Business and Sustainable Development
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Lecture - 12
Understanding LCA Through Examples

So, welcome to the session. In the last session, we have discussed about Life Cycle Assessment, how this is as a impact tool being used to understand the environmental impact of a product. So, this session we will take some example to understand this LCA mode.

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So, to start with let us take the first case study that is the case study of a case study of Levi's it is a pair of jeans. So, little bit about the product or little bit about the company.

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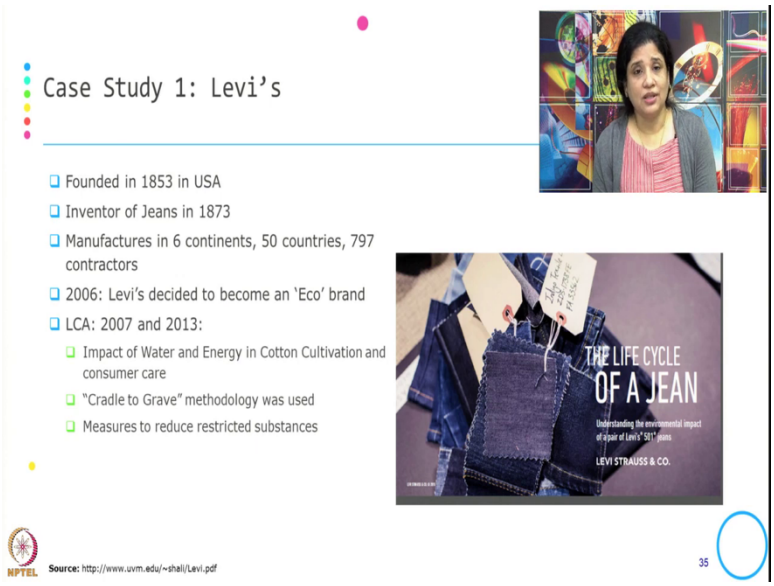

It was founded in 1853 in USA. They are the inventor of jeans in 1873 and they manufacture their product in 6 continent, 50 country and with 797 contractor. In 2006, Levi's decide to become an "eco" brand and the trigger over here is that they found that there are lot of restricted substance what is typically impacting the environment. They are using those substances few of them, few of the substances they are using in their product.

So, in 2006, they decided to become an "eco" brand and in they did a LCA to start with to measure that how much is the impact they are creating they did a LCA, and in 2007 and also in 2013 extending the scope further.

Now, the mostly the goal or the scope for the LCA is to understand what is the impact of water and energy in the cotton cultivation and consumer care because they somehow got into the point that before taking any changes in the product, they should understand what is the impact associated with that. So, they try to understand through the LCA what is the impact of water and energy in the cotton cultivation and consumer care.

Then, they use the variant whatever the LCA variant they use that is cradle to grave and they also try to say that the, they took the measures to reduce the restricted substances in the product.

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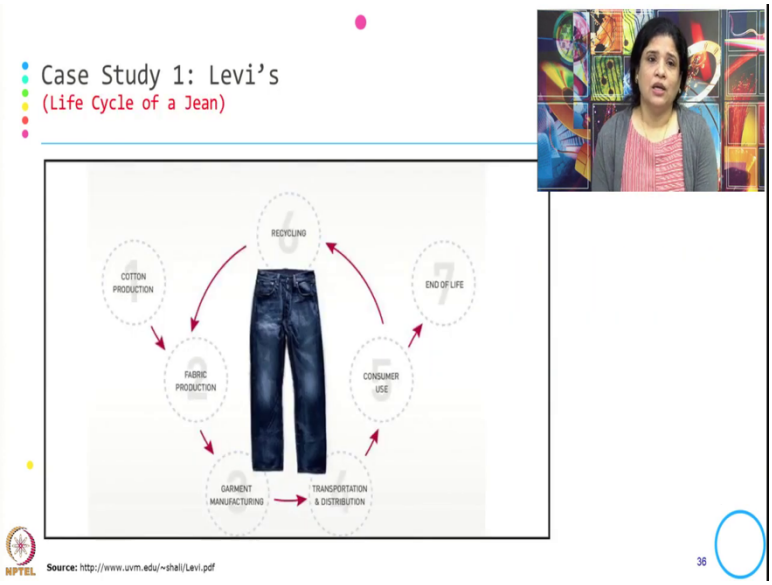

So, taking the product this is a jean, and the life cycle of the product it starts from cotton production, the source of the raw material. From cotton production we get into the fabric production, from fabric production it is garment manufacturing, from garment manufacturing it is transportation and distribution, then consumer care and end of life.

