All right, go ahead.
Okay, we’re waiting on everyone.

So, I’ll be very quick.
So today we’re very pleased
to have Dr. Laura Kahn joining us.
Dr. Kahn is a physician, policy researcher advocate also.

In 2006 she published,
Confronting Zoonoses, Linking Human and Veterinary Medicine

And helped launch the One Health Initiative.
So she’s a co-founder of the One Health Initiative

and a lecturer at the Princeton University.

So without further ado, let’s welcome Dr. Kahn.
Well thank you so much Kai,

it’s a pleasure for me to be with all of you,
and, let me share my screen now.

And,
I have to apologize,
I can try and go into presentation mode
but oftentimes it freezes,
but let me give it a shot and see if it works.
So I’m going to talk with you

a One Health analysis of food, safety and security,
antimicrobial resistance and climate change
in the 21st century, and yes, they are all connected.
It’s important for us to recognize that agriculture is the foundation of civilization. Climate change threatens agriculture and food security. Antimicrobials are the foundation of modern medicine, and antimicrobial resistance threatens antimicrobial use and food safety. And we need both if we want a modern advanced society.

Just a few definitions. When I say food security I mean no hunger, and food safety means no foodborne illness. When I talk about antimicrobial resistance in this talk, I’m gonna focus on bacteria that are resistant to antibiotics.

Now the One Health concept is very simply that human, animal, plant, environmental and ecosystem health are linked. And this concept provides a very useful framework for examining these complex issues such as those that I’m talking about today. And if we wanna develop effective policies to address these health threats, we must examine the root causes. And people interact with their environment every day by inhaling air, drinking water and other fluids, and eating the plants and animals that we call food.
And I just wanna point out the One Health initiative website that my colleagues and I run. Now many people have tried to visualize the One Health concept, and some use intersecting circles with increasing coordination, communication, collaboration. Others have humans, animals, environments intersecting with One Health in the middle. The wildlife folks like to highlight wildlife health separate from domesticated animal health, and human health. And my colleagues in Sweden use an umbrella graphic that includes a lot of, but most importantly, zoonotic infections in one intersecting circle and comparative medicine and chronic diseases, translational medicine in the other. In this talk I’m going to focus on the zoonotic issues. 

Now, I visualize One Health as a multidimensional cube, a matrix, interdimensional matrix if you will. In one dimension are the One Health factors, humans, animals, plants, environments, and ecosystems. On another dimension, the complexity factors looking at providing scale, microbial, or cellular individual and population levels. And then you can have the political, social and economic factors along another dimension.
And that can be represented by political borders, such as local, regional, national, or international and global.

And there can be a fourth dimension which I’m not representing or trying to represent and that’s the dimension of time, which can be in days, months, years, decades, or eras.

Now you can squash the cube into a two dimensional framework, and then you can see the intersections between these different dimensions.

And in this talk I’m going to define environments as the abiotic or the soil, water, air aspects of defined geographic areas, and ecosystems, the biotic interactions, the microbial, flora, and fauna, within defined geographic areas.

So in this talk then we’re to do a One Health analysis looking at different factors, One Health factors, complexity factors, and following it up with the political, social, and economic factors, just a brief, touching on that.

So in other words let’s do a One Health satellite perspective on these issues.

Our first analysis.
We have almost 8 billion humans on the planet.

And according to the UN Food and Agriculture Organization,

we have around 30 billion terrestrial food animals.

And as the famous children’s book author, Taro Gomi writes,

all animals eat, so everyone poops.

And indeed, according to this paper published by David Berendes in Nature Sustainability,

they estimate that humans and their domesticated food animals produce around 4 trillion kilograms of fecal matter each year,

and that is increasing.

And to just put it into perspective on how much that is,

4 trillion kilograms would fill over 1.6 million Olympic size swimming pools,

or to put it another way, to bury the entire surface areas of Los Angeles and New York in six feet of feces,

which is a lot of fecal matter.

