Remote Sensing and GIS for Rural Development
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Week 1
Lecture 03
Food Security and Issues

Hello everyone. Welcome to NPTEL course on remote sensing and GIS for rural development. This is week 1, lecture 3. As indicated earlier, this week is mostly for you to get introduced to the topic and to understand why do we need to contribute to rural development, what are the issues in rural development and what are the reasons for these issues. We will also focus on tools that are available to lessen these issues or provide solutions to the problems and more importantly, what other open source systems. By definition, open source includes free software, free data are open to public tools. So, let us go ahead with the lecture 3 today.

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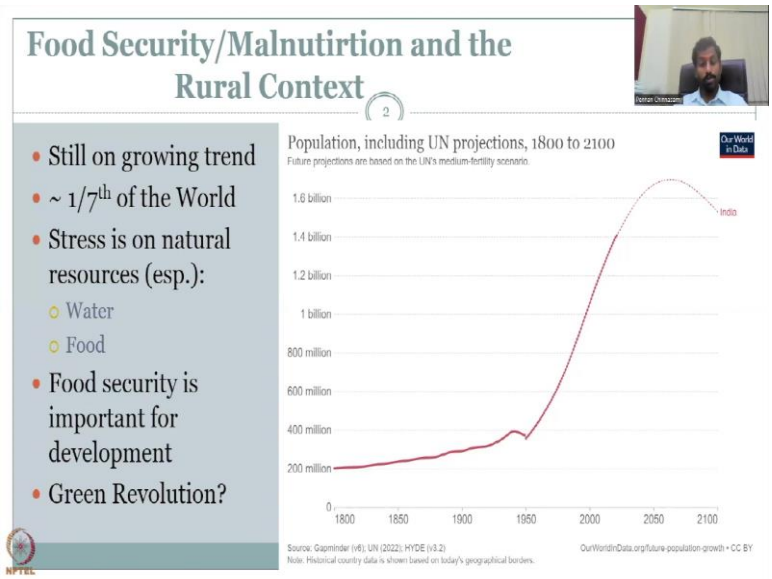

In the last lectures, we looked at the water security and how it is tie to rural development. Another thing which is very very important is food security, malnutrition in rural context. Food Security does not only mean that are we producing enough food, but is it also going to the vulnerable people. And in this case, the most vulnerable are the rural population. Sometimes it is sad to understand that those who produce the food cannot afford to consume it. We will go through the reasons on how and why and what can be done in this context. So, start with while we discuss this important topic today, as per the news that came up today, the world has at 8 billion population and the projections are not that good also.

The hope is we will be peaking by 2060. You can see here the peak is still rising. So, we are on the rising land of the population. And due to many many schemes and information education training, the publishing curve is expected to come down after 2060 and then India's population will come down hopefully. We should understand that the population has increased not only because of our past activities in having more children, but also it has been due to advancements in science and technology that has saved many lives. So, the death rate has come down, the population is still increasing. So, there is an ongoing trend and we cannot expect sudden tapering off or sudden peaking and then coming down like the COVID cases we saw last two years. It will be slowly growing and then slowly going down.

So, for this approximately we are one seventh of the world India's population and 70 percent of the population lives in rural entities. So, leave the population that is at the rural entities. For all this 1.4 billion as per this data 1.4 billion, 1.7 billion people in India the phone mostly comes from within India. We do import food produce but it is not that much. Still the major staple as in rice, meat, pulses, cereals, oil, all these come from local entities. Some of the oil like sunflower and palm oil does come from outside, but mostly we do produce our coconut oil and et cetera, sesame oil and mustard oil.

So, to cater for the entire population there is tremendous stress on rural entities and this stress comes in two major resources which is water and the soil fertility et cetera that contribute to the food production. So, the natural resources as water has been highly stressed, which we saw in the previous lecture. In today's lecture, all these population increase and the slowing or lessening of the soil fertility and water resources is contributing to lesser food production or yield as we call crop yield from the ground. And this impacts food security so, food security is important for development.

