ILSI 2021 Annual Symposium Session 7: Greenhouse Gases from the Food Supply Chain: Paths to Mitigation and Sustainability

Transcript of the presentation, Science for Agriculture Towards Sustainability and Potential CO2 Management, **John R. Tafkaj Porter**, PhD, University of Copenhagen, Denmark

Thank you very much. I'm sitting in Denmark, up in the North of Europe. And it's dark outside because it's 10 at night. I'd just like to thank the invitation to present some ideas to you today. I was asked to say what my conflicts of interest were. Well, I'm a retired scientist, so my only real conflict of interest is if I get my pension at the end of the month. This is the only thing that I think causes conflict. Thank you for the introduction. I did work with the IPCC for a long time. And I've also spent quite a lot of time working in France as well, which is where I spend quite a lot of my time these days. The important thing- whoops... I don't want to do that.

Yeah. One of the things [inaudible 00:01:11] did not mention this, but he certainly drew attention to it but if we look at the 17 sustainable development goals that we have globally, it is very interesting and I put a little red star on the ones which had connections to agriculture, connections to food systems, and connections to the land. And you can see, there must be about six or seven of these sustainable development goals which are directly related to how human beings work on the land. And one of the things where we get somewhere confused, I think, is this, Professor Lyle referred to this. And I would like to discuss this with him really. But we can improve the efficiency of the use of fossil fuels and sources and produce more efficiently, but it's just not being that we're good to reduce greenhouse gas emissions.

So, there is this trade-off really, or this interrelation between what we can do relatively and what we can do in terms of absolutes. And why is this? Well, one of the reasons why this is true is because of something called the Jevons paradox, which William Jefferson was an economist in the 19th century. And he showed basically that if you improve the efficiency of things, what this did was not to decrease consumption, it actually increased consumption because people find it cheaper to buy things so they could buy more. And this leads to the conclusion that I'm going to talk about is that the emissions are basically combination, both the production, but also consumption. And we basically really have to think about both of these aspects, that production, and also the consumption. And hopefully I can say a few words about this.

I just wanted to say that Frank, I completely 110% agree with him saying that being carbon neutral is not being the same as climate neutral. There is a lag between what happens to the global carbon, but to them, what happens to the global climate budget or what happens to the global climate. And I'm very glad that he made that point. It's a very important point.

There are four hypotheses that I have presented in different forum, and one of the things I think is very interesting, this is John Maynard Keynes, he was a very influential economist. Of course, in the 20th century, I'm actually writing a paper about him at the moment, but I really liked his statement. It says, "when the facts change - I changed my mind. What do you do?" I think that's a very good question to ask. And I think we are seeing that getting more from less- increase in efficiency does not always lead to increase robustness, and that system redundancy is a good thing. I think we've seen that very clearly in the pandemic that we're in love with at the moment or hope becoming out of it at the moment. That those societies, which had put a great emphasis on efficiency, actually when it came to this pandemic were not very well equipped to deal with.

So, I would say that system redundancy, having some slack in the systems. System redundancy is a good thing. There's also a discussion in ecology. I can remember when I was at the ecology student, what is the position of our complexity? Is this complexity lead to stability? And I think that the consensus now is that increased complexity can and cannot lead to the increased robustness and resilience. It can do, but it also can have a system where things get over connected that does not lead to increased robustness and resilience. I'm convinced now that we understand that decreased robustness, and I mean, robustness is different from resilience. Robustness is like a preventative thing. How do you prevent things from happening? Resilience is how can we recover from a shock? And I think we have to think about robustness much more than we think about resilience, decreased robustness leads to decreased efficiency. I'm convinced about that.

An increased robustness leads to increased efficiency and resilience. And I think it has been clear with, with COVID-19 that those societies, which had some inbuilt robustness actually have come out of this better than other societies that didn't have that.

What I want to do now is to talk about greenhouse gas emissions in a slightly different way than we had Frank. And what I'm trying to do here is time to connect a couple of things. This is a diagram which shows the relative and total greenhouse gas emissions and how it's spread between the efficiency of production and the consumption. And this was developed by a Japanese scientist called Kaya. It's called a Kaya Identity. And what it is doing is actually breaking down greenhouse gas emissions, since of these different elements. So, if you reduce the greenhouse gas emissions per unit energy, and that basically has been happening, for example, if you change from coal to methane as a source of energy.