If you look at just human fecal matter,

lot of people are still defecating outdoors,

called open defecation around 673 million, according to Statista,

A lot of these people are in developing countries
A lot of people don’t have access to basic sanitation. And so they use open fields, which has health, environmental and human health consequences. Animals use open defecation all the time.

Sanitation systems are designed to process human fecal matter, they do not, they’re not designed to process animal fecal matter.

Very little research actually done on all the animal fecal matter. Now it’s important to point out that 4 trillion kilograms of fecal matter that we produce, 80% of it comes from animals. Very little study, this one study done in 2014 looked at 34 countries to see if they had policies related to manure management.

30 of them did, but, having legislation on what to do with all this fecal matter is one thing, but actually enforcing it is another. And most of these countries have weak enforcement on manure management.
for poor or developing countries, wealthy countries, such as the United States have large concentrated animal feeding operations that have hundreds, thousands, tens of thousands of animals being raised in enclosed concentrated areas, and they’re producing a lot of fecal matter. And indeed this one study, the latest one, 2008, the U.S. Government Accountability Office found that there’s no federal agency consistently collects reliable data on these CAFOs, but they did find that some large operations can produce more than 1.6 million tons of manure a year. Some that can generate more raw waste than some U.S. cities produce annually. So, this is a major issue that’s just not being discussed. There’s a lot of pathogens in human fecal matter, I’m not going to go into the detail of all of these pathogens, but, just as there’s lots of pathogens in human feces, there’s lots of pathogens in animal feces, but again, very few studies examining these pathogens looking at their health implications
on, foodborne pathogens, waterborne pathogens,
or just a direct contamination of people.
Nevertheless, in 2015, the World Health Organization
released a report estimating the global burden of foodborne illness.
They estimate that around 600 million people get sick,
around 420,000 die.
Children under the age of five makeup 40% of the cases.
But most importantly, most of these illnesses are due to diarrhea disease agents.
And most of these diarrhea disease agents are in fecal matter.
Many of them in animal fecal matter.
Sorry, it’s problematic.
Again, we focus primarily on human fecal matter
and the sanitation systems that either do or don’t exist,
but nobody’s talking about all of this animal fecal matter
in the environment that’s contaminating our food,
our water, and the people living in those environ,
making the people sick.
So that now brings me to this second One Health analysis
looking at plants.
So the world has over 50,000 edible plants,
but just three of them, rice, maize, and wheat provide 60% of the world’s food energy intake. And these plants have health needs that’s relevant in our discussion today are the macronutrients, nitrogen, phosphorus, and potassium.

Now in 1944, Norman Borlaug, pictured here who was a plant pathologist, worked for the Rockefeller Foundation to try to improve wheat harvest because a lot of the wheat crops were dying from disease and there were problematic growing conditions.

So he developed some new wheat varieties and new crop management practices, which spread from Mexico to Asia and south America, and this was known as the Green Revolution. And the Green Revolution was tremendous in staving off famine for much of the world, and you can see in these graphs that for the same amount of land that was being used to grow the crops, the yields just took off, and it was just amazing.

And you can see here the serial yield in some countries are very high. However, there were problems with the Green Revolution. Intensive farming practices that were needed for this intensive yield from the land
led to soil erosion, water shortages, micronutrient deficiencies in the soil, a dependency on high nitrogen synthetic fertilizers which we’ll get to more in a minute. Vulnerability to pests and a high need for pesticides. And because these crops were genetically engineered, they were labeled genetically modified organisms which could lead to political opposition. Now in 1961, 1.5 times more animal manure was used as fertilizer than synthetic fertilizer, but because of the Green Revolution now in 20, four times more synthetic fertilizer now is being used than manure. And if manure is not being used as fertilizer then we have to ask, well, what’s being done with it? Because again, we’re producing 4 trillion kilograms of fecal matter, 80% of which is from animals. And if it’s not being used as fertilizer, than what’s being done with it? Now, there are some advantages to using manure as fertilizer, because it does help renew, to nourish the soil that you don’t necessarily get with the high nitrogen fertilizers.
And that brings me now to my third One Health analysis, looking at environments and ecosystems. And you’ll see where I’m coming, it will kind of all tie together with this section. Now, climate change threatens agriculture, and agriculture worsens climate change. And in order to truly understand climate change we need to think like geologists. And we need to look at the geologic timeline of the temperature of the planet. If we look at the Paleozoic era, yes, the planet was very hot, but it’s important to point out that the land was barren because it was hot, and there was thriving life in the seas. We definitely do not wanna get back to this level of heat on our planet. With time, the planet began to cool, you get to the Pliocene era, and then the Pleistocene era, which was the ice age. Now, the planet, much of the planet was covered in thick layers of ice, humans did exist. Their survival was tenuous. And then inexplicably, around 10,000 years ago, the planet began to warm. The ice age ended and you get to the beginning of the Holocene.
Now, so for the past 10,000 years, and this is sorry, this is when agriculture was developed about 10,000 years ago. And the reason why it could develop was because the planet was warm enough to allow it.