So, the product life cycle start from cotton production beginning from the sourcing of the raw material and the cotton production and its gets into the recycling, so part of it gets into the recycling part of it gets into the end of life that is for the disposal.

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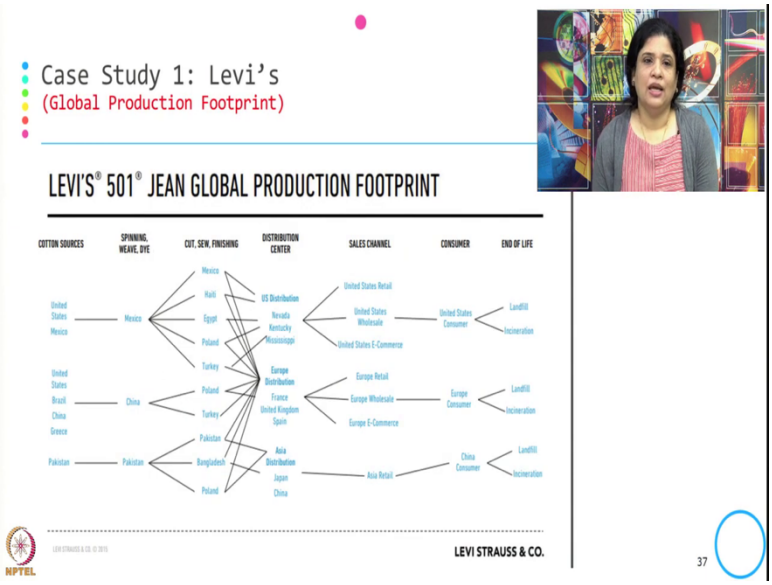

Now, if you look at the production footprint of Levi's, then in this slide if you look at the location where each of these activities are taking place that say that how globally they have spreaded their production and if they are spreaded their production globally. Obviously, the impact is also going to be the over all the area where they have their production, production facility or the production location. So, if you look at the sources of cotton what they use for their product that is typically sources from United State, Mexico, and also Brazil, China, Greece and Pakistan. These are the sources for cotton.

Then, the spinning weaving and dyeing happen in Mexico in China and Pakistan. Then cut sew finishing happen in Mexico, Egypt, so if you see the whole list of places where this cutting sewing and finishing's are done.

Then, there is distribution center that is US distribution, Europe distribution, and Asia distribution, and also the sales channel with respect to each zone or with respect to each area again it is United States retail, Europe retail and Asia retail. The consumer is all over the globe and finally, the end of life is gets into either it is gets into the landfill or it gets into the incineration.

Now, this is just a example of their production footprint. There are many more places possibly not added over here, where they are having the sourcing or spinning or garment manufacturing or the sales channel or the consumer.

But the idea what we get from this is that the sourcing is happening in one place, manufacturing is happening in another place, distribution is happening all over the globes, and the consumer also all over the globes. So, accordingly the footprint also across the globe based on the production footprint what the product is having. And this is specifically for the products Levi's 501.

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Now, going further what they have done before doing LCA, they have identified what is the functional unit, what aspect they are going to cover. So, from 2007, when they conducted LCA in 2013 they extended the scope.

So, here the functional unit what they have taken to understand the impact is Levi's 501 jeans and other core LS and Co product. And they consider the multiple consumer marketing, consider the multiple consumer market because they are looking also what is the impact from the consumer use.

So, they have consider United State, UK, France and China. Then, they have also look at the primary cotton producing country from where they are sourcing. The primary data sources is from Levi's and also 11 supplier factory and 6 fabric mills, and the product attributes what they have started is 5 fabric, 8 finishes that is low to high complexity and 2012 is the production year.

The aspect what their, analyze is cotton production, fabric production, garment manufacturing, packaging, sundry, transport, distribution, consumer care and end of life. So, mostly here we are trying to see what is the goal, what is the scope of their LCA, and what are the different aspect they have considered because from there we can see what is the LCA inventory, LCA inventory will cover which aspect of the product.