At the end of the day, we all need food. Development happens or not, you are in a high developed country or in a poor country we need food. So, the only common denominator here is food may not be a luxury food but it at least say it should be the staple food as rice or itself of something. So, we have to produce food and that is why food security is very important. So, please understand that rural development should incorporate food security. But also for the nation's development we do need food secretary, if suppose we just develop industry produce more cars, computers, cell phones and the food security is not attained then we will have to go and ask food from other countries wherein we will have to be dependent on other countries for the basic means.

So, food is always the basic needs food, water, clothing, air quality, et cetera. So, it is important to understand that even though our development is peaking, which is healthy, your GDP is rising, we need to make it sustainable, but by also considering the food security and the food security comes from rural entities. So, we need to develop rural economies to support the Food Security Act.

Another widespread thing is the malnutrition which means people get food but is it nutritious. In those days, we had chicken and eggs coming from the local breeds. But now we do have other breeds. So, quick fast, growing chickens, more eggs produced et cetera. So, if you compare the nutritious value of both these produce, you will see that the local variety and the native species would have highly nutritious content compared to the broiler or poultry industry chicken.

However, this takes a long time to produce the desi chicken we call or the native species whereas the poultry chicken is quick which is better for the Food Security Act. In those days just compare this, this was small comparison for those who eat non veg in those days I am talking about like 20 years ago, or even 30 years ago. The food we eat the non veg or because non veg consumes a lot of effort and water and other resources. That is why I am picking on these aspects. Those we would have only once a week or once during the festival seasons. But now, due to the demand and the affordability because we do have high GDP compared to the previous 30 years, we are buying and the demand is high. So, we have industry produced.

So, food security is important however, is the food given at nutritious level is also important. Otherwise we will be spending more money on health issues. So, the Green Revolution was big part as you would have known because the population was increasing. Before the Green Revolution, we used to import a lot of food.

There was lot of starvation, rationing of food, but nowadays we do not see that much because of thanks to Green Revolution. The way Green Revolution expanded there is lot of debate. Is it sustainable or not? We will not get into that. We only concentrate on how it impacted the food security because once you understand that concept, you would also understand that for rural development, Green Revolution is important. However, it has to also be sustainable.

And for that, there are lot of indicators that we can attach to Green Revolution and this increase in food productivity. And that can come from your remote sensing and GIS, this is how we tie it up, because there is no data. So, for example, I need to go 20 years ago, 30

years ago, and look at the soil fertility, the water availability, there is no data observation data. But if you use remote sensing and GIS, yes, you can go back for at least 40, 50 years, some level of accuracy is there.

Right now the accuracy level is very high. But if you go for 50 years ago, and use remote sensing and GIS imagery to understand the water resources for rural development, or soil and food security, the accuracy level is low. But still you get the best vision, you get the best data available, because observation data was not there.

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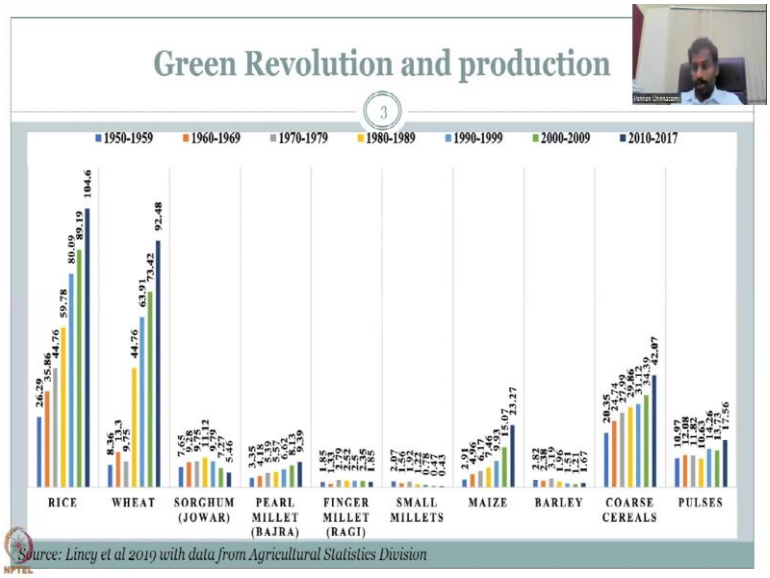