So, when we talk about climate change, it means change from this Holocene baseline that has allowed agriculture and civilization to exist. Now, there was a little deviation below the Holocene baseline, and that was the little ice age. We have now gone up about one degree above this Holocene baseline, and we’re starting to see the effects of climate change. Now the artists from, during the little ice age documented for us what it looked like. You had a lot of frozen, the Thames froze over in Britain, and they had frost fairs. They had frozen wasteland and Flanders ice skating on the main canal in Rotterdam.

But most importantly, the little ice age was noted for crop failures, bread, riots, famine, and wars. So, when food security breaks down, so does civil society and you wind up with wars. And it’s a very ugly,
ugly situation indeed, one that we want to avoid at all costs. Now in 2010 the World Bank did some climate modeling, estimating agricultural yields in 2050 due to climate change effects. Assuming current agricultural practices and crop varieties. And they determined that much of the planet is going to become too hot and too dry to grow food. And as again, as we said, we’re already starting to see the impact of this. But even with that situation, even today though, we still have a lot of food insecurity, a lot of hunger, particularly in poor developing countries like Sub-Saharan Africa, south Asia, south America, but even in the United States where the color is a monolithic blue, we have a lot of food insecurity here as well. So, this is a major issue that, one that really needs to get much more attention than it’s getting. Now that brings me to greenhouse gases. Because manure and synthetic fertilizer emit greenhouse gases. In fact, they’re major emitters of methane and nitrous oxide.
Now, if we use carbon dioxide as the baseline, methane is about 28 times more potent than carbon dioxide at trapping heat, and nitrous oxide is about 265 times more potent at trapping heat than carbon dioxide. So these are greenhouse gases that are extremely potent and should be of major concern.

I just wanna point out that basically these greenhouse gases that we’re burning are decomposed plants and animals, pressure, heat, and time, produce coal, petroleum, gas. So we’re just burning old, dead animals and plants up into the atmosphere.

And that’s what the fossil fuels basically are made from. In terms of what we in the United States emit according to the U.S. Environmental Protection Agency, we emit about 17% of our greenhouse gases are methane and nitrous oxide. Of the different economic sectors, agriculture produces about 10% of the greenhouse gases.

But most importantly, if you look at the sources of methane and nitrous oxide, manure management produces 9% of methane, Enteric fermentation a whopping 27%. Nitrous oxide, manure management 4%,
and a whopping 78% of agricultural soil management produces nitrous oxides. So in other words, Enteric fermentation, manure, and the use of high nitrogen fertilizer, agricultural soil management, major emitters of the most potent greenhouse gases that are trapping heat. Now you might ask, "Well, what is Enteric fermentation?" Well, cattle have four chambered stomachs, one of which is called the rumen, and it acts as a fermenter of the feeds, and that produces methane. And, when this methane builds up, the cow burps and releases it. And if you’ve got a lot of ruminants, you’ve got a lot of methane. Different animals produce different levels of methane, the beef, the ruminants, beef, dairy, and Buffalo produce a lot of enteric methane. Chickens not so much. Goats are ruminants, they also produce methane as do sheep but not pigs. So, chickens are probably more environmentally friendly than your average ruminant. Let’s now shift gears and move from environments.
to ecosystems and talk a bit about antimicrobial resistance.