If you decrease the energy needed per unit of gross domestic product- And again, the industrialized societies, since the second world war, that's generally been the case, but what has actually happened of course, is that GDP global gross domestic product per unit population has increased enormously, like about twice as much as the energy per GDP has decreased. And then you've got population. So, you can see if you multiply all those elements out, then you basically come up with greenhouse gas emissions. So, it's a way of what I call deconstructing the emissions into these different factors. But this only applies, this is what we're seeing here, only applies to the fossil fuel industry. This only applies to emissions from fossil fuels. I am just going to drink some water.

It doesn't actually apply to the land use emissions. And because it does not apply to the land use emissions- I was one day on my bike, cycling back from the university, and I've been teaching the card identity to the students during the day. And then I thought, "well, you could write an equivalent identity analysis for the agricultural emissions." And so, I came up with this, which is basically that the yield per unit area times the energy needed to produce particular amount of view times the greenhouse gas, is that all the amounts of greenhouse gases you used to produce, product per unit energy times the area.

You can also deconstruct the emissions from the land use emissions into this identity as well. And you can see area in this case takes the place of population. This is the integration [inaudible 00:09:03] in this what's called the Kaya-Poter Identity.

And we had a couple of students. I did this work with [inaudible 00:09:13] Copenhagen at Pete Smith. I'm sure you've heard of Pete Smith at Aberdeen. He and I were the PhD supervisors of [inaudible 00:09:22]. And we were able to create these identities for different components in the production of greenhouse gases from crops. We also did it for livestock as well. And I don't actually have time to show you this, but you can see the elements that we included in this integrated Kaya-Porter Identity, or the greenhouse gas crops. And it allowed us to produce these kinds of figures. We published a couple of papers in global change biology. And what was interesting I find here is that if we look at the relative values, if we take a 1970 as a starting point, and that has a relative value of one, then you can see that for instance, greenhouse gas energy per produce units is actually increased quite substantially.

Total emissions, greenhouse gases from crops have also increased, but there have been some elements in this identity, which have actually fallen since 1970. So, greenhouse gases per land use change per produce units. And I think it's also very important to think about the fact that many times we talk about greenhouse gases per unit area, but we really need to think about greenhouse gases per unit product. And I think Jeremy at the beginning of the talk, when he was talking about his work in New Zealand with Pantera. So that was very interesting, I think, because of the emphasis that was on the emissions per unit product, and we have emissions per unit area, but we also have emissions per unit product. And this idea of trying to break these things down into different components can also be used in terms of the resource use efficiency.

So, what is the efficiency with which resources, particularly: radiation, water, and nitrogen fertilizer I use. And you can write these equations, which is trying to break down the yield per unit evapotranspiration into these other elements here. And you can draw some pretty pictures, which you can see at the bottom, where you can look at the relations between these different resource efficiencies and resource and the trade-offs in a quadrat system. And I take no credit at all for the originality of this because this is going back to case the Wits PhD in the 1950s in [inaudible00:00:12:01]. And he was the first person to have these ideas about how you could deconstruct these efficiencies. These resource use efficiencies, and there have been some experimental work. This is done by [inaudible 00:12:18] here at Lincoln university in New Zealand and Hamish Brown and other people down at Lincoln university.

And one of the things I think is important here is, and what [inaudible 00:12:28] and others were looking at was how resource use efficiencies interact with each other, because I'm sure we would agree that resource use efficiencies by themselves. You know, they're interesting, but what's more interesting is how to resource use efficiencies, interact with each other. So here we have the relationship and the top graph here and the A graph here, which is the water use efficiency against the nitrogen use efficiency. And you can see that as in a dry land situation, this water use efficiency per unit dry matter, or nitrogen use efficiency decreases. And it does here with the dry lab and also the irrigated. But when you look at the relationship between radiation use efficiency, this is then B C graph here, against nitrogen use efficiency, you see that the order of these efficiencies has been reversed. So here we have dry land irrigated and here we have irrigated trial of dry land.