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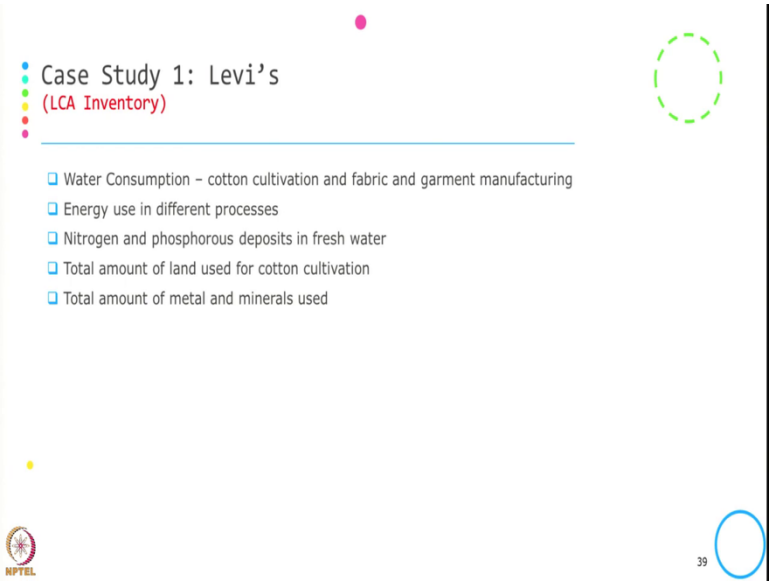

Now, considering the LCA inventory, so if you look at in the previous slide we have given the aspect what they have considered. From that aspect these are what can come under the LCA inventory that is water consumption that is both in cotton cultivation, fabric and garment manufacturing, whatever the consumption of the water.

Then, energy use in the different processes, in the manufacturing, garment manufacturing, and also in the fabric manufacturing of the fabric. Then, nitrogen and phosphorus deposit in the freshwater because this gives the account for the eutrophication. Then, total amount of land use for the cotton cultivation that gives the footprint on the land. And total amount of metals and mineral use that is to understand the raw material for the product.

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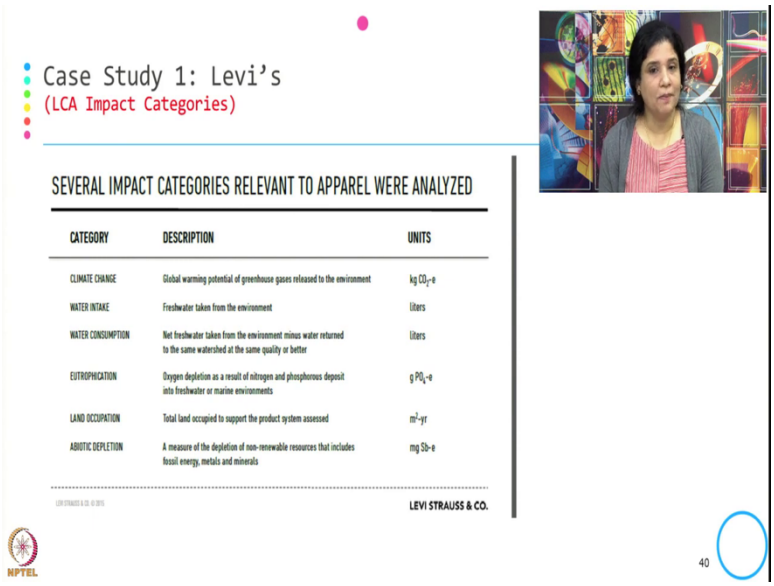

Now, this is how they have, after deciding the inventory this is how the impact is been what would be the impact category. So, the impact category what they have considered is climate change and how they have tried to capture the impact on the climate change to look at the global warming potential of the GHG released to the environment.

Then, water intake, fresh water taken from the environment. Water consumption, net fresh water taken from the environment minus the water return to the same water set at some the, at the same quality or the better quality. Then eutrophication, the oxygen depletion as a result of nitrogen and phosphorous depositions of fresh water or the marine environment.

Because this is a garment manufacturing the amount of chemical they use for the dyeing process in the fabric that gets release to the nearest water body and whatever the oxygen depletion happens because of this nitrogen and phosphorous that creates the impact for the marine environment. And interestingly there is one more factor is that typically we all possibly like the faded jeans more than the dark color jeans.

And in fact, the faded jeans use more of dye and also the water use and the water discharge coming out of that is more chemical and it gets deposited into the water body. Land occupation, total land occupied to support the product system assess. And a abiotic depletion that is the major of depletion of non-renewable resources that include fossil energy, metals and mineral.

