HOUSE OF LORDS

Environment and Climate Change Committee

Uncorrected oral evidence: Methane

Wednesday 17 April 2024

10 am

Watch the meeting

Members present: Baroness Sheehan (The Chair); Baroness Bakewell; Baroness Bray of Coln; Lord Duncan of Springbank; Lord Frost; Lord Giddens; Lord Grantchester; The Earl of Leicester; Earl Russell; Lord Trees; The Duke of Wellington.

Evidence Session No. 4 Heard in Public Questions 63 - 83

Witnesses

I: Dr Rebecca Fisher, Reader in Atmospheric Science in the Centre of Climate, Oceans and Atmosphere (Department of Earth Sciences), Royal Holloway, University of London; Professor David Frame, Professor of Physics, University of Canterbury, New Zealand; Professor John Gilliland OBE, Special adviser to the UK's Agriculture Horticulture Development Board (AHDB); Phil Bicknell, Chief Executive Officer, UK Agri-Tech Centre.

Examination of witnesses

Dr Rebecca Fisher, Professor David Frame, Professor John Gilliland and Phil Bicknell.

Q63 **The Chair** Good morning, everyone, and welcome to the House of Lords Environment and Climate Change Select Committee. This morning we will be taking evidence for session 4 of our inquiry into methane emissions. This will be the first of two sessions focusing on emissions from the UK agriculture sector. I extend a very warm welcome to our four expert witnesses, who will help guide us through our inquiry for this session. Thank you so much for making the time to be with us today.

I have some items of housekeeping. I should remind all attendees that the session is webcast live and will subsequently be made available to view via Parliament TV and on the parliamentary website, and that a transcript will be taken and made public. Witnesses will have the chance to review the transcript beforehand and to make any necessary amendments with the agreement of the committee clerk. I remind all members that they should declare any relevant interests the first time that they speak.

I will start by asking each of our panellists to take a minute to briefly introduce themselves. I will start with those around the horseshoe first and then move on to our online witnesses.

Dr Rebecca Fisher: Good morning. I am a reader in atmospheric science in the Greenhouse Gas Research Group at Royal Holloway, University of London. My research is on the atmospheric measurement of methane, including identification of sources using stable isotopes and mobile methane measurements.

Phil Bicknell: I am chief executive of the newly formed UK Agri-Tech Centre. We have come together through the merger of three agri-tech centres that previously had a focus on plants, animals, and technology. We have done quite a lot to date in the livestock sector, particularly related to sustainability and specifically related to emissions and the topic today. I should add that I am also a part-time beef farmer, for the sake of being open and transparent.

The Chair: Thank you very much, and we will move on to Professor David Frame, who is joining us all the way from New Zealand. Good evening, Professor Frame.

Professor David Frame: Good morning, everyone. I am a professor of physics at the University of Canterbury in Christchurch, New Zealand. My background is in atmospheric physics. I worked in the UK for a long time at the University of Reading and then at the University of Oxford. My interest in this area is that I was a lead author on the fifth and sixth assessment reports of the Intergovernmental Panel on Climate Change. For the sixth assessment report, I was on the energy budget climate sensitivity chapter and we looked at the metrics of greenhouse gases—

how you compare short-lived and long-lived greenhouse gases. That is the active area of research that I have interests in.

Professor John Gilliland: I am a farmer, and my farm has already been independently audited to have been beyond net zero. I am also professor of practice at Queen's University, Belfast. I am an environmental adviser to the Agriculture and Horticulture Development Board in the United Kingdom. For the last five years, I have chaired a farmer-led innovation project called ARCZero, taking seven farms in Northern Ireland on a journey towards net zero. Previously in my career, from 2005 to 2012, I chaired Defra's Rural Climate Change Forum, answering directly to the Secretary of State.

Q64 **The Chair:** Thank you again to our panel for joining us. We are very pleased that you are able to be with us today. Before asking the first question, I will refer to my own interest as per the register on the parliamentary website and add that I am a director of Peers for the Planet, which is a non-remunerated role.

Could you outline the main sources of methane emissions in the UK agricultural sector? I will start with Dr Fisher.

Dr Rebecca Fisher: The two main sources from the agricultural sector are enteric fermentation from ruminants and agricultural waste. Enteric fermentation is part of the digestive process in ruminant animals such as cattle, sheep and goats. Methane is produced when organic material is broken down in anaerobic conditions. Microbes in the digestive tract decompose and ferment food, producing methane as a by-product. Methane produced in this process is released mostly as eructation, through the front end or in the breath of the animal. This is the largest source of agricultural methane into the atmosphere in the UK.

The next largest source is animal waste. Methane is produced in slurry or liquid manure, or piles of wet manure wherever there is a wet, anaerobic environment. Environments lacking oxygen are the ideal conditions for methane to be produced. Dairy waste, non-dairy cattle waste, and pig waste are the largest sources of waste.

The latest inventory for the UK for 2021 had methane emissions from enteric fermentation as 841 kilotonnes and from manure management as 153 kilotonnes. About 85% of the agricultural methane is from enteric fermentation, and that is mostly from dairy and beef farming. A dairy cow produces more methane than a non-dairy cow. However, as there are overall more non-dairy cattle, the non-dairy enteric fermentation is the largest source. This is followed by the dairy cattle and sheep enteric fermentation. There are also minor sources from leaks from anaerobic digesters, and I think we will probably talk more about that later. Also, some methane is produced in composting.

The Chair: Excellent. Before we move on, could we hear from Professor Frame?

Professor David Frame: I think that Rebecca has covered it all; I do not have anything to add. I am not that familiar with the details for the UK. My expertise is more on the metrics and then policy side, how you go about using these things.

The Chair: Would the other two witnesses like to contribute?

Phil Bicknell: All the numbers are the same as I have written down in front of me. The only point that I will make is that context is important when we start thinking about the diversity of different production systems. In particular, when we start thinking about our beef and sheep production, the majority of those systems are taking low-quality foodstuffs in terms of fibre, in the form of grass, and turning it into a high-quality, nutrient-dense food product.

Professor John Gilliland: I think that Rebecca has done an extraordinarily good job. The only thing I will add as a farmer is please remember that methane is only one of the three greenhouse gases that I produce. It is important as we go forward in this conversation that people respect that I cannot single out methane on its own; I have to look at what my nitrous oxide and carbon dioxide emissions are. Much as I appreciate the investigation of methane, as a practising farmer we go forward looking at the total basket of greenhouse gases in our journey to net zero.