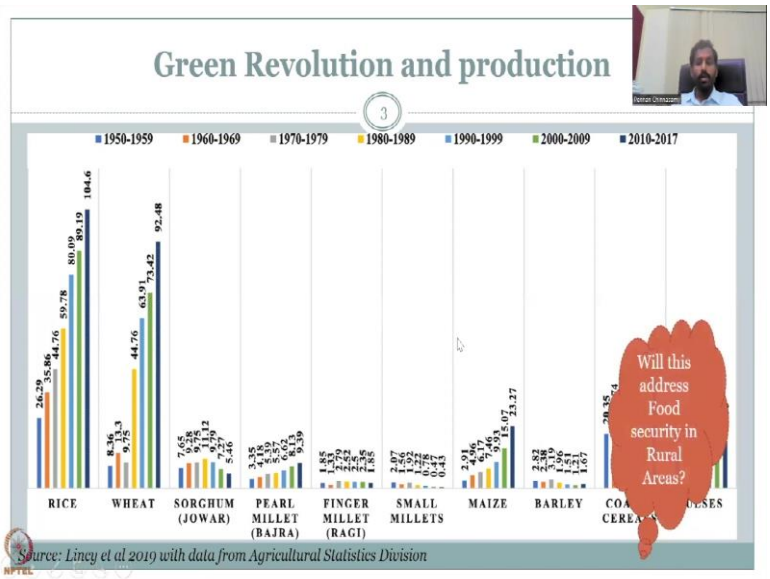

So, let us look at Green Revolution and production. This is for food security, please put on a lens that looks at this data as what has it done for food security. But also growing these require lot of natural resources, which may impact rural development. For example, if you

take so much water out, then you do not have that good quality water for drinking or for industrial purposes as for sanitation. And this has been a cause in big urban cities also you would have noticed. So, let us look at the Green Revolution production, what has happened. And also you will understand the nutritious value right now.

So, you could see rise in 1950s, we were already 6.29 but then it increased almost four times by your 2010 - 2017. This is highly unsustainable if you can go four times in as much as 60 years. Because rice and wheat requires a lot of water and soil fertility. It does not put back soil fertility like other crops I am going to talk about. So, the traditional crops as sorghum, pearl millet, finger millet, small millets, maize, corn, barley, all these traditional food it consumed less water, less fertility, and more important, it also helped in fixing certain kinds of nutrients in the soil. So, when I said go back 50 years, so you would have seen that 50 years ago, using satellites and GIS data, the rice cultivation was less, wheat was less compared to now.

And the millets was really really low compared to the other crops. And those regions would had good amount of water and good amount of soil fertility, which contributed to rural development. But that is not the case now. So, let us look at it. Rice has increased four times. Whereas your wheat has increased 10 times in 50 years. Just look at how it is just rising. And if you take the data now, which is 4, 5 years from the last data in this study, you will see that still more crops in these two categories have been growing.

On the other hand, you would see sorghum coming down jowar and your bajra and ragi, your pearl millet and finger millet which are claimed to be very, very good for diabetics, cholesterol, hypertension, et cetera. So, those have actually come down except bajra. The others have come down. The point is even though Green Revolution helped, what a Green Revolution bring, a lot of technology, fertilizers, pesticides, groundwater pumps to enhance the yield and to increase the intensity of crops. I will have another slide to talk about that. But here what you could see that even though the technology came in the Green Revolution time 1960s I would say. It did not impact more on the low cost or low impacted crops which is the millet sorghum maize barley.

It was mostly used for the high cash crops rice, wheat, sugarcane, even cereals and pulses, but mostly rice and wheat. Wheat we used to import a lot. Now we are exporting, you would have looked at the news and all. So, the point here is yes Green Revolution helped to increase your crops yield production et cetera. But also it has damaged a lot on the fertility and the

water availability. And these may not be the most nutritious food, because nutritious food did not grow as much. It compare the nutrition values you can see that it has compared. And when something grows very fast and using different techniques, the nutrition value is different compared to traditional, always a traditional that is why organic is that.