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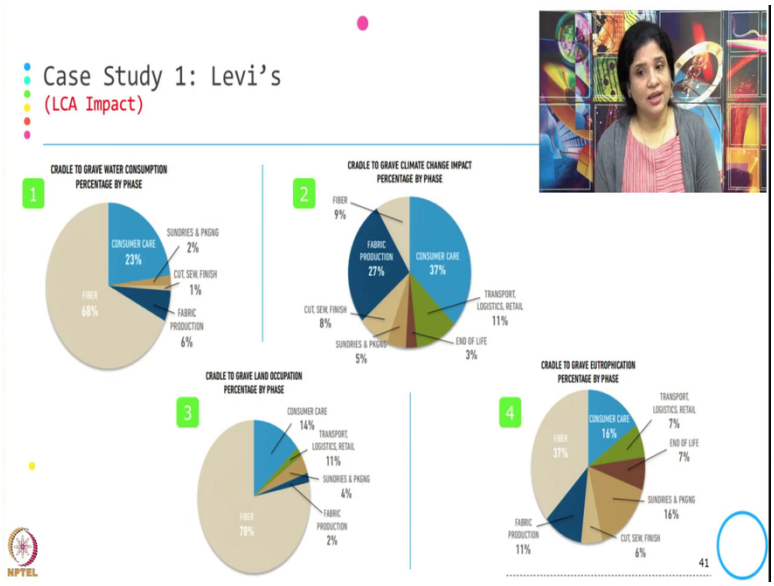

Now, let us see how it is coming in the form of the impact. So, the first stage cradle to grave water consumption percentage by phase. So, here if you look at the maximum water consumption agent fiber that is 68 percent and 23 percent in the consumer care.

So, how the water consumption or what how do you categorize the water consumption in the consumer care? It is mostly about how much water we need to wash our jean. And if you look at the facts given by the company, they have given a, zone wise they have given a country wise consumer and how typically based on their washing pattern and based on the region where they use this particular product based on that how the water consumption changes.

So, if you get into the impact of the water consumption then most of the consumption happens in the fiber and the rest of the consumptions get into the consumer care that is 23 percent and fabric production is the 6 percent.

Similarly, coming to the climate change impact then, the again the maximum impact here over here is consumer care that is 37 percent, then fiber is 9 percent, fabric production is 27 percent. And this again if you look at the climate change impact mostly it is from the consumer care and the fabric production.

Then, coming to the land occupation percentage by phase then again for the fiber it is maximum obvious, then consumer care and again fabric production is just 2 percent over

here. And coming to the last type of impact that is for the eutrophication percentage by phase, then mostly it is from the fiber it is 37 percent and consumer care 16 percent, fabric production 11 percent.

So, mostly and here, in fact, one of the component what we did not see in the previous 3 cases is that the sundries and packaging also creates the impact to the eutrophication that is 16 percent. So, mostly if you look at all the 4 impact the contribution coming from fiber and consumer care is almost leading in all these cases.

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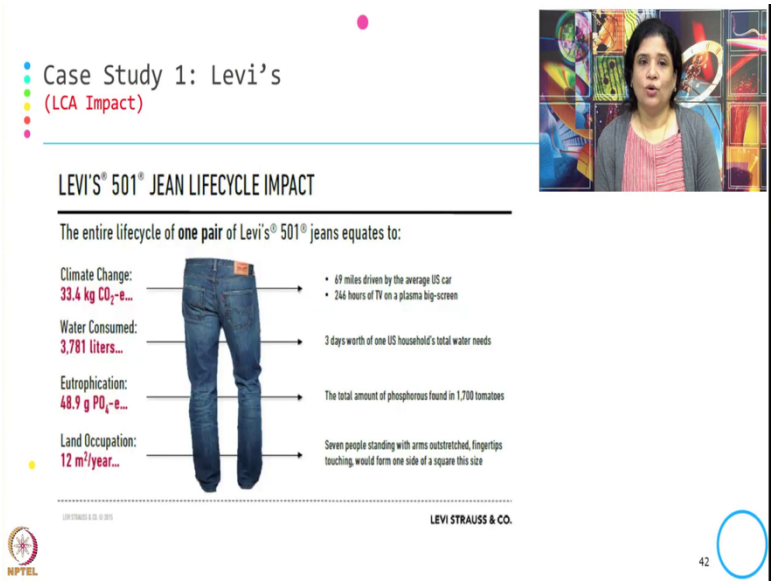

Now, to summarize this a impact of Levi's that is this 501 jean the for the one pair interestingly if you look at the they have given a nice comparison, that whatever the impact that is created by this one pair of Levi's 501 jeans this equates that how what we could have done with the we are not using it for the one pair of the Levi's jeans.