Remember, it threatens the practice of modern medicine.

Oops.

And it turns out that any microbial resistance is ancient in everywhere.

For a long time to people thought that, or scientists thought that microbes used antibiotics as a form of chemical warfare against each other.

But it turns out it appears that they use minute amounts as a form of communication with each other.

which is a very different thing.

And using metagenomics, where you extract DNA or genetic material directly from the soil, they have found resistance genes everywhere in the Arctic, the Antarctic and places that have never seen anthropogenic exposure.

And so we’re dealing with a much bigger issue than we originally believed.

This isn’t something that is just due to our practice.

This is preexisting, and our massive use of antibiotics in humans, in animals, on crops, is increasing the expression of these resistance genes.
and the bacteria are sharing them with each other much faster than we can develop new antimicrobials. So, we are working against nature and we’re going to lose. So, how are we adversely impacting the global resistome? Again, poor sanitation leading to foodborne waterborne illnesses from all the manure in our environment. Indiscriminate and antibiotic use. Untreated human and animal waste. Land and water contamination. And then the wildlife spread these resistance genes as well. All of them together conspire to worsen antimicrobial resistance. Manure, particularly animal manure also can serve as a potential hotspot for microbes to share resistance genes with each other. So again, the manure connection. So let’s now quickly go to the fourth analysis, looking at this political, social and economic factors. Food security is the foundation of civilization. It means no hungry people, and it’s built on three pillars. Food availability, food access, or affordability, and food use food. Food security is so important that the UN listed it as number two of its sustainable development goals.
in terms of zero hunger. There are political implications of food insecurity. If food becomes unavailable or too expensive, civil society breaks down and people riot. So it’s in government’s interest to make sure that their people have enough food to eat. Now, there are countries that eat a lot more meat than other countries, particularly the United States. We are one of the highest consumers in the world, so we are in no moral position to tell anybody else what they can or cannot eat. But, eating meat is the norm in most countries, with one exception, India, where they have the largest fraction of vegetarians in the world. But even in India, demand for animal proteins such as Buffalo milk is increasing. It is possible to change national dietary preferences but it’s not easy and it requires cultural and societal change. In the U.S. more Americans are cutting back on meat. Some of the reasons are concerns about their health, or the environment.
But again, this is not an easy thing to do and you can’t force people to demand that they all become vegetarian because it’s, you know, eating meat is ingrained in many of our societal functions and religions. It’s not, again, not an easy thing to change.

So now a recap on our findings. Humans and domesticated animal populations are growing and producing increasing amounts of fecal matter each year. Animals produce 80% of it, but it’s generally ignored. Human and animal fecal matter contain many pathogens, but sanitation systems are designed to process human fecal matter, not animal fecal matter. The question is what’s being done with all of this animal fecal matter produced in CAFOs, and in countries around the world? There’s little oversight of it. Now plants need nitrogen, phosphorus, and potassium to grow which is contained in manure, but synthetic fertilizer uses predominates, and of course, all of this manure is emitting methane and nitrous oxide which are potent greenhouse gases, worsening climate change.
Manures also contaminating the global resistome which worsens antimicrobial resistance. And all of these together, these findings impact food safety in the practice of medicine, and food security and the continuation of agriculture and civilization. So you might be asking, "Well, what can be done?"