So, I really think it's important that we need to think about these resource use efficiencies in a more integrated way, and how they interact with each other. And finally, I mean, this, I have not really done very much work on this, but I was thinking, how can we tie together these identities so that we have the

Kaya identity here, we have the Kaya-Poter identity here, and then we can also write identities for demand. So, this is demand is animal protein divided by total protein, total protein per unit calorie, calorie per the capita times population and the other. We can write other kinds of identities as well. And what we see here is that the same element may appear in more than one identity.

And this is what gives us the possibility to look at the interactions between wealth, health, consumption and greenhouse gas emissions. So, what I'm trying to suggest here is that we know we can create a framework where we can look at these interactions, which I think are very, very important as many of the speakers have said.

Now I'd like to just move on to talking about food systems for a couple of slides, about 10, 15, 12 years ago, we did a study actually in the European union of the food system of Europe. And the food system of Europe looks like this. This is before the expansion of the EU, but I mean, you have a number of producers at the bottom, and then you have suppliers, semi manufacturers, manufacturers, and then you come down to this place in the middle here, which is [inaudible 00:15:23] of supermarkets.

And then it expands from there out to the customers and the number of people who are the customers in Europe. And this is the shape of the supply chain, funneling Europe. And you can see the cost of the power in this hourglass- like an hourglass, is in the center of this organization here. There may be less than maybe 1200, probably increased since this figure was done, but maybe there are less than 2000 people in Europe who are basically deciding what's most Europeans actually eat. And I don't want to go with this in much detail, but one of the things that we were interested in when down in Montpellier, working in Montpellier was this distinction between linear food systems and circular food systems. And I think there's a lot of interest in how these two different types of food systems. This is actually from HTO. And there's a lot of interest in how linear and circular food systems are working.

One of the things that we worked with on, in the work that we did in Montpellier was what are the elements? What are the basic elements in circular proof systems? And I think these came out as some of the four principles that biomass as the basic building block of which should be used by humans. I mean, we talk about getting more from less, but I think the alternative is enough for less, reducing waste and increasing what we say. I mean, I think the idea that it's just more for less, more for less, is a really- idea. It's a bit passe. The by-products through production processing consumption should be recycled back into the food system. I think we're about that and use animals for what they're good at. I mean, they are valuable sources of protein for many people, particularly young people, pregnant women, for example, but we need to think about how we use animals for what they're good at. And this is really some work that came from Martin [inaudible 00:17:41] professor.

I just want to say, because I think I know that the TF was telling me that there's an interest in the food systems of cities, particularly Singapore. And I just wanted to refer to a study that we did in global food security about 10 years ago now. When we looked at the food systems of three capital cities, this is Australia, which is Canberra and the Australian capital region and Denmark. This is the light can actually point to the place where I'm sitting just at the moment, which is about that. And then Tokyo, we had three cities, Canberra, Copenhagen, and Tokyo. And what was interesting about this was how they scaled in terms of population density. So, Canberra is about 0.1 person per hectare. Denmark is about 4.4 people per hectare. And Tokyo is about 12 persons per hectare. And I haven't got time to go into the information really, but we were able to look at the food systems of these different country, of these different capital cities.

And this- excuse me, was the situation in Tokyo, a huge import, you can see the inputs of wheat in 2005. And one of the things that we also were able to do was look at how these food systems in cities have changed over time. We were able to get hold of data. And so, you can see really if the production of wheat gets short globally, that countries like Japan and Tokyo are going to be some problems because they could not go anywhere near supplying. The only place we really found it could go supplying its own needs was Canberra.

And now after saying all that, I really want to do what I call some really out of the box stuff. And this is come up out by the fact that when you were a retired professor and you don't have to teach students and you don't have to apply for research grants, you have a real chance to, to think about some other stuff. And this has been one of the things I've really been enjoying doing in the last two or three months, of course with thinking about the COVID story, the COVID-19 story. And I wanted to just say here, this has a connection. What I'm going to talk about here has a connection to what I was talking about with the identities. I'm basically thinking about how to use identities in connection with the COVID-19 pandemic.

