Pavan:** All these reports confirm that the soil salinity increased alarmingly. That's why your crops are failing.

Chandrayya: Sir, Most of us in this area are cultivating rice for the past several decades. But in recent years the crop yields are very low. Now the lab reports show that the soil and water have become saline. Why is it like this?

Simhadri: Sir, is it a problem with the seeds we are using?

Dr Pavan: No Simhadri bhai. It is all due to global warming and climate change. The impact is more in coastal areas like yours. We shall discuss all these things briefly.

Mutyalu: Sir, we are all cultivating rice. In our neighbouring village some farmers are growing rapeseed, cabbage etc. The yields are good.

Simhadri: Despite irrigation, the plant growth is very poor and the crop is withering. The yield is almost nil.

Dr Pavan: These are all characteristics of saline soils. Some crops like rice are not salt-tolerant (glycophytes). However some crops like rapeseed and cabbage are salt-tolerant (halophytes).

Chandrayya: Sir, you said the problem is due to climate change. Please explain.

Dr Pavan: Ok Chandrayya garu. Our climate is changing because the earth is warming. This is due to the alarming increase of levels of heat-trapping gases, mainly carbon dioxide, in the atmosphere by our actions. These gases have warmed the surface and the lower atmosphere of our planet during the last 50 years. The trend is continuing.

Chandrayya: Climate change is real sir. We have been facing droughts repeatedly. There are severe cyclones also in recent times.

Simhadri: Droughts in some areas but heavy rains and floods in some other areas.

Mutyalu: It's true. Heavy rains and unprecedented floods have wreaked havoc in Kerala state.

Avani: What you all said is correct. Green house gases are also changing the world's oceans and ice cover. Warming causes snow to melt. Even the great ice sheets on Greenland and Antarctica are shrinking. Owing to thermal expansion and melting of ice the sea levels are rising along the coasts.

Chandrayya: How is all this affecting soil salinity?

Dr Pavan: I will tell you, Chandrayya Ji. Soil salinity is increasingly contributing to land degradation worldwide.

Simhadri: What is soil salinity? Is it only due to accumulation of common salt?

Dr Pavan: No. Many people think like that. But it is not correct. Salinity refers to total salt content. It is a combination of sodium, calcium, potassium, magnesium, chlorides, nitrates, sulphates, bicarbonates and carbonates. Salinization is the

process of increasing the concentration of total dissolved salts in soil, ground water and surface water.

Mutyalu: What is the origin of these salts, sir?

Dr Pavan: These salts often originate from the earth's crust. They also result from weathering and sea water intrusion. You know, sea water contains several dissolved salts. So, the salinity is very high.

Avani: Climate change is causing sea level rise and precipitation changes in coastal areas. These are having impact on soil salinization and agricultural production as seen in this area and several other areas in our country and elsewhere like the coastal regions of Bangladesh.

Dr Pavan: Climate change will impact directly and indirectly on a wide range of soil processes and properties.

Chandrayya: How does it happen, sir?

Dr Pavan: There are several things involved. I will tell you all a few points briefly. Madam Avani and the Tahsildar will add a few more points related to our local conditions.

Tahsildar: some posters on climate change are outside the meeting hall. You can see and learn many more details

Chandrayya: Ok sir. We will now break for tea and assemble again in ten minutes. (Scene Ends)

SCENE-4

Chandrayya: Let us continue our discussion.

Dr Pavan: Primary source of salts in soil is from rock weathering, a process that breaks rocks into smaller particles. In arid regions less rainfall available to leach the salts and high rate of evaporation causes concentration of salts in soil at various layers. In coastal areas inundation of sea water adds salts to soil.

Simhadri: Are there other reasons for salt build up in soils, sir?

Dr Pavan: Yes, Simhadri garu. Irrigation with water high in salts, poor drainage allowing too much evaporation from the soil surface, very little of the salt in the soil leached out and shallow water table are the other reasons for salt build up in soils.

Avani: Irrigation water containing high concentration of soluble salts, particularly sodium salts, leads to salinity of soils. Drainage restrictions reduce permeability of soils. Salt-affected soils are usually found in arid or semi-arid regions when salts often accumulate because there is not enough rainfall to dissolve them and leach them out of the root zone.