Well in 2016, the UN General Assembly met to deliberate on antimicrobial resistance. They agreed that this is a crisis and requires political solutions, and tasked the World Health Assembly and the World Health Organization to develop global action plan. One of which had objective three, to reduce the incidence of infection through effective sanitation, hygiene and infection prevention measures. But nowhere in the action plan is the issue of animal manure management, and its ecosystem impact. And that is a major oversight, and we won’t make any headway until that is addressed. Now there are strategies to reduce methane and nitrous oxide in terms of manure management.
You can change the way manure is stored. You can have methane digesters capturing it, converting it into renewable energy. For agricultural soil management there are strategies to use low nitrogen fertilizer, you can have drip irrigation. No till farming where you’re tilling, when you till you release methane, nitrous oxide. The use of cover crops. So there are strategies in agriculture where you can reduce the nitrous oxide emissions. Unfortunately, there’s been no mention of agriculture’s contributions to greenhouse gas emissions. There was no mention of it in the Paris Climate Agreement. There was no mention of it in COP26 in Glasgow. There was some mention of it, there’s recognition of it at COP23 in Fiji in 2017, but most of the discussion was on climate changes impact or threat to agriculture, not so much on agriculture’s contributions to climate change. So, both of them need to be discussed.
In California, there was a bill that was passed in 2014 to reduce methane. They allocated 12 million to support dairy methane reduction projects using dairy digesters.

New York State recently passed the Climate Leadership and Community Protection Act into law in 2019. And there is a brief little mention of management practices and land use and agriculture and forestry for long term carbon sequestration, but, not so much focusing on methane and nitrous oxide emissions from agriculture.

The U.S. Congress, there was the Agriculture Resilience Act of 2021 that was introduced with a goal to reduce in net greenhouse gas emissions in agriculture, but this bill has not been passed.

So there are efforts. They need political support to get this done. This is a role that we can all play. And to sum up, we wanna restore our beautiful planet.

One Health recognizes that life is interconnected, and the matrix analysis that we’ve done shows that there are microbial connections between food safety and security,
antimicrobial resistance and climate change. We all need to work together to promote One Health education, research, policy development, and outreach for the public and for the policy makers to understand these connections and why we need to address them if we wanna continue agriculture and food security and civilization on the one hand, and the continuation of antimicrobials and modern medicine on the other. If you’re more interested in One Health I have a Coursera course available focusing on primarily zoonotic diseases, also food safety and security.

I’d like to acknowledge my colleagues in the One Health initiative. And I’d like to thank all of you for your time and attention, and am happy to take any questions. So thank you. Thank you Laura. (audience applauding) 

For our online audiences, if you do have any questions, so please type your question in the chat box. And while you’re thinking about the questions, we do have already pre-collected the questions from our students.
I mean they’re over excited by this topic, and we have a couple of questions to ask. The first one is regarding the, manure management. So, the students, couple of students were wondering like, are there any other ways that we can reduce the animal waste other than, just the manure you mentioned the anti, you know, mentioned the greenhouse gas emission issue, that, (indistinct) infectious disease issue. So what are the other ways that we can do about it? We need to figure out what are we going to be doing with this trillion of kilograms of animal waste that’s being produced each year. Again, sanitation systems are designed to process human waste. There’s no system that I’m aware of that is designed to process animal waste. And if animal waste isn’t being used as fertilizer, then it’s not clear what it’s being used for. And I think this is, an opportunity public private partnership to try to figure out what to do with all of this animal waste. You know, I’ve just, all I’ve seen really is the methane digester collecting the methane from it.
but, it’s not really been used much for anything other than fertilizer. And if it’s not being used for fertilizer, then it’s not really being used for anything other than contaminating the soil, the water and the atmosphere. So it’s a major unaddressed problem that we as a civilization must figure out if we want to have a more sustainable future. We do have another question regarding the policy. We can see obstacles or implications for this One Health framework. I think, we see that a comment from Dean (indistinct) also kind of related this issue, so I will read this question first. So we have powerful economic interest in fossil fuels. Food industry is, what political and economic strategies have been successful to pivot the western interest to consider the alliances. So, for example, progressing such elements as the use of manure as fertilizer, use of low water agriculture practices. Animal feeding, feeding including 10% seaweed to reduce methane.
There are industry and now there are products, electric, electric copper (indistinct) et cetera.

Well, you know I’m very interested that California and New York state were able to pass some legislation. I’m not aware of other states doing this. So, I’m very interested to find out what were the political conditions that allowed these states to do this. And I’m not aware of countries doing this, focusing on these is these areas. So, I think it’s a right for study, to figure out how we can tip the politics to get legislation in place or to get companies in place.