The Chair: Thank you for putting that into context. However, I will say to all the panellists that the focus of today's session is methane emissions from farming. We understand that this has to be in context with all emissions. We are also looking across other sectors that produce emissions from methane.

Before we move on to the next question, Dr Fisher, you mentioned that burping is the main source of methane emissions from cattle. However, we do have slurry produced. Can you quantify how much of methane emissions from livestock comes through slurry and the way that it is dealt with on farms?

Dr Rebecca Fisher: Roughly 15% of the methane that is released is in the form of slurry or manure. That is what the inventory says and it may be that it is a higher proportion. Mobile measurement campaigns in other locations have suggested that the higher content of the methane is from the waste rather than from the breath. It is at least 15%.

The Chair: There is a little bit of a question mark over that.

Lord Trees: You mentioned that there was more methane produced by dairy cattle in general than beef cattle. Is that related to the diet, that dairy is predominantly grass-fed to a greater extent than beef, or is there a breed difference?

Dr Rebecca Fisher: It is related mostly to the amount of feed that they intake. Dairy cattle would take in more food in general and so produce more methane.

Lord Trees: Dry matter intake?

Dr Rebecca Fisher: Yes, dry matter intake.

Q65 **Lord Giddens:** Let me echo the welcome of the Chair and I will ask two quick questions. How are methane emissions monitored across the potential sources in the agricultural sector? The second question, which you could answer very shortly, is: how are AI and satellite measurement being deployed? If you could answer that in a preliminary way, it would help for later discussions in this session. Mr Bicknell, would you like to start?

Phil Bicknell: At one level, the UK greenhouse gas inventory is the key tool for understanding the origin and the magnitude of emissions, including methane. From an agri perspective, this is done based on assumptions and on calculations. It starts to provide a great aggregate view of the impact. When you start taking it down to the farm business level, there is a range of different technologies and approaches to measuring methane—whether that is thinking about enclosure chambers, measuring emissions on a test and trial basis, or whether it is around tracer techniques or sniffer techniques and the ability to use sensor technology. Handheld lasers is another area that is quite interesting.

The angle that I will always come from on that industry perspective is the difference between the macro level of what we produce at the national side versus what I would want to know as a farm business: what is relative to my farm? What emissions am I producing that emerge from my livestock and my farming practices? At present, the ability to measure at the national level versus the farm level is the big disconnect and is one of the barriers that comes up.

On the satellite ability, I am aware that there are different trials and opportunities being explored. We had a quick conversation outside and both our views are that the technology is not quite there yet. However, it is improving all the time in cost and accessibility.

Lord Giddens: The Google satellite is just about to come on stream and that has a huge database. I think that is an interesting initiative.

Professor David Frame: We have had a similar story in New Zealand about the national versus on-farm level. That is an ongoing area where New Zealand has had a lot of ongoing research for more than a decade. It is one of the features that has come up when trying to price methane emissions and getting a scheme to cover agricultural methane emissions at the appropriate level, given the scientific uncertainty at the farm level versus the more macro level.

The Chair: Thank you. Earl Russell would like to ask a supplementary and then Dr Fisher would like to come in.

Earl Russell: I was interested in what you were saying about the difference between the macro and the micro level. On the micro level, in your view, do you think it would be useful for Defra and the Environment

Agency to do more research at farm level on different types of farms to get a better understanding of the emissions that are produced and where they come from?

Phil Bicknell: Yes, undoubtedly. At the UK Agri-Tech Centre, we are all about trying to accelerate innovation. If we have better information and better evidence, that supports better decisions. The more information we have, particularly around the diversity of systems, and information that helps us take it down to a micro level, helps inform not just what Government can do but also informs farm businesses to be more proactive when making decisions and taking actions themselves. If they have data that relates to them, they are much more invested in it and are much more likely to take action, in my view.

Dr Rebecca Fisher: One thing we are doing a lot more of recently is mobile measurements of methane. Our research group at Royal Holloway is looking at driving around farms and you can map exactly where those emissions are coming from. You see higher emissions as you drive through the cow barn, downward of a slurry lagoon, for example. Whereas most work in past research has focused on improving emission factors by cows in respiration chambers—which is very important for the inventory calculations so that we have accurate emission factors for the UK—those real-world, on-the-farm measurements are valuable.

Professor John Gilliland: I have had the privilege of measuring methane on my own farm. If we cannot measure, we cannot manage. The reason we were managing was part of a research project with Queen's University, Belfast, and the Agri-Food and Biosciences Institute in Northern Ireland. We were looking at the consequence of grazing different sward heights—straight grass, then looking at other species. If we cannot get a low-cost solution it is difficult for practitioners like myself and my peers who continue to change our behaviour and reduce this. It is anything that can be done to help bring a low-cost smart technology on to farms that empowers farms with direct results; as they change their practice they get a feedback loop and that encourages them to go further. This is an important area and currently for me, as a practising farmer first and foremost, one of the biggest barriers is we do not have smart on-farm technologies measuring methane as we change the diet of our animals and they graze other products. It is a big knowledge gap.

Q66 **Lord Grantchester:** Welcome, gentlemen. I declare my interest as having been involved in the dairy industry in the supply chain throughout my career. I will ask for any comments from the panel members in terms of my early experience when carbon measurements were first being introduced into the dairy industry and being a bit of a trial experimental farm, and then looking at, "What does my farm tell me?" I was thinking during that process that there is a different approach whether you do it from the bottom up or the top down and how we could meet in the middle somewhere. I was then reflecting on the margin of error in the calculations on my farm. If you magnified that margin of error up to the industry you could produce some pretty wild numbers, but then coming

to the conclusion as that trial went further on—as has been said by Professor Gilliland—the improved data collection can perhaps help in those answers. Do you have any comments on how to get accuracy in those measurements?

Professor John Gilliland: Thank you for the question. There is a statutory process about refining and improving measurements. In IPCC and in carbon calculators, we use things called emission factors. When we started on this journey in 1990 we were at tier 1, which was an international agreement that the amount of methane from a cow was the same regardless of where it was in the world or what species. Now in the United Kingdom we are at tier 2 so it is a national average. In AHDB we have a vision to try to give leadership around how we get to tier 3, which is primary data from individual farms. It is important. It is knowledge that drives behavioural change and having that feedback loop.