Mutyalu: Are saline soils the same everywhere, Madam?

Avani: No. Some soils are slightly saline. Yields of sensitive crops may be restricted. Some are moderately saline as seen in your area. Yield of many crops are restricted. Some other soils are strongly saline. Only tolerant crop yields are satisfactory.

Dr Pavan: Let us see in our country. On the basis of their characteristics saline soils are categorised into different types.

Chandrayya: Madam, I can name two. Saline soil, coastal saline soil....

Avani: Yes. There are some more. They are saline-sodic, sodic and acid- sulphate soils.

Chandrayya: How are they different, madam?

Avani: Saline soil has white or greyish appearance. Texture is sandy or sandy-loam. Soil conductivity is greater than for normal soil. The principal salts are chlorides and sulphates of sodium, calcium and magnesium. Concentration of calcium and magnesium salts is high compared to sodium salts. Small quantity of bicarbonates is also present. Saline sodic soils are similar to saline soils except that they have higher concentration of sodium salts than calcium and magnesium salts.

Simhadri: What are coastal saline soils, madam?

Avani: Coastal saline soils are found in deltaic regions of major rivers in the east and west coasts. Both ground water and the soil are rich in chlorides and sulphates of sodium, calcium and magnesium.

Mutyalu: Madam, What are sodic and acid sulphate soils?

Dr Pavan: Sodic soils occur in relatively low lying areas with lack of drainage. There is high concentration of sodium salts. The soil is tight and has low permeability to air, rain and irrigation water. Plants will not get enough oxygen and water to grow. Acid sulphate soils develop due to leaching of soils containing high amounts of sulphate minerals. The top soil is very acidic.

Dr Pavan: Soil water contents respond rapidly to variability in the amounts and distribution of precipitation or the addition of irrigation. Temperature changes affect soil water by influencing evapo-transpiration. You know carbon dioxide levels in the air are increasing enormously. Plant water use is further influenced by elevated carbon dioxide concentrations.

Simhadri: Sir, I know that plants use carbon dioxide for photosynthesis. Is it not good for plants if carbon dioxide levels increase?

Dr Pavan: It is a good question, Simhadri ji.

No doubt photosynthesis rate increases. Plant growth and yield of most crops such as cereals increase in a CO₂enriched atmosphere. The realisation of the beneficial effects of the gas in the field is uncertain due to interactions with

temperature, nutrients, water, salinity and other stresses. soil nutrients will be rapidly depleted. Soil fertility decreases. Consequently positive impacts of increased photosynthesis rate will not persist.

Chandrayya: How does salinity affect photosynthesis, sir?

Dr pavan: Salinity in plants can have a huge effect on the rate of photosynthesis. Because the salt absorbs water, a large amount of salt can dry out plants and brings down photosynthesis rapidly or even make photosynthesis cease totally. If too much salt gets into the plant then the stomata may close up. They will not allow carbon dioxide in or out.

Avani: Soil organisms will be affected by elevated atmospheric carbon dioxide concentrations. This changes litter supply to fine roots in the soil as well as changes in soil moisture.

Dr Pavan: Climate change will modify soil structure also. Soils with large clay contents shrink as they dry and swell when they become wet again forming large cracks and fissures.

Avani: Crack formation results in more rapid and direct movement of water and solutes from surface soil to permeable substrate or drainage installations through bypass flow. This will decrease the filtering function of soil and increase the nutrient losses and water pollution.

Dr Pavan: Soil salinity is an important land degradation problem. Crops are very badly affected by the amount of salts.

Mutyalu: How are the crops affected, sir?

Dr Pavan: If the soil has salinity, seeds will germinate poorly and plants will grow slowly. If the salinity is high enough, the plant will wilt and die, no matter how much you water it.

Mutyalu: Why do the plants wilt when there is water around?

Dr Pavan: Crops will wilt as they can't take up water from soil.

Mutyalu: What is the reason, sir?

Dr Pavan : The plant roots contain varying amounts of salts that create a natural flow of water from soil into the plant roots (by osmosis). As the level of salinity in the soil nears that of the roots, water becomes less and less available to enter the root. In fact when the soil levels are high enough, the water in the roots is pulled back into the soil. Plants will then wilt and die.