So, if you look at that climate change that is 33.4 kgs CO 2 equivalent, it is equivalent to 69 miles driven by average US car or this is equal to the 246 hours of TV on plasma, big screen. The water what they are consuming for one pair of jeans that is 3 days worth of one US household total water needs.

The eutrophication is whatever the amount is going getting into the eutrophication that is the total amount of phosphorous found in 1700 tomatoes. And the land occupation is

whatever there for the cotton needed for this jeans that is equivalent to 7 people standing with arms outstretched fingertips touching would form one side square of the size.

So, this, in fact, if you look at this slide summarizes the impact of one pair of jeans and what is the alternate use for this. And this is since the scope we are only talking about the, what is the impact of it. We are not going further to understand how Levi's they have address all this all this impact. We will just stop here to understand what is the impact of the one pair of the jeans, the life cycle impact of the one pair of jeans.

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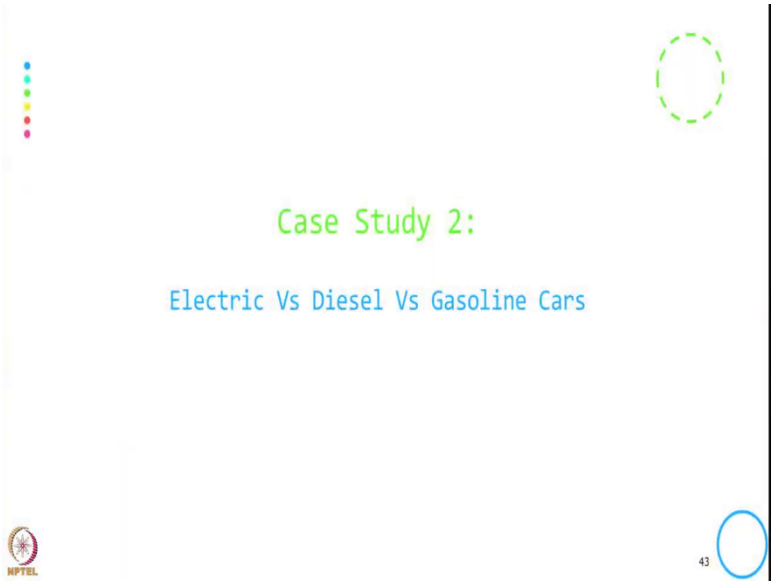

Now, get into the second case study. This is, this is from a student project of last year. They have done this assignment to understand what is the LCA impact of electric versus diesel from the gasoline cars. So, they had done a comparative life cycle analysis and in this life cycle analysis they have taken all types of car to understand, where the impact is more.

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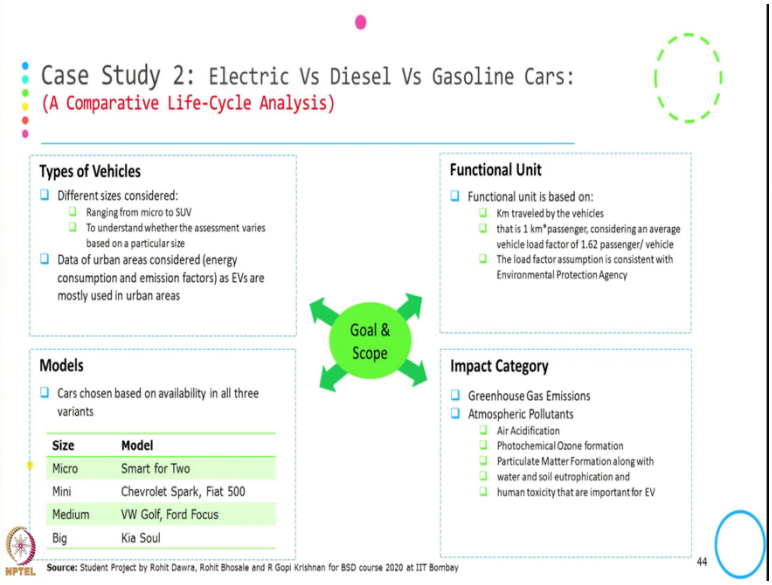

So, the types of vehicle is ranging from micro to SUV and to understand whether the size makes a difference when it comes to the impact. Typically, the data of urban area is considered over here because EVs are mostly used in the urban area.

And this is what the cars those have been picked that is micro mini medium and big. And the functional unit is kilometer travel by the vehicle. The load factors and the average vehicle load factor as per the environmental protection agency. And the impact category it is being considered, so the goal or the scope is, goal is to understand how the how is the impact is changing for the different kind of vehicle from the fuel different, fuel sources.