There is a lot of variation at the moment. The factors we use in the calculators are an average and the downside of that is where you have pioneers and early adopters leading the behavioural change, when they go into the calculator their personal results are averaged downwards. That gives the pioneers and the early adopters no incentive to move forward. The way we see it in AHDB is the best way is to continue the investment in science and measurement technologies so that we are looking at on-farm primary data, where we are measuring the actual business that is making that decision so there is an accurate feedback loop and that is caught and reported in the greenhouse gas national inventory and reported in scope 3 emission declarations.

Professor David Frame: In New Zealand we have an initiative under way called Know Your Numbers where, to quote from the website, "All farmers and growers in New Zealand should now have their greenhouse gas numbers and will need to have a written plan in place for them for managing them by December 2024". There has been an election fairly recently and we will have to see exactly what happens with that scheme, but there is a range of tools people use from quite simple online calculators that are estimates to more thorough explanations that farm advisers and others are working with, through to more direct measurements. There is a spectrum of different tools for assessing those numbers—simple through to quite thorough—but New Zealand has been trying to get its farmers to know its numbers so we know what to manage. All the countries who are taking this particular part of the climate change problem seriously will have to go through the same journey.

The Chair: Professor Frame, to follow up on that, to what extent is the drive towards knowing your numbers driven by the setting of the 10% target to reduce methane emissions? I forget by what date.

Professor David Frame: By 2030 is in the current nationally determined contribution. I will be talking to that in one of the later questions, but in summary New Zealand has split out its agricultural methane target from its other greenhouse targets and its nationally determined contribution.

Short-lived and long-lived climate forcings act differently on the climate so that is a reasonable thing to do scientifically. It is partly the target but it is mostly a suite of policies bundled together with the Māori language name He Waka Eke Noa, which means "we are all in it together"—"we are all in the same canoe".

That is an attempt ultimately to price methane emissions, but to know what those prices are we have to get the data. There is a feeling, as there was with the first emissions trading systems, for instance, that the early round of the EU ETS had a fairly peppercorn price as people learned their numbers and worked through the same thing on the carbon dioxide side. We are sort of along that process but it is a number you need to know because we are looking to regulate and price those emissions to manage them to meet the targets.

The Chair: May I confirm that New Zealand is a signatory to the global methane pledge?

Professor David Frame: Yes. The global methane pledge mostly talks about fossil methane emissions but we are a signatory to it. Agricultural methane is definitely something that is subject to climate targets in New Zealand. I do not think anybody thinks we have the tools in place to meet those targets at the moment and that is the challenge for the next six years.

Phil Bicknell: On the original question, there is an ability to make sure that we are closing any gaps between lab and trial conditions and those controlled conditions and what happens on-farm, as far as possible so it is representative of commercial farming practices. That is part of what we are trying to do at the UK Agri-Tech Centre.

The second point you mentioned is the experiences from dairy. It is important to recognise that there are some processes and businesses in the supply chain that are looking to help their farmer suppliers with proactive moves in this area. The likes of Arla and Müller are helping farmers understand where they are now with emissions. On the red-meat side, the likes of ABP are not just helping farmers measure their footprint, they are helping them develop action plans and putting in place some small-scale capital investment to improve practices on-farm as well. If we focus on the farmers, there are some good examples of where the supply chains more broadly are helping farm businesses with proactive change.

Q67 **The Chair:** Before we move on to Lord Grantchester's question I want to ask Dr Fisher to elaborate a little bit on something she mentioned quite early on. We heard in earlier sessions that the greenhouse emissions inventory from agriculture is mainly derived from a bottom-up measurement. However, we have also heard in conversations that the reporting of emissions from farms depends in part on whether they are seeking administered grants and subsidies from organisations like Natural England and others, and that some aspects of the sector have minimal regulation and reporting requirements. What impact does that have on

the modelling outcomes? To what extent are they underreported?

Dr Rebecca Fisher: We have a very good idea of things like the number of animals, the different types of animals that are in the UK from Defra statistics. The quantity of animals is very well known. The emission factors vary and that is more so in the agricultural waste side of things because of the different management processes. I think that the biggest uncertainty in numbers going into the inventory is in the waste management practices.

The Chair: Like slurry?

Dr Rebecca Fisher: Yes, like slurry.

Q68 **Lord Grantchester:** I will do a little addendum to Mr Bicknell's comments about data sources and supply chains helping their farmers. I will be most unpopular among the farming world when I point out farm assurance schemes as another good way of identifying, clarifying and collecting material for everything from the bottom up being recorded in data management. I say "unpopular" because it already takes most farmers over a day for the interview of the farm assurance schemes, never mind the huge amount of time beforehand trying to make sure they have all the different certifications ready for every bit of action they do, but the farm assurance schemes are very helpful in identifying best practice and helping farmers collect data.

That aside, I will move to my question and ask Dr Fisher to clarify to the committee the particular sources most associated with leakage and fugitive methane emissions in manure and slurry stores. Are the difficulties associated with that data collection well recognised and are they being sufficiently monitored? What needs to be done?

Dr Rebecca Fisher: We have several different ways of dealing with the slurry and the manure. The methane is mostly produced when you have very wet conditions—anaerobic conditions—so the slurry lagoon tends to be a very big source. Even if the slurry lagoon is covered, unless the methane is being captured and used, then there are fugitive leaks from that. Anaerobic digesters are used by a small percentage of farms and methane generated from the livestock manure is used for heat and power, but methane can leak from these as well. We have been doing a lot of work recently looking at what the leakage is from anaerobic digesters. Anaerobic digesters are a very good thing; they are collecting and using methane, but if they have high leakage rates you can overcome the good you are doing by that leakage. More measurement is needed to be sure of the leakage rates.

Lord Grantchester: Have you a signpost of the way ahead?

Dr Rebecca Fisher: Measurement is important to identify leakage rates. We see quite a big range in leakage from the different types of environments, which means that when leaks are identified and fixed then we can have very low leakage rates and that is good. But unless you

know that leak is there, that is wasted methane to the atmosphere and that is a problem—so back to—measurement.

Q69 **Lord Grantchester:** Before asking other panel members to come in on that, I have a follow-up that other panel members may wish to come back with and that is following up on Lord Trees's earlier question on different production methods. Are the different production systems material to methane production? I include all greenhouse gas in any of that materiality. I mean extensive grazing to intensive grazing, and so on. There are, as we know, grant schemes that are trying to promote less intensive methods of agriculture and I wonder how material that is in methane production.

Dr Rebecca Fisher: On waste, there is more methane produced when you have wet lagoons that are venting methane to the atmosphere. Animals on a field where their waste is deposited on the field does not mean an anoxic environment for that long, so the methane from that waste is not so high. This is partly why dairy cattle tend to have higher waste emissions than beef cattle, which tend to be outside more on the fields.

