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

Transcript of the presentation, Rethinking Methane: Uncovering Climate Solutions within Animal Agriculture, Frank Mitloehner, PhD, University of California, Davis, United States

Frank Mitloehner:
It's in my opinion, methane is really one of the really big deals in and around animal agriculture right now. Just give me an okay. That you can see my slide and you can see me. Is that the case?

Geoffry Smith:
Yes, we can.

Frank Mitloehner:
Okay. So, my disclosures, I mentioned here. Yeah, I've been here in Davis since 2002, and California has a very large dairy sector. We produce 20% of the U.S, milk. Our Dairies are rather large, you know, 1500 cows, probably on average. Some of them are 3000, 4000 or 5,000 cows per operation, and so different from the pastoral farming system in New Zealand. But I love to see what you had to say that Geoffry.

Geoffry Smith:
Sorry to interrupt him, can you maybe put your sites on full screen? Yeah. They're a bit small.

Frank Mitloehner:
The reason why they are small is because I have a really large screen.

Geoffry Smith:
Ah,

Frank Mitloehner:
that's probably why.

Geoffry Smith:
Okay. If it can't be helped.

Frank Mitloehner:
Yeah. I think that's the reason why.

Geoffry Smith:
Okay.

Frank Mitloehner:
Okay. So, if you're on Twitter, then please follow me. My handle is @GHGGuru here at UC Davis. We also have my center and the Kia center represented on Twitter at UC Davis clear. I put a video together with my center called rethinking methane, and do you find that on YouTube it's freely available and it only takes five minutes to watch. I think it breaks down this whole issue very nicely, and I encourage you to go watch it and share it. So really briefly for those of you who don't deal with methane and with other greenhouse gases often, why do we care about these gases? Well, it all starts with the sun, which radiates solar radiation to the surface of the earth.

Normally that radiation would be reflected back into space. If there weren't these greenhouse gases that kind of retain that solar radiation and the related warming in our atmosphere. So, without these greenhouse gases life on earth would not be possible. It would be too cold here. So, we need greenhouse gases, but the problem is we are producing too many of them.

So, imagine this layer of greenhouse gases, almost like a blanket over your body on a cool summer evening, where that blanket helps you to stay warm. That's what these greenhouse gases do. They keep us warm by retaining solar heat, in our atmosphere, most climate scientists will tell you that the main culprit with respect to compound causing human related greenhouse gas or climate change is CO2 carbon dioxide. But some people particularly those who are not fond of animal agriculture will say, no, we should focus on methane. Indeed, methane is a potent climate. There's no question about that, but there's a lot more nuance, which I will talk about. But in my speech, when looking at greenhouse gases and comparing them to one another, then a unit is used called GWP 100 Global warming potential 100. It compares methane and nitrous oxide to CO2.

So, if something let's say a dairy produces 10 tons of methane, all they need to do is multiply the 10T the 10 times this factor, the 28 and then you arrive at 280 CO2 equivalent and CO2e CO2 equivalent units of methods. So, 280 CO2 equivalent tons. The same is true for nitrous oxide. So that's a factor that you need to use in order to arrive at a value that compares it to CO2. This unit has been used since 1990 and it's actually okay to be used.

If methane goes up, if methane increases then GWP 100, does a rather good job, an okay job, but when methane sources stay stable or when they decrease, then GWP 100 has a problem, said all of us. Let me explain more how methane is different from other greenhouse gases. So, if you produce CO2 or nitrous oxide is that gases that only have sources, but there is no real process that destroys these gases. Okay, but for methane, that's different methane has both sources and sinks. Please remember that sources and things, and they're depicted on this slide here on the left, you see various sources of methane, including fossil fuel production use agricultural waste, biomass burning wetlands, and so on amounting to a global total of 558, let's call it 560 tera-grams of methane per year. This is where most people stop the discussion, even though they shouldn't because methane is not just produced, but it's also destroyed on the right side.