That are, you know, that their mission is to address manure’s impact on the environment or on ecosystems. There is some research done at UC Davis on using seaweed to reduce Enteric fermentation. Now seaweed has a compound in it called bromoform. And apparently bromoform if it’s released into the atmosphere it has deleterious effects on ozone. So, we don’t want to solve one problem by worsening another. So we have to be very careful in whatever we do.
to make sure that our solutions don’t cause unintended consequences. But, you know I think this is all still in its infancy.

Thanks Laura, yeah. I think a related question from students is that, this is a fascinating idea, the framework of One Health, and you actually mentioned a lot of those things in actually considering the policy engagement. So overall, the students are interested to know what do you think are the largest obstacle you see to kind of engage, or implement the One Health framework into the current policies?

I think, well, this concept has been largely driven by veterinarians. inEurope, on the continent of Africa, Asia, less so in the United States again, not sure why.
I think our divided politics is certainly not helping. So, my goal is to try and get the word out, through promoting the concept. And, I’m very grateful to you to give me an opportunity to speak to your students today.

Thanks Laura, we’re thrilled to have you here!

And I’m sure this is a very exciting topic that we have a very large online audience and that’s the one of the evidence or proof. So, another thing that the students are quite interested in is that, you know, you have a fascinating career as a researcher, as educator. So, our audience today, the students and PhD students, so they are wondering, can you talk a little more about your personal experience? About your route in the field as a woman in the STEM field. So it’s kinda very general just for the students. Yeah. Well, you know, I wish I could say... that I had a laser focus on this, but, I started out in nursing. My interest was always in public health, and, I worked as a nurse for a couple of years before deciding to go premed.
and then went back to do a Postbaccalaureate. This was long before they had Postbaccalaureate programs. But I did that and got into medical school. My interest was always in, again, public health, the big picture.

I did a, internal medicine residency and then got a master’s in public health and a general medicine fellowship at Columbia.

And was working in government doing, first, I was doing drug safety oversight at the FDA, and then moved to the New Jersey Department of Health, where I was doing hospital quality oversight, when I decided to get a master’s in public policy, and there were a variety of reasons for that. And just as I was about to start my master in public policy, this was in the fall of 2001.

And, if you remember what happened in the fall of 2001, it was, turned our world upside down the terrorist attacks of 9/11, followed a month later by the anthrax crisis, and that changed the trajectory of my career. I went into bio defense.

And, I took a course, prevention against weapons of mass destruction,
where the focus was on nuclear issues, nuclear discernment,
but I was interested in the biological aspects of it.
I joined that research group,
and, in the course of my policy research,
reading the veterinary medical literature,

it was stunning to me that there was this overlap
between the agents of bioterrorism on the one hand,
and emerging infectious diseases on the other,
in that the vast majority of both were zoonotic,
meaning that they were diseases of animals

And yet, I discovered that physicians rarely ever talked to each other.

And, that’s what prompted me to do my research
and to write up that article
in the emerging infectious disease journal in 2006.
And I got a huge response from the veterinarians,
and I heard not, I heard crickets from the physicians,
and that lack of interest has continued.
Not clear if COVID 19 will change things, but I'm not so sure.

I think this is a fascinating story, Laura. I'm sure people, students will be inspired by your story.

And, since you mentioned the COVID 19, one of the questions students have exactly, how has the One Health community responded to the COVID 19?

Especially, regarding the start of this pandemic has a lot to do with animals in China, treating everything.

So what do you comment on that?

Well, those of us in biodefense, this was a catastrophe waiting to happen for a variety of reasons.

I mean, it was very clear and I'm, right now I'm researching and writing a book about One Health and the COVID 19 pandemic.

So I'm using this framework to examine this pandemic from all angles.

And, there's several things that have come out in my investigation.

If you compare this pandemic with SARS that emerged in 2002-2003 in the Guandong province of China,
and with MERS, Middle East respiratory syndrome that emerged from Saudi Arabia in 2012.