Lord Grantchester: Is the answer that between the two ends of the scale it is material but as you get into the middle with different production systems it is less relevant what your system is?

Dr Rebecca Fisher: Yes.

Phil Bicknell: There is definitely a common theme that comes out around measurement, and particularly trying to account for daily and seasonal variations. I suppose you start to think about the questions in intensity of production. As somebody who last winter had the shortest winter housing period for our cattle ever, which was fantastic because that saves me money, this year the wet conditions have meant that cattle have been housed for longer and has meant more manure in the shed. What my measurement might have been 12 months ago is very different to where I might be today.

For me, it is trying to understand the balance between intensity of production because there may be fewer emissions related with the waste from the animal in more extensive systems. However, if the meat product is taking longer to get to the market, what is the impact of that on the 85% of the enteric emissions that come forward? All of this boils down to how it can be quite complex for farm businesses to make decisions, which comes to that common theme around, "Where am I now in data?"

Professor John Gilliland: Mr Bicknell has made a very valid point and certainly our experience with the group of seven farms that I am chairing is looking at our emissions on a three-year rolling average. We have considerable seasonality and the last two years have clearly flagged that up. It is important to understand the complexity of different systems. We have a range in our seven farms. On the best farm, only 10% of total

greenhouse gas emissions are methane. On the other side, 53% is methane.

Going back to Professor Frame's view—and I absolutely endorse it—we need somehow to get a system that all farm businesses know their own numbers because this generalisation does not give the sophistication to help fine tune the farm management and the journey to net zero. What New Zealand is doing around Know Your Numbers is very similar to what AHDB is doing—knowing your numbers. This is about empowering decision-makers in farm businesses to make better-quality decisions. Around this too we have a big ammonia problem, particularly with manure. It is very important that we do not divorce methane from ammonia.

Q70 **The Earl of Leicester:** Good morning, everybody. To confirm my entry in the register of interests, I am a farmer. We have a suckler beef herd and a few sheep that are also ruminants. I will also say that I am a grass farmer and even go as far as to say a carbon farmer.

Could you outline the methane and carbon cycle as it relates to ruminants, the soil, and the atmosphere? That is my first question and I put that to Professor Gilliland. Secondly, is this over or understated in our understanding of the contribution methane from cattle adds to greenhouse gases? Are the benefits of biodiversity and soil health forgotten in the climate change argument?

Professor John Gilliland: Ruminant agriculture is a cyclic system. We produce biogenic methane. Animals eat predominantly herbage, whether it is grass, herbs, legumes; it goes in, their rumen ferments it, most comes back out the front end, some comes out the back end. The faeces is defecated and the faeces then is broken down. The faeces is full of bacterial fungi that are then driving the soil microbiome. What most people do not understand is healthy soil has a microbiome that is nearly a mirror image of the gut of a cow. It comes as little surprise that it is the faeces that is the vehicle for inoculating the soil and the healthy soil then drives the herbage production.

In the last nine months a collection of papers have been published and peer reviewed, clearly highlighting the role that faeces have in driving the soil microbiome. The reason this is important is that we need ruminant farmers to also remove carbon from the sky through carbon sequestration and carbon removals, and key in that is the microbiome. We have a balancing act. We have to be very careful. If we get rid of all animals we get rid of the inoculant that drives the soil microbiome, and a healthy microbiome is what will drive carbon sequestration and carbon removals and lock atmospheric carbon into the soil and hopefully deeper.

As we go back to what my grandfather did, it is diverse herbal leys with multi-species swards, particularly things like chicory where grass roots are 20 centimetres long and chicory roots are 60 or 70 centimetres long, so we are laying down more carbon and it is deeper. Being deeper, hopefully it will have a better degree of permanence. It is important in

this discussion that we look at the totality of the biogenic cycle that happens on ruminant farms and its interaction with soil and the role that the soil bacteria and fungi play in helping us in carbon removals, which is the flipside of the same coin.

The Earl of Leicester: Would anybody else like to come in on that before we move on to the second and third parts of the question?

Phil Bicknell: Are benefits forgotten? Perhaps. They are certainly looked at in isolation and the carbon lens that has been focused on agriculture risks parking some of the biodiversity, both positives and negatives, around different agricultural systems. The other bit for me feels like the way that we approach the national inventory. The UK imports a significant proportion of its food and so the emissions footprint of food consumed in the UK occurs in other countries. The national inventory does not provide a reflective picture of the emissions associated with our consumption in the UK when it comes from other parts of the world.

Professor David Frame: We have had exactly the same conversations about biodiversity being a missing feature here. There is forestry offsetting, which in New Zealand is normally Pinus radiata. We tend to have a monoculture and people log them and send them off to Korea or somewhere, and it does not enhance biodiversity. There has been talk in the He Waka Eke Noa policy stream about to what extent and via what mechanisms you reward biodiversity as well. The question that comes up time and again in all of AFOLU—in all of forestry, land use, climate policy—is whether to have things simple and narrow where you have a particular lever or whether you have them broader and try to price all the externalities and find some gains from trade in there.

The parliamentary commissioner for the environment in New Zealand commissioned me and another scientist as several of us were converging on this idea at once. It turns out that unlike CO_2 emissions, where if you have a constant set of emissions year on year you need to plant a standard forest this year and a standard forest next year and so on indefinitely, with ruminant methane you can offset the warming with a finite stand of trees. It happens to be bigger than the traditional exchange rate suggests but it is permanent. A stand of trees of some given size—for a sheep in New Zealand it is about 0.08 hectares and for a beef cow it is about 40% of a hectare, so 0.4 hectares—permanently offsets the warming from that ruminant. That is the exchange rate in New Zealand but local conditions matter a lot on the forestry side as well as on the ruminant side.

Thought about creatively, on the point that has just been made about narrowness and breadth and whether or not we are comparing gases in the right way, if we take a warming-centred approach we have new levers we can use. That is something worth at least exploring.

Q71 **The Chair:** Professor Gilliland, in your initial contribution about methane and the carbon cycle you spoke about it being a little bit out of sync. Currently one of the issues is that the carbon cycle is not balanced as it

should be; it is out of balance and this is an issue. I want to get your views on my thinking that modern farming methods are in part responsible for this carbon cycle being out of sync and we need to do something that we would not normally do to try to bring it back into sync. One of the things is to deal with methane and ruminants as part of the solution—obviously not the whole solution. Can you comment on that?