You see that there are very large sinks for methane amounting to almost 550 tera-grams. So, 560 are produced 550 are destroyed leaving a total of 10 tera-grams behind and that is the amount that we have to deal with. Okay, that's still an amount we want to reduce and again, methane is an important greenhouse gas, but it's important to know that there is, and remember that an atmospheric removal process of methane and atmospheric removal process of methane and this GWP 100 unit that's currently being used is not taking that into consideration in the way, check GWP 100 X as if methane were only produced, but not destroyed when indeed that is wrong.

You can see on the right side here, a large arrow pointing downwards and underneath it says sink from chemical reactions in the atmosphere. What that is referring to is a process called hydroxyl oxidation, a process by which radical molecules in the atmosphere attack methane and steal some hydrogen away from the methane and that destroys method and that generally happens in around 10 years or so. So, this aspect of atmosphere removal affects the lifespan of method because that methane is literally taken out and it happens after approximately one decade. So, what CO2 and nitrous oxide have a life span of 100 or 1000 years and now in long lift climate pollutants, methane is not, it is both produced and destroyed, which causes a very short lifespan of approximately a decade.

This is important as you will see in the next couple of slides before I go into describing methane in more detail, just a little idea as to how the livestock related methane is different from let's say fossil fuel related carbon sources. So where, where does the methane that CH for that animals belch out, or that comes from them [inaudible 00:07:17] or where does it come from? Well, it comes from a process we all familiar with called photosynthesis.

What do plants need to grow? They need sunlight. They need is they need water, and they need a source of carbon and that carbon they get from the air. Atmospheric CO2 makes it do photosynthesis into our plants and the plants convert that CO2 into either cellulose, which is the world's most abundant biomass or into starch. A bovine comes along and eats that above ground material here and with the cellulose, let's say convert some of that carbon into methane gas, that methane gas that [inaudible 00:07:59] out are coming from the manure is not new carbon added to the atmosphere. It is not additional carbon added to the atmosphere, but it is a recycled form of carbon because that carbon on the right side, in the methane originates on the left side from atmospheric CO2. So, this is not new and additional carbon added to the atmosphere.

What happens to that methane is that after approximately 10 years, it's converted into CO2 again, through a process called oxidation to be scientifically correct. It's called a hydroxyl oxidation. So, you might notice that, well, why is that a good thing? Didn't you just say, methane has a lifespan of 10 and C02 one of the thousand years. Yes. And this is not a question of good or bad. It's just a question of whether or not a stable livestock herd, whether or not it's stable, livestock herd adds additional new carbon to the atmosphere and hence new warming to our climate. And the answer to that is no, they do not stable herds do not increase warming because the amount of methane produced and the amount of methane destroyed through this atmospheric removal process, [inaudible 00:09:16] balance, if we increase herd size, then we add new additional method to the atmosphere and we don't want that.

But if we through whatever means reduce methane, then something beautiful happens and I will show you that in the next couple of slides. On the livestock side, we see carbon cycling from the atmosphere through the plants, to the animals, back into the atmosphere and so on. This process goes on and on and on in a circular, how is this process different or similar to let's say fossil fuels? Fossil fuels, oil, coal, and gas, originally forest dinosaurs, and so on that died decade, fossilized accumulate in the ground for a very long time, hundreds of millions of years and then over the last 70 years, seven, zero that is. We humans extracted about half of all that carbon, and we burned it and now all that carbon that was down there is in the atmosphere because cars trucks, trains, planes, ships, power plants, and so on brought it there.

This is not a short cycle of 10 years or so this is a one-way street where fossil carbon made it into the atmosphere and this fossil carbon related CO2 is accumulating at a very fast pace. So just to contrast

these two on the left side, you see the fossil fuel situation. Carbon fuels the carbon that was stored in the form of fossil fuels. We're down there. We unlocked them by drilling or digging them out and then we add in this ancient carbon to the atmosphere on the livestock side, you have atmospheric CO2, which makes it do photosynthesis into our plants. Some of it stays above ground. The majority goes below ground into first the roots and then into the soil, a process called soil carbon sequestration. Please remember about one third of all human-caused carbon is stored in our soils.