Organic food has a lot of traditional nutrition value. And traditionally, it has been grown as in with what we compost opposed to fertilizers, chemical fertilizers and with good water resources. So, these crops have been tremendously increased due to Green Revolution. And now people consume a lot and have access to food but are they eating the correct food? So, that is a different angle. But since this course is going to be looking at food security, which is are you getting food the first step, then the nutritious value. So first, you need food to live and then healthy food to be nutritious and then you go down a level.

So, let us look at the food security. Yes, we have better food security compared to the last 40 - 50 years, thanks to Green Revolution. And to keep this sustainable and to develop rural economies, we need to be cautious about it. We should also look at has these actually impacted rural development as in has the farmers become more economically stable or socially stable is a question. So, there are lot of aspects and that is where I am going to come into the picture of wastage and how much wastage we do.

Then we will look at the issues and concerns. So, has this address food security in rural areas? Almost yes, because the access to food has increased. Rice and wheat has been the most stable food and now people have access to it. However, there are some issues and concerns. Let us look at them.

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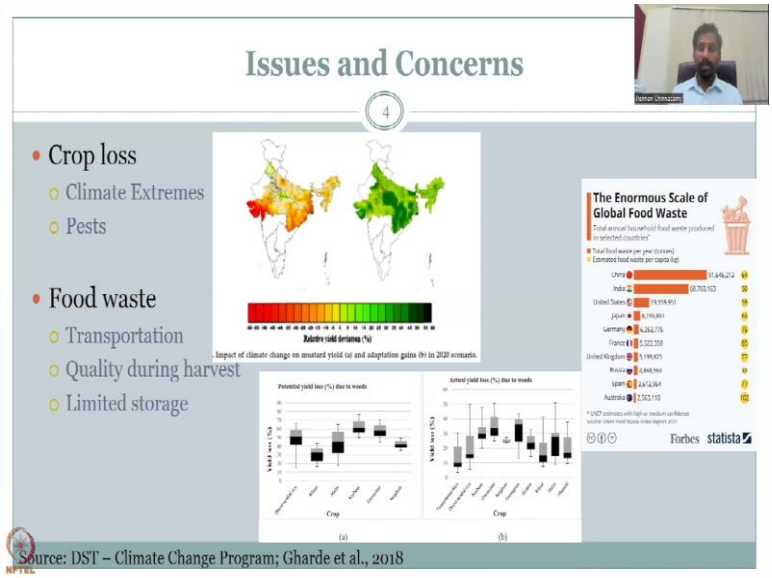

The first major issue is crop loss. The crop loss is defined as you are growing a crop and before it is time to harvest you lose the crop. And the most important factor that drives these is climate extremes. What do you mean by climate extremes is tremendous floods, too much water because it just washes away the crops or the flood water stagnates the on top of the soil and suffocates the roots because the roots need also air to breathe, but then if water is totally inside the roots, it suffocates and dies. You should not let the roots rot in water, but that happens during floods. So, that is one climate extreme.

The other climate extreme is too less water which is drought. So, if you have a tremendous long spell of summer time, you will see nowadays like lot of heat records broken, the summer is expanding and all the soil water has evaporated or lost in the groundwater pumping. In those times, what happens is the crop is lost. The crop starts to grow healthy, but because of the intense heat too much temperature air temperature and less soil water availability you lose the crop. So, the crop loss is driven by climate extremes, one of which it is too floods and droughts. You could see here in this study, that impact of climate change on master yield, just one yield one crop yield and adaptation gains in 2020 scenario.

So, what they have done is you could see that if you look at the master yield, the standard deviation or the relative yield deviation, you could see that most of it is the red which means the cause of climate, the yield is reducing, the crop is lost. Yield reduction can also happen by the crop can grow but the produce does not come as big. So, for example, if you are growing a coconut tree or let us say mango tree and each mango is 200 grammes. A yield reduction

can be the total tree is lost or the mango is only 30 grammes, smaller in size, no flesh and that is lost in the yield.