On another thing, I was not quite sure of what you were saying. You talked about the removal of carbon from the atmosphere by ruminants. Ruminants breathe in air, a very small part which is carbon dioxide and mostly it is oxygen and nitrogen, so—

Professor John Gilliland: When I look at my business as a whole, we have ruminants, we have trees and we also have our soils. The legislative imperative is our net zero by 2050. That has been our focus. We have two things we need to do in our business. We need to reduce our emissions but we also need to build the carbon stocks in our soils and the carbon stocks in our trees and hedges. The reason the ruminant is important is it is the catalyst to engage our soils. Last year on my own farm we had a master's student from Wageningen University & Research in the Netherlands—a world leading university—and we compared our soil biology across our 250 year-old oak trees, our 30 year-old oak trees, our silvopasture, our permanent grass, and we also have some willow crops for energy. What we found on our farm is that, in areas where we did not have faeces being defecated, our soil biology had collapsed and so had our soil pH. This comes from this issue—if you measure you can manage. I now will measure my farm better so I will correct my soil pH.

I will also try to make sure I have faeces in key areas to reinvigorate that biology, because it is the soil biology that is the key to then healthy plants sequestering carbon and locking it under the soil. If we have soils that are anaerobic, that are compacted, we will never have the same carbon removal potential. The cow itself cannot remove carbon, but its consequence of the faeces on to the soil can. Where we take the ruminant out of the landscape we are losing part of the biogenic carbon cycle. What we have learned here, certainly in the case of our 250 year-old woodland, when my great great grandfather planted it, he fenced the animals out of it. We now regret that and we are going to introduce the animals back into the trees. We will have trees and animals coexisting together rather than one or the other, so that we can complete the biogenic cycle.

The Chair: Thank you. Professor Gilliland, could you send in writing some evidence about what you have been saying about the role of cow faeces in particular in improving soil health and sequestering carbon? That would be really helpful. Thank you.

Q72 **Lord Trees:** On Professor Gilliland's point, there is a fertiliser sparing effect here as well, is there not? We know production of and use of fertiliser is a source of important emissions. Is the fertiliser sparing effect ever taken into account when you are doing your total calculations on a farm?

Professor John Gilliland: When we do our calculations, we currently use one of the six carbon calculators that have gone through the recent Defra-funded ADAS review. The one we use is called Agrecalc. They look at the total fertiliser we use. We are on a movement at the moment. We were addicted to synthetic nitrogen, and synthetic nitrogen on our wetter soils created a lot of nitrous oxide emissions. We know nitrous oxide is a long-lived gas, somewhere around 260 times more potent than CO_2 while biogenic methane is only 26 times.

The big switch we are doing on our farm is to wean ourselves off that addiction to synthetic nitrogen and go back to what my grandfather and my great grandfather did, which is put in herbs and legumes along with the grass and use biology to take nitrogen out of the sky and release it on to the soil. The reason that helps—we have extended our grazing season—is it allows us to better use our manures. Where we have done switches from our monoculture of perennial ryegrass to a herbal ley or a multi-species sward, we have seen reductions of nitrogen fertiliser between 60% and 100% and we see that as a collective good.

We have topped that up because we have changed our slurry spreading activities. We are now using trailing shoes—injection systems. We can put a little but often on in a way that we do not taint the sward and, therefore, we have less refusal of the cow when it subsequently eats it.

In the old days when we spread our slurry, we just did what they call a splash plate, and we splashed it up in the air and it spread everywhere. Now we have learnt our lessons; that was not the right thing to do. We have improved how we apply our nutrient, but we do it now in a way that means we can do it regularly and in a manner that does not leave a smell or an odour that—surprise, surprise—the cow does not like.

It is really about using all the tools in the toolbox. We do not have a silver bullet. On my farm we have had to reach for about five or 10 different tools to help us on this journey.

The Chair: Thank you, Professor Gilliland. We are running short of time, so I move to the Duke of Wellington and then we will come back to the Earl of Leicester for his next question.

Q73 **The Duke of Wellington:** I should also declare my agricultural interest as on the register.

This has been a completely fascinating discussion. One thing that I would like to ask, which is slightly off the set question, is that we hear a lot about the effects of the Industrial Revolution on climate change—all the emissions that have resulted from the Industrial Revolution over the last 200-plus years. Do any of you have a feel for how modern farming methods have increased the generation of bad gases versus the traditional farming methods as in the 18th and early 19th century? One point that I want to try to understand is whether methane production has increased a lot and whether that has contributed to climate change.

Nobody has yet made mention of wild animals. There are lot of ruminants

in the wild. I do not know whether it is true in New Zealand, but wild deer numbers in this country are increasing all the time. I have seen estimates of there being 2 million deer in this country and they are ruminants. There is obviously no way of monitoring that. I suppose there can be some estimates of the production of methane from wild deer and some conclusions could be reached from that. Do any of you have opinions on how significant methane production by wild animals is in relation to agricultural production of methane? Who should I ask? Professor Gilliland?

Professor John Gilliland: I was hoping that you were not going to ask me. No, I will put my hands up. I apologise, I do not have an informed answer as such. My speciality has been focusing predominantly on agriculture as a farmer and as someone who helps my peers. I am sorry, I cannot give you an adequate answer, but I am sure someone in AHDB might be able to and we could come back later on, after the event, and give an opinion.

The Duke of Wellington: That is on the deer point, Professor Gilliland, but what about the development or the increase in methane production from modern farming methods, livestock farming methods, versus how it was done in the 18th century?

Professor John Gilliland: I will argue that actually the rumen has not changed much over that period. I think what has changed is we are feeding our animals different things. As Mr Bicknell has already highlighted, one of the big impacts on what produces methane from an animal is what you feed. A lot of work has been done in the UK and in New Zealand looking at feed additives but also looking at the constituent parts.

On my farm, I am doing something that some people would say is absolutely crazy. We are currently grazing short rotation willow trees with our cattle and we have recorded a 28% reduction in methane per kilo of liveweight gain. Why? The willow leaf is full of condensed tannin, just like red wine is, and that condensed tannin is a natural wormer and it also interrupts the formation of methane.

There are also synthetic products out there. We know that in Australia, CSIRO, the Australian Government's organisation, has been working with asparagopsis, which is a red seaweed, and has recorded up to 80% reduction in methane. This is where science is now looking at as part of its toolbox. I would say it is not all the toolbox.