Our salts extremely important in storing carbon and keeping it out of the year. So, the previous speaker just referred to soil, carbon sequestration, not being accounted for in most schemes. This is really something we have to overcome because it is such an important tool for humanity to store carbon, where it needs to be in the ground, in our healthy soils. So now the bovine comes along and eat some of that plant material, some of that cellulose or starch convert some of that into methane, which stays in the air for 10 years. It's converted back into CO2. So, you have a one-way street on the one side, and you have the cycle on the other side, nobody should compare a car to a car. That's my take home message on this one, because they are totally different. We're adding new, additional carbon on the one side and we are recycling carbon on the other side,

I will now explain to you the difference between CO2 along with climate pollutant versus methane. So, let's imagine you were to drive from home to work on Monday by burning gas. You will put new and additional CO2 two into the atmosphere on Tuesday, you drive the same distance, and you add new additional CO2, to the atmosphere on Tuesday. But that's now on top of what you put out the previous day on Wednesday. You drive again, you put new, additional CO2 into the atmosphere, and every time you do that, you add to the existing stock of CO2 in the atmosphere. Hence the name, stop gas.

Okay. Remember this CO2 and nitrous oxide are stock acids. Every time something produces these gases, they stay in the atmosphere. Every time you've ever driven a car. All of that CO2 is still in the atmosphere and on top of what your parents put out and your grandparents and so on. That stuff is in the air for a thousand years. Okay,

GWP 100 currently acts as if methane were also stock gas as if it were also to accumulate every time your cows on your dairy belch. It treats them as if that is new and additional carbon on top of what you've called us put out a year ago or 10 years ago, but that we now know is not true. It's not correct because methane is not just produced. It's also destroyed and that makes methane is so-called flow gas. The amount of methane produced by a constant herd of cattle and the amount of methane destroyed are in balance. It does not accumulate like CO2 does. I give you an analogy? I'm a big fan of analogies. Imagine two bathtubs. The one is the analogy for CO2. And then the second one will be the analogy for method.

The first analogy for CO2 is a bathtub that has a faucet, but no drain. Anytime you open that faucet, water goes into that bathtub and the levels rise. That's what happens with CO2. Every time we burn fossil fuels, we add to the existing stock of CO2s and as a result, temperatures rise.

The second analogy, the methane, bathtub analogy here, you have a faucet, but you also have a drain if you turn that faucet on the normal rate, then the same amount of water that goes into the bathtub is going out through the drain. Meaning no change in water levels, that's what happens when we have constant cattle herds let's say constant methane sources. If we crank that faucet on all the way, then we

might add more water than we let go through the drain and then levels rise. We do see that in some parts of the third world where livestock herds are increasing, we don't want to see that.

We actually have to work hard to circumvent that by helping them become more efficient. But what happens when you turn down that force, it is that you now have reduced the inflow, but the outflow is still the same, and that means now levels go down and that's a beautiful thing. That's only possible with the flow gas, not with the stock gas. So, it's really important to understand the behavior of a gas and how it affects warming and GWP 100 does not depict that impact on warming.

The first folks who came out with that were, Miles Allen from the University of Oxford, and then also Dave Frame from New Zealand and others who, who said, hey, what we're doing with methane is wrong. We are depicting it as if it were a stock, gas, as if it were to build up. Even though there is an atmospheric removal process and that's not counted for using GWP 100, we are making a mistake.

That comes at a very high price for our agricultural sector. So, they wrote a bunch of white papers and blocks and so on. You see some of them depicted on this slide, but also of course, a lot of peers reviewed published data in high impact journals. My own team has written several. They are currently under review and will soon be published. So, what they said was we need a new unit. GWP 100 does not do a fair job on methane. So, they proposed a new unit called GWP star. I will explain that on the next two slides. These next two slides will be a little technical, but they are very important to understand why the unit to quantify a methane is so important and why what we currently use is so inappropriate.