We talk about the race between vaccination and the social distancing measures. There's a race between the two, how many people are going to get vaccinated, to what degree did the social measures, social distancing, and lockdowns, and these kinds of things. How did these contribute to controlling the pandemic? And I [inaudible 00:20:58] at a V number with, I called it the V number to quantify these two effects. And I'd say it's a simple thing. The fee ratio, the V number is the ratio between center the population vaccinated divided by the percent of the population is active cases. And you can get all these data off [inaudible 00:21:20] and these are the websites, enormously interesting sites. And of course, the V number will increase as you increase the percentage of the population vaccinated, the V number would increase if you decreased the proportion of the population, which is regardless of active cases.

And the V number will really increase if you increase the vaccinated population, and you decrease the active cases via social methods. And so, then I thought, well, what's the link that you could get to the V number to this our infectivity statistics. This is actually... it's in some way, based on the Euler-Lotka equation for population growth, but it isn't really. And of course, you'd know that the R number is, if it's a value of one then this means that people are not transmitting the virus to another person. So as long as this value is one or lower than one, and there is no spread of the virus, and the virus would eventually tie out.

This is the figure that I drew the came up within February this year. This is looking at the data from world with data and all these things where I plotted the V number on the Y axis here against the R value. And this is the line. This is the regression line. And you can see that there is a line here. I've drawn this red line here, which is where we have the R-value of one slightly lower than one. And why does it cross this trend line where they cross it when the V number is about 10, so the ratio between the centers vaccinated over percent objective cases about 10 to one. And if you do that, then you're looking at a situation in which the R-number is going to be lower than one. And then I took it all the way from January the 11th to March the 27th. I took nine dates, look at all the data from nine dates. And here we have the R-value on this axis. And the V-value on here, you can see that the V-values have increased, and this is the best fit.

This is the polynomial fit. So here, we're looking at a V-number of about 20 to 30, which is going to give you an R-number, which is somewhere below one. There's a lot of spread here. And this means that- actually, what this shows you is that different countries have used different vicious. They use different ways of trying to control the pandemic. And I've just had this published in- it's actually a pre-print journal at the moment, but it's going to be put into a regular medical journal that when I get up at a time.

So here we're looking at a V-number, maybe between 30 and 40. It would be pretty guaranteed to have another number below one. So, my conclusions in this, out of the box thinking stuff is that food security is certainly more than production. We have to think about food security in terms of its aspects of consumption. And what does it mean for waste? How do we make robust food security systems? We need a suggestion, we need synthetic and quantitative methods to connect wealth, consumption, diet and population. And maybe these identities that I've tried to show to you this morning, or this afternoon, or this evening, it's something that we need to think about. I think that the mantra should be: "enough from less, save more, waste less". That is a mantra that I try to- we try to live by. My wife was actually just sitting by the side of me here.

What links are there between food systems and pandemic? I think that's a very important question for the future. And I think there are some possible, very interesting analysis that we could look at the link between food systems and pandemics. Robustness is not the same as resilience. Slack and redundancy are good statements, I mean that economist would say we have to run things as efficiently as possible. Well, I think they found out that's not always the case. So even the economist, the bastion of liberal economist says- "Capitalism must up its game; orthodox market economies has been useless in the current virus pandemic".

"A robust bar, flexible, resilience and efficient food system and society needs insurance and assurance."

"We cannot solve current global problems with endless efficiency gains, carbon taxes and carbon capture and storage." I mean, there's only so much carbon. You can stick into the ground, and it does take an enormously long time to do that. I think Pete Smith's record. It was about three gigatons per year. And it's very interesting. I think the situation we're in now, the people are decidedly getting uncomfortable. So, the question is, how comfortable do we actually feel at present in the current global situation tonight? I have the impression that when we started an IPCC back in the beginning of the 1990s, [inaudible 00:26:55]. And then we had the spirit where everybody was trying to just pull us apart. But I think that a situation is changing, and we need to change. We need to change very, very, very, very fast.

So, with that, I'd like to say, thank you and thank you for the chance to listen to all the presentations that we've had. I think it's been enormously interesting, and I've learned something in all of the presentations that we've had so far. So, thank you for that.