One of the challenges we have as we go down this route is: how do we do it in grazing animals? There is already a licensed feed additive on the market in the United Kingdom—its chemical name is 3-NOP—but you need to have the animal in a barn to feed it. What we are really looking at, the work that has been done in several research institutes in the UK—and I am involved at Queen's University, Belfast—is how do we also get it into the grazing animal because surprise, surprise—

The Chair: Professor Gilliland, we will be coming on to feed additives in more detail later on. If you could draw your remarks to a close for this session and then we move on to Professor Frame.

Professor John Gilliland: I am happy to stop there.

The Duke of Wellington: Professor Frame, do you have any comments on my two different questions?

Professor David Frame: Yes. On modern farming, it is hard to disentangle it from the actual emissions data, given that quite a lot of global emissions of methane are from totally different sources such as natural gas and fugitive emissions. There has been roughly a trebling of methane emissions since 1940 and perhaps a better proxy for modern farming is there has been a sixfold increase in emissions of N_2O. Nitrous is a long-lived gas with a very high per-kilogram effectiveness as a greenhouse gas.

The really deep question about the relationship between the methane emissions from wild animals and farmed animals is fascinating, because you touched on something there. 1750 is the date we use, slightly arbitrarily, for the beginning of the Industrial Revolution in Britain and one or two other places. That is a good anchor to choose because it is when the processes that have driven climate change really began. We use that date for all gases and at that point there were still a lot of bison running around North America, for instance. There is not really the same degree of obviousness or salience for that date for the methane case. What you have touched on there is an important point that is underdiscussed, that in a warming context needs to be fully accounted for and I do not know that our community does that terribly well at this point.

The Duke of Wellington: Would you say that the agricultural industry, as a generality, has not contributed as much to climate change as the Industrial Revolution has contributed?

Professor David Frame: Absolutely. We have about a degree of warming, perhaps a little more, from carbon dioxide. We have about 0.4 degrees of warming from methane as the second source. Some of this is masked by aerosol forcing, some of the warming that would occur from greenhouse gases. Methane is considerably less than carbon dioxide as a contributor. It is the second most important greenhouse gas, but I think about a third or a half of methane emissions are from agriculture; Dr Fisher will know this better than I do, but you are probably looking at about 0.2 degrees, 0.3 degrees, probably more like 0.2.

Q74 **The Earl of Leicester:** For the reporting of methane emissions, what are the benefits and/or disadvantages for the UK for utilising GWP* as the metric for measuring and reporting methane emissions?

Dr Rebecca Fisher: GWP* is a measure of the relative climate impact of a change in the emission rates of short-lived greenhouse gases compared with the pulse of carbon dioxide. The key point here is it is used to show

the global warming potential of changes in emissions. The key difference between GWP—global warming potential—and GWP* is the baseline. If emissions are reduced from a high baseline, GWP* can be negative.

My concern is that this can be a bit misleading as there are still emissions taking place and, therefore, still a warming but a bit less warming than before. It makes high historical emitters that are reducing their emissions look better than newer emitters. There are advantages to it with better accounts for warming from short-lived gases. Methane is a short-lived greenhouse gas in that it is around for about 10 years as opposed to hundreds of years for carbon dioxide. There are some advantages in the agricultural sector if you want to compare the warming effect of changes in methane, for example with nitrous oxide or carbon dioxide. I expect Professor Frame probably has a lot more to say on this topic as well.

Professor David Frame: Yes. I was one of the authors of the work on GWP* and I have also contributed on other possible metrics. The material we assessed for the last IPCC report discussed the fact that these step pulse metrics, as they are called, a family of metrics, are better at giving answers that converge with climate models in the actual warming you get from a time series of greenhouse gases.

I would not entirely agree with everything that Dr Fisher just said. There was an unfortunate paper out there a few years ago that was quite misleading on this, by Joeri Rogelj and Carl-Friedrich Schleussner. It is not the case that GWP* inherently benefits high methane emitters or past methane emitters. The best way to think of it is that GWP* and a climate model—because the two give convergent results—give you the warming of a time series of gases from the moment you start counting. They were developed—designed—to work alongside carbon budgets for long-lived greenhouse gases and they are accurate in so far as they do this.

What has tended to happen is they have been used with recent baselines, which means that if you only consider warming from today, all historical warming from all sources is ignored, and that can act in the benefits of those who have caused warming to date. The EU, for instance, was a keen proponent of using 1990 as a base year for emissions reductions for carbon dioxide, but that framing tends to ignore everything that happened up to 1990—high fossil fuel, high CO_2 use.

If you move across to a warming framework, the trick with GWP* and with carbon budgets is just to count the warming from when you think you should, which is 1750 in the case of the carbon dioxide. You could argue for 1750 just for consistency; you could argue for a later date if you have better measurements, because what happened between 1750 and 1800 is largely gone from the atmosphere as far as methane is concerned.

They actually work as designed in conjunction with carbon budgets. It can be used at any scale. I use the model FAIR, which is used by Myles Allen and Piers Forster, who I think is one of the people on the Climate

Change Committee. FAIR and GWP* give the same results if you give them the same inputs.

It is really about a choice to use a warming-based framework. You find when you do that if you have a new source, for example a pulse emission of methane that you were not expecting, like the Nord Stream leak last year, the traditional way of comparing those greenhouse gases provides an underestimate by a factor of four or five for the first 20 or so years and then an overestimate by a factor of three or four over the next five to 10 decades.

The current way we compare gases is an underestimate in the near term and an overestimate in the long term and GWP* or a climate model give you more accurate answers. If you care about the trajectory of warming and you care about a time series of gases, they are perfectly reasonable things to use and they work at all scales. Who they benefit and who they do not benefit depends on the policy-framing decisions you make about baselines, responsibility and costs and where they fall.

Phil Bicknell: As we have heard, there are pros and cons and advantages and disadvantages.

The Chair: Please keep your remarks short because we are running very short on time.

Phil Bicknell: The bottom line for me is that if we have better information and better methodologies available, we should be using those to measure. That helps get over the issue we have heard about of farmer buy-in and accuracy of the figures. I think there is scope to report on both. You can go to day-long conferences just about GWP* versus GWP100 and it is definitely a talking point when you get into meetings with farmers. While GWP* might give a more positive view of the national picture where livestock numbers have been declining, my watch-out is that for individual farm businesses it may create some challenges, given that farming and farm businesses tend to be larger scale and there is continued consolidation in the industry.

There are pros and cons with both. Regardless, I think there is scope to report on both. The more important thing for me is the action and what we do about the emissions.