This slide here shows three scenarios. The first one is an increasing scenario where we increased methane by 35%, over 30 years. This could be because in a certain region, we increased cattle herds and as a result increased warming, the second a theoretical scenario is one where we hold our methods pretty stable, maybe slightly reduced by 10%, over 30 years. The third one is a more aggressive scenario where we actually decrease methane by 35%, over 30 years. Okay. How would these three scenarios, the increasing, the stable and the decreasing scenario for methane be depicted using this old unit GWP 900.

If we were to do that, then, the GWP 100 calculation would depict all three scenarios to increasing stable and decreasing scenario as adding significant additional amounts of CO2 equivalent, greenhouse gases and that's wrong. Well, the top here is agreeable. I'm agreeable to it, at the middle and the bottom one here, we see where significant mistake is made because, it does not account for the atmospheric removal of this very important gas. It acts as if methane were stopped gas and not a flow gas. So hence the criticism of my colleagues from Oxford and other places, and they are pledged to use a new unit called GWP star GWP star predicts the same impact of increasing amounts of methane over a period of 30 years as GWP 100 does. What you see in blue here is a significant amount of additional warming that's caused when we increase methane.

Again, we don't want to do that, but look, what happens if we hold our methane emissions, stable or slightly reduced them, then you don't see any blue North of the x-axis. That means there is no additional warming from either constant herd or from any herd that has a slight reduction over time. You see even a little bit blue, and that means negative warming South of the x-axis and the sign in front of the number has changed from positive over here to negative on the right. That means there's now a little bit of negative warming occurring because we decrease methane by 10%, over 30 years. But look, what happens when it decreased methane strongly by let's say 35%. Then we actually pull carbon from the

atmosphere, and it induces a strong, negative warming, meaning a cooling impact. If we reduce methane, we have a short-term level for reducing our climate impacts and our dairy sector can do that.

Not just here, where I live, but also throughout the rest of the world, we have to find ways of reducing methane and when we do so we have an instantaneous impact on climate. As the next slide, will show.

Two scenarios here. One is, let's say a power plant that over, let's say 20, 30 years increases the amount of power produced and as a result, the CO2 levels go up from that power plant. What will the warming cost by this increasing amount of CO2? What will the woman look like? It will increase and you see this at the bottom here. It will increase exponentially. Why exponentially, because CO2 is the stock gas and as you remember the pyramid depiction, I showed earlier, it accumulates in the atmosphere. If we increase methane linearly, let's say by growing a feedlot population from 10,000 cattle to 15,000 cattle, then we see an equal linear increase in the warming caused by that method.

Okay. So, we do not want to see an increase in methane because that cause increase in warming. Now let's take a look at constant emissions. I'd say a power plant is running on constant load over 30 years. How does that affect warming? Well, the woman goes up from the constant CO2 source. Why? Because it's cumulate. It's, it's a cumulative, it's accumulated a constant number of cattle producing a constant amount of methane, leads to a constant amount of warming, no increased warming from constant cattle Herds. Remember that? Remember what the Paris climate accord is all about. It's not about net zero carbon or reduce our carbon by so-and-so much. It is about not increasing warming. Okay. We try to cap the warming by one and a half to two degrees. That's what the Paris climate is. The quarter's about a constant cattle herd does not increase warming. It leads to no change in warming, but now let's take a look. What happens when we reduce emissions? And that's what all my work is all about. Reducing emissions.

So, reducing the emissions of CO2 versus reducing emissions of methane. How does that look like? Let's say our power plant we're in a process of being turned down over time and then we would stop it. So, if you reduce that CO2, by turning that power plant down, then what happens to the warming? Look at that, that warming still goes up. Even though we are decreasing CO2, it still goes up all the way to the point of, until we stop that power plant and kill that power plant, then the related CO2 warming will plateau. That's what it takes. That's why the world is talking about net zero, because for fossil fuel, you need to go to net zero to stop further warming, but that's not the case for methane, for methane.