So, coming back the first image which is a shows that there is tremendous loss in crop yield across the mustard species, only some areas they have positive because the climate change also has positive side effects in a very small small places, but most of India is negative impact. You can see all of it is red or orange, which is below zero or zero and only some parts are getting more water because of climate change impacts and those are the green. So, the net is we are losing mustard due to climate impact.

But if you do adaptation, so, climate adaptation plans which is part of the rural development programme, which I explained about MGNREGA, IWMP in the previous lectures, if you do that, then yes, there is potential to lessen the climate impact due to adaptation and then the produce is increased or yield is increased and you will see the positives most of India's in the positives. This could be water sharing, soil and water conservation activities, better crop varieties, hybrids et cetera or pest management. So, that is one.

The next is pest. Pest is a tremendous reducer of crop yield and crop productivity. If you look at this study, you could see that mostly, the potential yield is approximately 60 percent for wheat, maize, soybean, groundnut and sorghum. So, 60 percent of the yield. So, let us say one acre you are planting more than 50 percent of the area is lost.

So, think about the water consumption for the loss, the time labour consumption, loss and all the natural resources, the soil fertility, et cetera, et cetera, because the crop will grow but the produce will not come. So, the crop is still taking the soil fertility, not only the seeds, which is the wheat and rice that we consume, but also the shoots, the plant itself consumes a lot of energy and for the nutrition from the soil. So, that is a potential loss due to weeds and pest.

Weeds are different crops that grow in between and most of them are also impacted less impacted by pest. Pest are insects that eat on the crops and stuff. So, that reduction in yield is there. And then the actual yield is the potential is the maximum the actual yield is around 30 to 40 percent from this data. The other biggest concern that we have is food waste or crop waste. So, now the farmer has sweated 50 percent loss in the land, but still they grow something, put it in your transportation containers or sack bags, and then they send it to the city or the industries to process. But on the way transportation is bad. The roads are not well connected. So, some crops yield is lost.

Let us say you are having eggs, and the transportation is very bad. So, you do lose some eggs. Let us think about fruits on the way because the roads are not good, the connectivity is not good, you have lost in the fruit produce. So, you could see that the fruit that is really squished and not as good as the when you harvested. Those sell for very less price on the street markets. Whereas the fruit which is covered in paper and plastic bags and thermocol, those are in high level shops. So, those do not cater back to the farmer because the in between there is a medium, there is a broker that works for this transportation and they take all the benefits.

So, for the farmer, it is still a loss, because all the food is not consumed at the market. There is a big loss. Then there is quality during harvest, food wasted during harvest. So, the quality of the food that you take produce rice and wheat that you harvest is not the same as it ends up because there is lot of loss in the transportation the processing of the food. Limited storage, this is a big, big concern. You put all this green revolution, the techniques and models and you have made this harvest. However, if you do not have a storage, then you lose the harvest.

Think about this, you are going to a market. You buy 20 kilos of fruits, vegetables, et cetera. And then you bring it to your fridge. However, in your fridge, you only have 10 kilogrammes space. So, you stuffed everything, but you leave the rest 10 kilogrammes outside. If you do not consume it fast, the 10 kilogrammes is lost. So, that is what actually happens in a big scale when you talk about storage. So, there are new rules and laws being drafted by the government to help build more storage structures and better energy consuming storage structures to help farmers, where do you place them, where is the need comes from remote sensing and GIS.

We will look into that in the specific food sector. And we also are losing a lot of food at a household level. So, you bring all the food, and then you save it, the farmer has sweated, rural economy has worked very hard to bring the food to your table. But then still, there is a lot of food. So, through this lecture, I also wanted to put a fact that India is the second highest food waste around the world. When people are starving for food, when people do not have access to food, it is very, very important to save food. So, please do not waste food. And think about rural development how people have worked very hard to bring this food to your table. So, let us try to bring this chart down.