And impact category is the scope is to understand what is the greenhouse gas emission and the atmospheric pollutant that is then again atmospheric pollutant is into the air acidification, then photo chemical ozone formation, water and soil eutrophication, and human toxicity.

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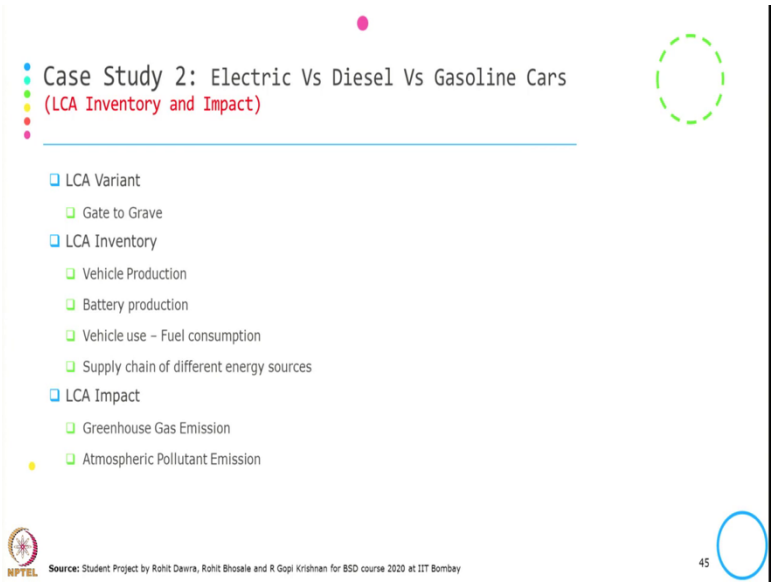

Then, the when come to inventory and impact the variant is use is gate to grave. And LCA inventory is done for the vehicle production, battery production, vehicle use that is fuel consumption, and supply chain of the different energy sources. And the impact, as I told in the previous case that is green house gas emission and atmospheric pollutant emission.

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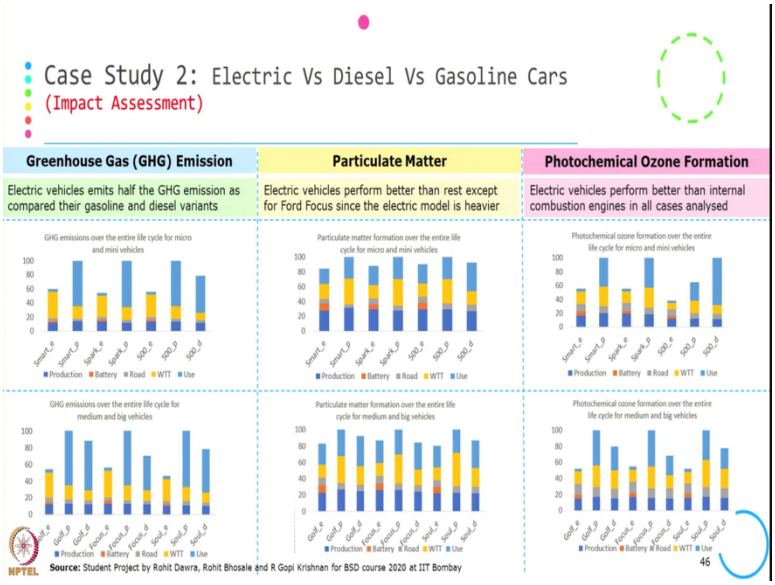

Now, this is what the impact assessment. I am not getting into detail of each of this graph. But the comparative picture what we are getting is that electric vehicle emits half

of the GHG emission as compared to gasoline and diesel variant. I think possibly it is known also.

Then, in case of particular matter also electric vehicle performs better than rest expect for the ford focus since the electric model is heavier. And in photochemical ozone formation again electric vehicle perform better than the internal combustion engine in all cases analyzed.

So, when the comparative life cycle analysis was done for all this model of cars, all from different energy sources with a variant of with a variant of gate to grave, then except particulate matter in GHG emission and photochemical ozone formation typically the electric vehicle is performing better.

But in case of particular matter the ford focus is better as per electric vehicle because the model of electric is electric model, electric vehicle is heavier.