In both those spillover events there was very clear evidence of a natural spillover event.

In the case of SARS, there was, almost an exact match of the virus in animals with the human strain. And also importantly, there was occupational evidence that the people who were working with the animals had a higher rate of antibodies, higher sero prevalence rate of antibodies to the virus compared to the general population. You saw that with SARS.

Similarly with MERS, there was clear evidence from the camels going back decades, showing that the virus had been circulating in these animals long before there was a spillover event into a human. And again, they did a serologic survey of large, like 10,000 people in Saudi Arabia. And again, there was occupational evidence, exposure of those who were working in the slaughter house.
or those who were working with the camels had a much higher sero prevalence rate of antibodies to MERS than to the general population. Now, none of those things are evident with COVID-19. There has been zero animal, there’s been no animal host, intermediate host of this virus, unlike SARS and MERS. And there’s no serologic evidence of occupational exposure in the animal work, in the workers in the Wuhan market. That paints a similar picture to what we saw with SARS and MERS. So, that leads us to a conundrum as to how this started, because we need to figure out how this started so we can prevent another one from happening. And, I know this is a very political issue in terms of the origin of the virus, but right now there is no evidence that it was a natural spillover event. <v>Thanks Laura.</v> I do want to give the opportunity to, for an audience, if you have any other questions so feel free to speak up. And also for online audience, if you have any other questions, please type in the chat box.
Yeah.

Professor (indistinct).

Yeah hi, thanks for that great talk.

I just wanted to raise a point that re-enforces the complexity of these issues, which is the capture of methane from manure, and using it as so-called renewable natural gas, which is what some people are calling it. And so, a lot of environmental justice people are actually against the use of that in CAFOs. Cause they feel that it essentially entrenches the CAFOs when, CAFOs as you pointed out have a lot of problems for the surrounding communities, et cetera, where a lot of people feel they need to be fundamentally reformed as a, and that the renewable natural gas is a form of greenwashing. So I don’t know if you’ve heard that argument, but I just wanted to put that out there and see how you respond. Yeah, thank you for that comment.

Well, yes, I know a lot of people in the environmental community are against doing anything with the CAFOs ’cause they feel they should all be going out of business.

I think given that eating meat is the norm
in most countries, I think expecting people to become vegetarian or vegan is unrealistic. I did not include my slide on the pros and cons to eating meat. There are pros of course, and there are cons. And some have argued that we evolved into modern humans because we hunted cooked and ate meat. You know, again, that's debatable, but, nevertheless, that it is deeply ingrained in our cultures and our religions, and I think we need to be realistic in what we're dealing with. So, we need to try and make civilization as sustainable as possible, and figure out ways to curtail the negative externalities of these industries, recognizing that, it would be ideal if everyone became vegetarian, but again, I think that's, I mean, we're divided politically as it is, demanding that people change their deeply ingrained eating behavior, not easy to do. I mean, it’s hard to do, as a practicing physician, to tell somebody to cut back on meat, telling an entire culture or an entire society, it’s just not realistic in my book. Thanks Laura.
I think, are kind of related to question to your last point, is the students also recognize that it’s (indistinct) to just shut down the meat consumption. So the students, they have an interesting question for you is that, do you think like to what extent do the more, so called, the affluent countries that have lot of power resources need to subsidize better sanitation systems in places for, with low middle income countries that they are lacking the resources. So do you think this, yeah. Yeah, I mean, we have a responsibility. I mean, since we’ve been such major energy users and meat consumers in this country, I think we have an obligation to other countries to try to ensure their survival. There’s much more that we can be doing, and I think those are important topics for, worthy of study and you know, and other courses. So, again, there’s much that can be done that we must do. Thanks Laura. Any other follow on questions? So thank you,
and thanks for everyone for joining us online and also in person. 

Well, thank you so much for having me. <v>Thank you so much.</v> 

it was a pleasure to be with all of you. <v>Thank you so much.</v> 

Just a reminder, 

our recording will be online on central website, 

so thanks again Dr. Kahn. 

(audience applauding)