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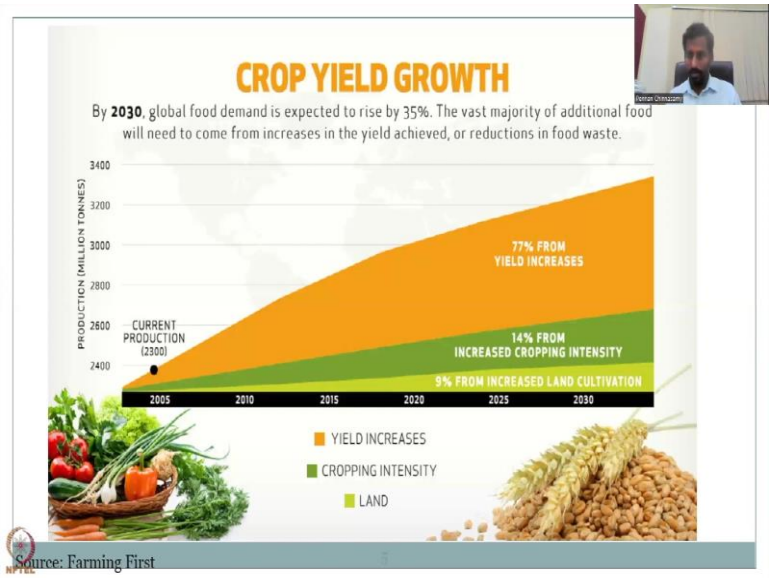

So, while we discuss this, the point the driving point is crop yield growth is needed to supply food security for the growing population. And for that, we need to have raise the food production by 35 percent. So, global food demand is expected to go 35 percent up, so you have to match that 35 percent by increasing the crop production. So, what has happened from 2005 from this study till date is that the land is limited, you are not going to build new land and then put crops on it and grow that the land is still the same. So, you can convert like some barren land some science and technology interventions, water that comes or aquaponics or use coconut fibers or wastage from fish farms to grow some crops. So, that is very limited. Only 9 percent you can increase.

So, let us say 35 percent, you have to increase, so let us break it into 100. And then 9 percent of that can come from increased land cultivation, there are some people who would, some countries if you see have cleared for us and then put crops in it, especially South America, but that we are not talking about. We are talking about using science and technology and increase land cultivation, very minimum, but the majority will still come from yield increase which means you are having the land, the land was giving 100 kilos. Now you are going to convert it to give 200, 300 kilos of crop that is called yield increase, what is cropping intensity increase?

So, for example, there is a land. It was growing only one crop per year. When you say cropping intensity increase, you are going to make it grow two crops, which means use two different types of crops that grow in 6, 6 months in this land. So, that is increasing the crop intensity, but still there is only 14 percent. So, if you combine 14 percent and 9 percent,

almost you have 25 percent which is not good for your entire 35 percent increase. So, the rest 77 percent has to come from yield increase, which is already the land is there, and that land has been producing crops 100 kilogrammes, but you are going to increase it to 200 or 300 kilogrammes.

And that comes by creating more rural development structures, let us say water, energy and food processing so that they develop and then contribute to more yield increase. If this is not sustainable, if the yield increase is not sustainable, suddenly it will fall. So, it is better to do it through the rural development. For example, how do you capture water excess water running off and capture it, apply it to the field, increase the yield. How do you capture your nutrients that are in the air like nitrogen and then fix it in the soil and create yield increase or how do you manage the land when using vermicompost and other things to do increase?

So, this is rural development, and all these yield increase can be studied very well using remote sensing and GIS. But more importantly, the negative impacts can also be studied using remote sensing and GIS, which we will be looking at.