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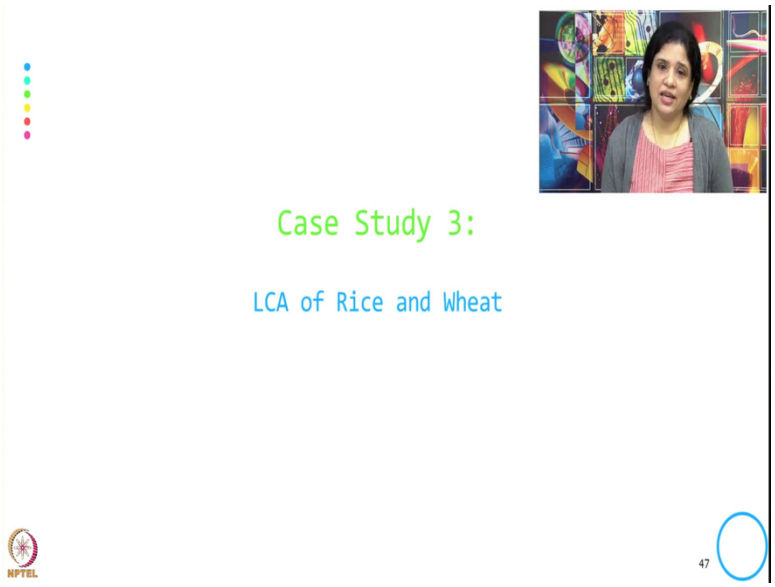

Then, let us get into the next case study that is the LCA of rice and wheat.

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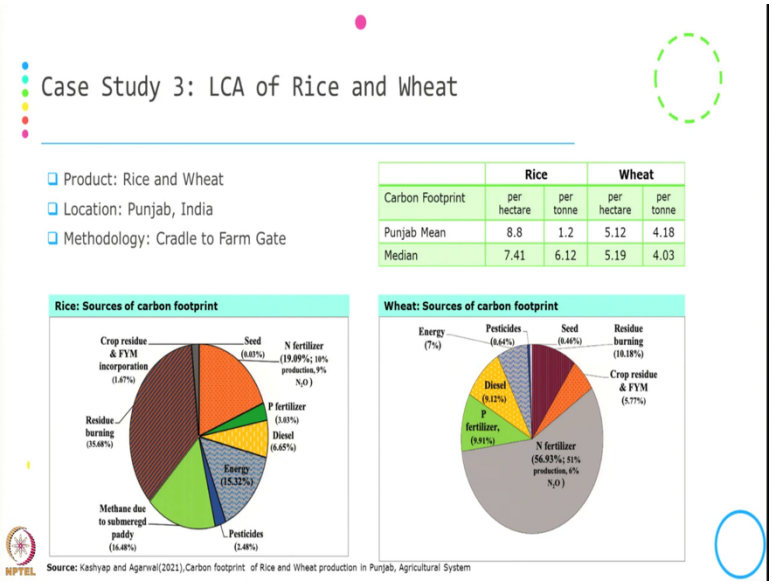

And this example is source from Kashyap Agarwal to 2021 from their paper what they published in carbon footprint of rice and wheat production in Punjab, and this is published in the journal of agricultural system.

So, what they have done? They have tried to understand what is the impact of two major crops in Punjab that is rice and wheat and the location of the study is Punjab, and the variant what they have use is cradle to farm gate that is what the LCA variant. And if you look at the carbon footprint for, so the first in the left hand slide left hand side figure gives the carbon footprint for rice and right hand side gives the carbon footprint of wheat.

And if you see the carbon footprint of rice, mostly the maximum footprint coming from residue burning mostly and also the methane due to submerge paddy, and also the energy which is 15.32, and in case of carbon footprint form wheat it is mostly from the fertilizer and that is out of that you will find that mostly 51 percent is from the production and 6.2 is from N 2 O.

If you get into the table above the in the right hand side of the slide, I am just focusing more on the median because there is a variation in mean. So, if you look at the per hectare carbon footprint for rice is 7.41, whereas the per hectare carbon footprint of wheat is 5.19 that is per hectare and per ton the carbon foot print is 6.12 and per ton is per ton for wheat is 4.03.

So, this gives us what is the impact of production of rice and wheat, and mostly from which source or which part of which part of the life cycle of the product we get how much is the impact.