Professor John Gilliland: The reason we are having this conversation at all is that there is not agreement on the science of the methodology of looking at methane and how it impacts global warming. There is on nitrous oxide and there is on CO_2.

I am not a climatologist; I am a practitioner. On our seven farms we now dual report. We are probably the first farm grouping to do that and I can give you an understanding of the impact where you do dual report. We have used the last 20 years' data of UK national herd trend and that is what we have used to overcome what Mr Bicknell has already highlighted. To give you a feel, in the dairy farms we had between a 25% and 50%

reduction in the position. In the case of beef and sheep we had somewhere between 60% and 75% reduction and in arable we had only a 15% reduction. That is reflection of different production systems creating different amounts of methane. Therefore, when you dual report, you highlight how much of that system comes from methane.

The only reason this is happening is that the science on the methodologies of looking at methane's impact on global warming has not been put to bed. It has for nitrous oxide and CO_2. It is really important that we do not make decisions that we later regret when we have not got this grounded.

The Earl of Leicester: Do the rest of the panel agree with Professor Gilliland's assertion that the science and the methodology of methane has not actually been physically agreed on? Yes or no.

Dr Rebecca Fisher: No.

The Earl of Leicester: You disagree, okay.

Phil Bicknell: There is not a consensus.

Professor David Frame: We know the physics. We disagree about metrics. That is the best I can do for yes or no, sorry.

Q75 **The Chair:** You can have equally short answers to my question. We have targets. We have the Paris Agreement signed up to by just about the whole world for what we need to do to limit global warming, or the need to limit global warming, to 1.5 degrees centigrade, and well below 2 degrees centigrade if we are going to limit the damage that climate emergency is doing. Then we have the global methane pledge signed in Glasgow. Could I ask you, Professor Frame initially, how important is it to meeting both of those goals that the IPCC does more than just acknowledge GWP* but actually starts to utilise it?

Professor David Frame: Great question. The IPCC has a non-prescriptive role. It was very surprising to me that two bullet points we made in chapter 7 on exactly this point were not elevated to the summary for policymakers. I do not know why that happened. You would have to ask the people who were in the room. I am in New Zealand and I was not in the room.

The Paris temperature targets are temperature targets. The net-zero targets the world has come up with are emissions targets. The most obvious way to make those things consistent is to use a framework that maps emissions, the warming, and that is what GWP* does. It is also what climate models do. I do not mind whether you use a climate model rather than GWP*—use your technology of choice, but if it is warming that you want to control, which I think everybody agrees, the way we compare emissions ought to be in service of that.

It actually says so at the start of article 4, where it says, basically, "in service of the temperature goals in article 2" and then a bunch of stuff.

Net zero as an idea was developed primarily around CO_2 because that fitted so well with stopping temperature increase. I think we should think consistently about all gases in that regard.

The Chair: Excellent. Thank you. I will move on to Baroness Bakewell. I have been reminded that we have seven questions to go.

Q76 **Baroness Bakewell:** I think it is all very interesting that the efforts are being made, but what interests me is what are the next developments, how much are they being pressed forward and who is doing that?

Professor John Gilliland: There is a collection of different things going forward. They are from a silver bullet, and we will come on to talk about methane inhibitors. There is a lot of investment in methane inhibitors.

Baroness Bakewell: You said there was no silver bullet.

Professor John Gilliland: No, but there are investments in trying to create a silver bullet in methane. Certainly, at the moment there is the first licensed methane inhibitor on the market. The chemical name is 3-NOP and the product name is Bovaer. That is already on the market today.

Its difficulty at the moment is twofold. One is making sure it is fed and, second, making sure that you get the consequence that you think you are going to get with it. There are two or three parts to this journey. The first one is finding the innovation that helps. The second one is: can you validate that the innovation has been actually taken up and you have had the results you want? Thirdly, currently if I change my behaviour on a farm, there is no direct link from my positive behaviour into the greenhouse gas national inventory or into scope 3 emission declarations.

There are three bits of the cherry we have to tackle, and from AHDB's point of view we are very clearly trying to get a smartening of the measurement. I personally sit in Defra's food data transparency partnership. Our role there is: how do we get more primary data but also how do we get scope 3 emissions declarations smarter and the greenhouse gas national inventory smarter? What you do not want is everyone to change their behaviour, but our reporting mechanisms are not smart enough to pick it up, or not. The key thing when you do this is it also finds the people who are not changing their behaviour. As you go on this journey, it is designed to reward the people who change their behaviour. It is designed to show up the people who do not and that is how you get behavioural change.

Baroness Bakewell: Is there agreement about the methodology or is there disagreement about how to go forward?

Professor John Gilliland: On the methodology, the last document that came out that I have was published by the FAO, which is the United Nations Food and Agriculture Organization, in September 2023. It clearly flags up the debate around the metrics of measuring methane and I can quite happily furnish that document. The debate is very clear around

that. Its conclusion is, "Recent guidance recommends considering using multiple metric choices in life cycle assessments". That is what it says, directly quoted from the document, and that clearly shows the confusion that is out there at the moment.

Baroness Bakewell: I think we would like to see that document.

The Chair: I think we would. Thank you, Baroness Bakewell, we certainly would. I know Phil Bicknell wants to come in on this—if you may, briefly—and then we will move on to questions from Baroness Bray because we are very short of time. I apologise.

Phil Bicknell: I will share two reports with the committee that we have produced. One looks at new technologies and what will help contribute to reducing emissions. The second report looks at farmer options and what they can start to do right now. The key message for me out of that is not to necessarily discount what is in our gift currently as farmers. What is good for emissions is also good for farm performance and profitability, such as improving genetics, improving animal health, improving feed and nutrition. That outlines a number of different options for farmers looking across different sectors and also considers the cost of them, the ease, the potential impact: is the science reliable.? There are a whole host of factors and I will make sure I share those with the committee.

Q77 **Baroness Bray of Coln:** Are there any further reductions in methane emissions from the agricultural sector to be made? Is there anywhere that needs to be looked at?

Dr Rebecca Fisher: As I said earlier, slurry is a big issue and covering a slurry lagoon is one thing to slightly reduce emissions, but can you capture the gas that has been released and then use it on a farm? There are some demonstration projects in the south-west of England at the moment where that methane is then collected and used in a tractor, for example, on site. It is beneficial to the farmers in not having to worry about fuel costs in the future. That is one thing that can be done. A lot can be done in the waste reduction, particularly from dairy farming where you have got the slurry lagoons at a farm. That is one thing I think we can do.