Any reduction of methane will lead to a negative woman scenario, meaning a cooling scenario. So, it's the reverse of what you saw on the left side were increases of methane need to linear increases of warming from that method. If you decrease methane, you see a linear decrease of the warming related with that method. So, you will now probably ask me, is it possible for us to achieve as, as at a situation where we by reducing methane can actually contribute to negative woman, meaning having a net cooling effect such as planting trees would provide us with, cause when we plant trees, what trees do they suck carbon out of the atmosphere. That's what trees do, so reducing methane would have a similar, a similar effect, but an instantaneous one. So, in California, we have a new law it's called SB 1383 and it mandates a 40% reduction of 44, 0% reduction of methane to be achieved by the year 2030.

So only 10 years from now, when our farmers first heard that they wouldn't, they went wild, and they thought never can we achieve that. Little did they know that our state, the State of California had something planned that actually worked well, which was to incentivize, financially incentivize the use of techniques and technologies to reduce methane. They put in half a billion dollars that was matched by

the dairy industry to put in an anaerobic digesters and other technologies. The State established a cap-and-trade system, and one way of the dairies benefited from it was that they could convert biogas from digesters into fuel. Here you can see that this is a typical cuff on a dairy. You see here, what used to be an open lagoon now being covered. And as a result, it's called a covered lagoon.

So instead of off-gassing just into the atmosphere like this lagoon did before now, the biogas is trapped underneath this tar and not burned or flared off or so, not burned to make, to be made into the electricity. But this biogas is then used to make fuel from it. So-called renewable natural gas RNG. And that RNG is then sold to the vehicle fleets that say, semi-trucks that now no longer burn diesel, but RNG, this conversion of biogas to fuel biogas to RNG is considered the most carbon negative fuel type there is. The most carbon negative fuel type there is. That means that's a good thing. Sounds negative. Sounds bad, but it's a good thing. In this case, carbon negative means is much lower in its carbon intensity than other fuel types, as a result, the State of California pays for people who do what I just said.

Convert biogas from digesters interview by granting them low carbon fuel standard credits, low carbon fuel standard credits. So, five years ago, we might've had maybe 10 or so functioning digesters in California. Very soon we will have 150. And then the next five to 10 years, I'd be shocked if not at least half of our dairies were to have technology such as this, where did it take us? Well, we have already reduced our methane by 2.2 million metric tons, which is a reduction of 25%. Our dairy industry has reduced its methane by 25%. I told you the goal is 40%. So, we're over halfway there, in other words, and I go back to this slide we have achieved, or we are on path to achieving this bottom scenario of reducing methane sharply, as a result affecting negative warming, which means cooling from the methane portion of the dairy.

The dairy still produces nitrous, oxide and CO2 and they have a warming potential. That's significant, but by dropping the methane that drop in methane will contract the other greenhouse gases leading us on a path to climate neutrality. Notice I'm not saying carbon neutrality. I'm saying climate neutrality because in my opinion, that's what it's all about. It is not about carbon. It is about getting our sector to not contribute to further warming, making us become climate neutral. That, ladies and gentlemen, is possible within the near future. We did calculations for the United States, and we found that if we were able to reduce greenhouse gases from the dairy sector by 0.4% annually. If we were able to reduce greenhouse gases by 0.4% annually, that by 2038, our entire dairy industry in this country were climate neutral. We're at a point where it doesn't affect the climate of our planet.

That is what I call the path to climate neutrality. This, ladies and gentlemen, is not some kind of green washing or creative accounting. This is absolutely quantifiable and verifiable because for example, in the case of covered lagoons, all the biogas is metered. The conversion to RNG is metered. That fuel is sold off and it's verified by the state. These numbers were verified by the state of California, secretary of agriculture, and I'm very proud to be part of that, but this is not the only technology. Okay. This is just on the manure side. Very soon as the previous speaker said, we will have other technologies like feed editors. We've done research, comparing dozens of feed additives. Most of them didn't work, but five of them did, these five had reductions of anywhere between 10 to 50% of methane as a result. So, we are making aggressive steps to lead our industry into a situation where it will not affect the climate in the near future.

So, with that, I want to just announce that we have a block as part of my career center here at UC Davis. And I'm very active on Twitter and you'll find my Kia Center on the web under this address. So, with that, I'm looking forward to discussions later on. I thank you very much for your attention.