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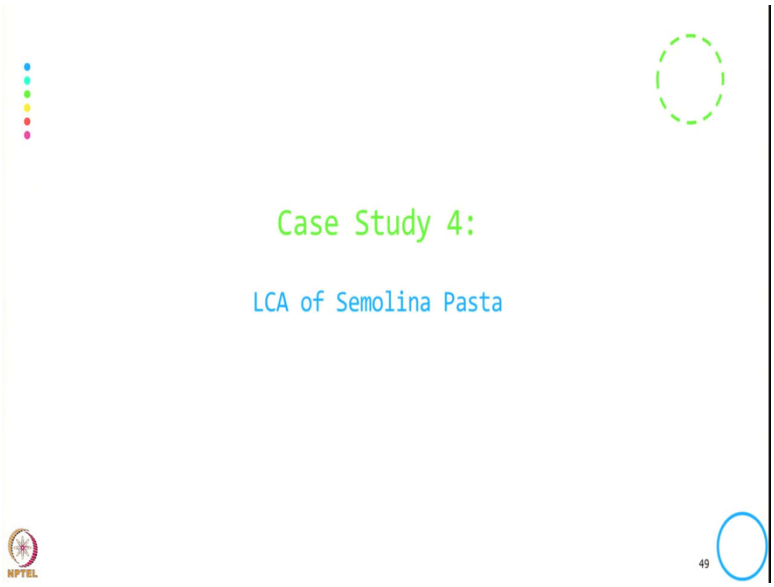

Now, going further this is the interesting LCA analysis done for a semolina pasta.

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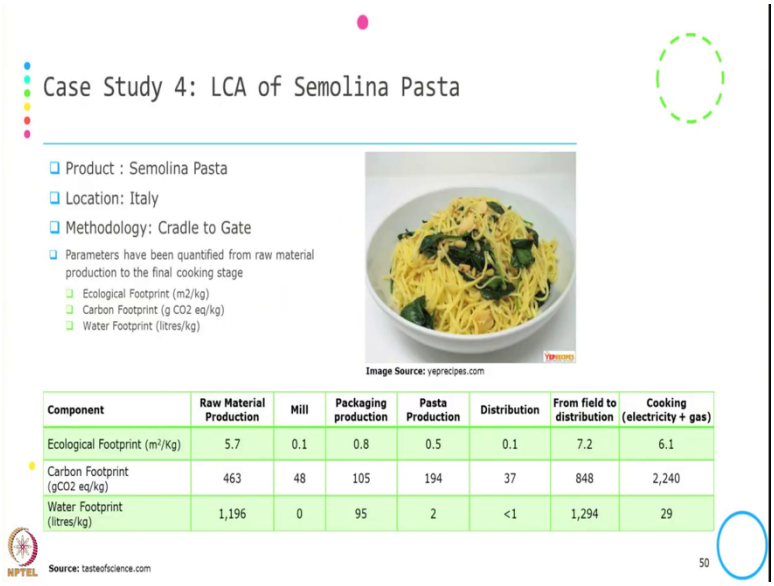

Possibly we never think when we consume all this food or food item or all these goods that how much is the impact is being created by this product. So, you will find many studies talking about life cycle impact of a burger, life cycle impact of a specific food,

life cycle impact of a specific fruit. So, this is a interesting example from the LCA of semolina pasta.

The methodology is cradle to gate and this has been this data has been sources from the different sources, but this is mostly being presented as a post in taste of science, and the parameter what they have quantified from raw material to the final cooking stage. And they have tried to see the impact with respect to ecological footprint with respect to carbon footprint and with respect to the water footprint.

So, if you look at the stages of this semolina, its start from raw material production, then milling, then packaging, then pasta distribution, then distribution to the sorry pasta production, then getting into the distribution from field to distribution finally, cooking. So, here if you look at the ecological footprint is mostly in case of raw material production, cooking and from field to distribution it is high.

Similarly in case of carbon footprint also this is 463 that is CO 2 equivalent per kg, and again this is cooking it is more and from field to distribution it is more. And water footprint also it is more in all these 3 stages, but except possibly the distribution and also in the milling rest all the water consumption is more. So, mostly when you compare all this footprint, ecological footprint, carbon footprint and water footprint, you will find that in few of the stages their footprint is more.

So, what we have tried to do in this session is there by taking different types of examples, different types of product and understand, how the impact has been calculated or how using LCA, how they have created the impact assessment at the different stages of the product. So, we took the example of a Levi's jeans, we took the example of the different variant of cars, we took the example of rice and wheat, and we took the example of the semolina pasta.

So, possibly when next time we consume a product the immediate thought comes over there is that how much is the impact or where are the places where we are creating the impact by consuming this specific product.

Thank you.