Mutyalu: Sir, please give an example.

Dr Pavan; Sure. Take a carrot and put it in salt water. Observe what happens. The salt water will draw water from inside the carrot. Within a few hours the carrot will be limp.

- Mutyalu:** Ok sir. Now I understand.
- Avani:** Salinity can increase nitrogen leaching from soil and reduces crop yield.
- Mutyalu:** Our ground water salinity is also increasing.
- Avani:** Yes. Lab tests of ground water samples at shallow depth also confirmed it. Shallow water containing salts may move upward into the root zone by capillary action similar to the way a lamp wick works. Here evaporation serves as the suction of water up through the soil.
- Chandrayya:** So, saline water also causes soil salinization and soil degradation.
- Avani:** Ye. Shallow saline ground water allows salt accumulation near root zone and causes poor root aeration affecting germination of crops.
- Mutyalu:** Madam, you have collected drinking water samples also for testing.
- Avani:** Yes. The salinity is higher than the maximum permissible limits.
- Mutyalu:** Why is this happening?
- Avani:** This is due to sea level rise induced salinity intrusion into coastal rivers and aquifers.
- Vijay:** Increase of salinity in drinking water means increase in daily salt intake. This will lead to health problems such as high blood pressure. That's why we are arranging to supply safe drinking water through tankers to the salinity-affected coastal villages.
- Chandrayya:** Thank you, Tahsildar garu.
- Dr Pavan:** We must also understand that water and food security are the key challenges under climate change as both are vulnerable to continuously changing climatic conditions. So, we should think about sustainable agriculture even in salt affected soils.
- Chandrayya:** Sir, we seek your suggestions for reclamation of salt affected soils.
- Dr Pavan:** Chandrayya ji, you raised a very important issue. There are some integrated management practices including biological, hydraulic, chemical and physical/mechanical methods for reclamation of salt-affected soils.
- Simhadri:** Please explain briefly sir.
- Dr Pavan :** ok. Biological practices include organic matter application, mulching, green-manuring and tree plantation. Hydraulic practices include flushing, leaching, improving irrigation/drainage and safe disposal of saline waters.
- Mutyalu:** Ok sir. What are the other practices?

Dr Pavan: Chemical practices include application of amendments, soil conditioning and mineral fertilisers. The physical /mechanical practices are scraping, land levelling, sub-soiling, sanding and improving plantation techniques.

Chandrayya: Our farmers want more information on these processes, sir.

Dr Pavan: Ok. But I will tell you briefly. In soils with poor drainage, deep tillage can be used to break up the soil. This helps water move downward through the soil. Leaching can be used to reduce the salts in saline soils. We have to add enough water to the soil surface to dissolve the salts and move them below the root zone .Applying mulch to the soil will reduce evaporation rates.

Simhadri: What about chemical treatments, sir?

Dr Pavan: Before leaching saline-sodic and sodic soils, we must first treat them with chemicals to reduce the exchangeable sodium content. We can add calcium in soluble form like gypsum .After the calcium treatment sodium can be leached through the soil along with other soluble salts

Avani: Saline soils are the easiest for reclamation but it is more difficult for sodic soils. We will help you to choose the processes suitable to our area.

Mutyalu: Thank you, madam

Dr Pavan: The soil here is moderately saline. You can think of reclamation or go for salt-tolerant crops.

Simhadri: Please suggest a few such crops.

Avani: I will tell you all. Corn, cabbage, cauliflower, cucumber, pepper, potato, tomato, pumpkin, radish and spinach are only moderately sensitive to salinity. Yellow mustard and beet are moderately tolerant.

Avani: Our field officers will visit your farms and give more suggestions.

Chandrayya: Thank you, madam.

Simhadri: We are all thankful to Dr Pavan Ji. He gave us lot of information about saline soils and also good suggestions for soil reclamation.

Chandrayya: We also thank our tahsildar, Vijay garu for helping our farmers . We request the government to reschedule agriculture loans and arrange fresh loans.(SCENE ENDS).

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