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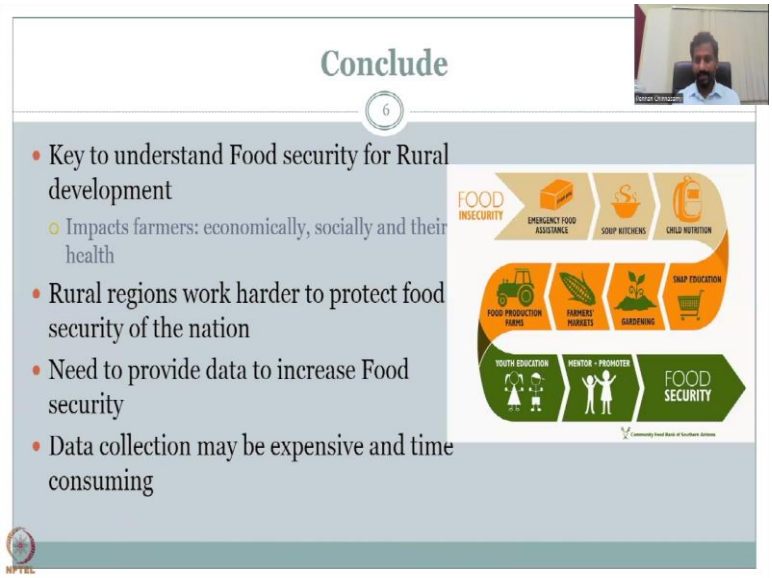

So, to conclude today's lecture, food security is very important. There are food banks, you are seeing across the world in urban cities, we have some fridges on the roads like Chennai has in some places, where people have food, there are small canteens by the government which sell idlies and dosas for 2 rupees, 5 rupees, very, very minimum so that the food security is reached, people should not go hungry, you should bring down the death rate due to hunger. So, hunger deaths is not good for our country. It does not reflect well as a developing

nation. So, we will try to bring it down, soup kitchens are set up something like canteens that give free food a lot of NGOs are doing it. And then child nutrition is being taken up.

If you look at the Government's program, there is tremendous increase in the child nutrition by supplying nutritious food like millets in the midday scheme, for example, Odisha and Karnataka are giving millets through an NGO called Wasson, I worked very closely with them. But mostly you can also see other states picking up ideas from like, for example, Tamil Nadu on introducing eggs in the midday scheme. So, eggs have a lot of protein and nutrients. So, this is about food secretary is feeding them but also bringing up the nutrition value.

So, to cater to that the rural development should occur. And then the food is produced and given to these sectors and in the food security is rich. Let us see how it is. So, you have better gardening and farmer's markets to connect farmers to the local demand. We know where the farmers are, but we do not know where the demand is. So, if you have two maps about a map with farmers and a map with demand, then you can match them and see how long it takes and distance et cetera.

Food production farmers, the farmers need high technology and to understand what is happening in their soil and water resources, remote sensing and GIS we will be using for that. Education, we need to know where to put the schools and then the mentor program where like for example, IIT, me go and teach some schools in the villages. So, how do you connect with that, how far it is, all these can be mapped. First you map it, and then you put infrastructures to create this education system. So, food security combines all this structures for food distribution and nutrition checking, food production on the ground through rural enterprises, and most importantly, educating the people.

So, key to understand food security for rural development is to understand the impact of farmers socially, economically and their health because they have to eat healthy, nutritious food to produce nutritious food. So, a farmers are weak, they cannot put so much time and energy in the field to bring food to you. So, it is also as important to check on their health and nutritious level. Rural regions work harder to protect food security of the nation. Actually the hardest I would say because no one else works that hard to attain the food security. If the farmers stop, if the farmers do not produce food for our food security, then we will have to go to other countries and ask for food that does not look good on the international scale.

So, we are giving lot of food as ration as an aid. So, the government helps and suppose a lot of countries during tremendous times like for example, you would have seen the news that Sri Lanka was given lot of food because there was a food security issue. And that time, India was giving milk powders, food rice, wheat, sugar, all these things to keep the people under food security and then development. So, need to provide data to increase food security, actual data is needed. Otherwise, if farmers over produced there is no storage to keep the food so, that is the other issue.

So, we do need a lot of food related data and map it on remote sensing and GIS platforms to understand food security. So, there are production may be expensive and time consuming. Thankfully we have this course where we will look at remote sensing and GIS tools which are free and open source and it is less time consuming to understand this data for food security. All this is tied back to rural development. I hope this lecture gave ideas about food security and rural development. I will see you in the next class. Thank you.