On other things in the future, there will probably be some emissions of methane. However good a feed supplement becomes, there will still be methane in the breath of ruminant animals coming into the atmosphere. We may then have to look at removal techniques that filter methane out of the air if we really want to get down to net zero from agriculture.

Lord Grantchester: Can I quickly jump in to ask you to specify the difference from permeable and impermeable covers or which is perhaps better, because opinion has changed on it?

Dr Rebecca Fisher: Yes—whether your methane can leak out through the cover or not. These are very beneficial for ammonia, I think more so to avoid ammonia leaking, which is another important thing to consider in farming. For methane, I have made measurements outside of a lagoon

that has a cover but you are still seeing gas emitted into the atmosphere, but capturing it under an impermeable cover that is stopping that leakage, using that methane, is key here.

Lord Grantchester: Is it a trend towards impermeability and, therefore, capturing a gas as well as an add-on after reductions of the emissions?

Dr Rebecca Fisher: Looking ahead, that is something that could be used.

Q78 **Earl Russell:** Do you think that the slurry and the methane capture could be done at farm level or should Defra be helping to do it at a multi-farm level—a local place, a central place with multiple farms? Would that be a better way of doing it?

Phil Bicknell: It is being done at the farm level. I am aware of some examples down in the south-west. There is a link-up between a company that has the technology for capturing the methane and then also a major machinery manufacturer that is providing the tractor and the technology. My understanding is that it works where you have multiple farm sites and are able to capture the methane and that goes in for further processing at another site. Think about it almost as a milk tanker goes up to the farm to collect milk; there is a tanker going up to collect the methane. There is circularity of the systems. Particularly I think Cornwall Council has got quite heavily involved in it, using the fuel effectively to run some of its buses and transport links.

The Chair: In a previous session Professor Esteves outlined some research that she had done showing that if you grossed up emissions from individual farms it comes to many millions of tonnes of fugitive methane emissions that are currently not accounted for. To what extent do you think those could be accounted for? We would like to hear more about the technology that enables individual farms to capture their methane emissions, so I hope that, Mr Bicknell, you will be able to provide us with that. We want to explore the question of how we enable these methane emissions to be captured. Back to you, Baroness Bray.

Baroness Bray of Coln: It is just a quick question, a thought that occurred to me. You say that these vehicles can come and capture the methane and take it away. What do they then do with the methane? How do they dispose of it?

Phil Bicknell: The methane is turned into a fuel to power vehicles. The challenge is that you need the infrastructure to capture. It is about slurry capture, so it works well on dairy farms, large campuses generating slurry. It works less well on more beef and sheep farms where the waste is probably in smaller volumes and you cannot necessarily plan and it is not managed in such a way. There is effectively a cost that farmers have put in to manage their slurry requirement that generates the by-product that has value.

Q79 **Lord Trees:** We have heard a bit about slurry and I think there is a question about slurry again later, but I will ask about the technologies we

could apply to the animals that are responsible for about 85% of the methane compared to 15% coming from slurry and manure. We have heard about feed additives. Who would like to comment about the application of genetics? I think I am right in saying that methane production is a heritable characteristic. Particularly, can we use genome editing techniques to speed up potential breeding on genetics? Endemic disease control is important; I must declare my interests as a veterinary surgeon. There is the potential, and it is a fair way off, of vaccination against methanogenic bacteria. I know that New Zealand has an interest in that and is collaborating with UK research institutes. Are there any quick comments about the potential of those three issues—genetics, endemic disease and vaccination?

Professor John Gilliland: You have raised three very important ones and I would like to add in a fourth one. The great thing about genetic improvement is you bank it—it is repeatable. For me it is the most cost-effective way of reducing methane and improving profitability on my farm. On the economics of methane mitigation, genetic improvement is the very first thing.

The second thing that we have not mentioned in the case of beef and lamb production is the age at which the animal goes to slaughter. If we can have productive animals that go to slaughter earlier, they produce less methane. I am delighted to hear that there is a vet sitting around the table. The biggest parasitic cost of methane out there is animal ill health and I do not think this gets enough focus. It is really interesting that one of my seven farms that we work through had a dysentery outbreak in their dairy herd and that methane consequence completely outweighed the benefit of switching from nitrogen fertiliser to multi-species swards. We cannot say enough about animal health.

I will leave Professor Frame to say more about vaccines because I know that New Zealand has been leading on the vaccines.

Professor David Frame: New Zealand is doing a lot with vaccines, or trying to, and also the selective breeding. There is research into animal genetics and people are doing a bit of trial and error, I think, but those are areas that New Zealand has particular interests in. We have a slightly different problem. Our cows especially spend less time inside than cows in Europe and that means that things like the capture approaches are a way in which Europe, and probably North America, has a leg up on us. I am a pluralist about policy, so I think that the sorts of things we do will probably appeal to other countries with strong pastural agriculture traditions where the animals are outside all the time. That is why we hang our hat on vaccines and breeding.

Phil Bicknell: On genetics, I am conscious that in the dairy sector we are already seeing genetics being marketed on the basis of their improved sustainability. The genetics companies do a lot to probe and go back into the data to start to look at performance and I think you will start to see more genetics being marketed on the basis of that. The challenge is perhaps that the rate and adoption of genetics in beef and

sheep is a bit slower than you tend to see in the dairy sector, but I completely agree that the cumulative effect of each year offering small gains over a long term gets us a big way there in improving that.

On endemic disease, I take Professor Gilliland's point about improving animal health and that being something that is overlooked. I think that endemic disease also creates a bit of a mindset challenge and particularly where you are not seeing endemic disease being tackled, that is perhaps a deterrent for farmers to start to be more proactive in the changes that they make.

Vaccines is one of the technologies in the report that I mentioned. There is a bit of information in that that I will circulate.

Q80 **Lord Frost:** I declare an interest as an unpaid trustee of the Global Warming Policy Foundation. I want to follow up the two previous questions. We have talked quite a lot about the technical means of reducing methane in various ways. I am interested in the view of everybody on the panel about whether that is enough. Is it your view that you can achieve the necessary reductions in methane however one defines that, and it seems there is a degree of uncertainty about it? Can you achieve these reductions solely by technical improvements or would you take the view, as the Climate Change Committee did, that you also need to look at changes in land use, changes in diet, reduction in the actual numbers of animals in the country to achieve these gains?

Dr Rebecca Fisher: The technical means can get us a certain way. I do not think they can get us to net zero agriculture. We also need to look at perhaps removal of methane from the air in environments where you have high concentration—cow barns, for example—using filters. There is a lot of research work going on at the moment on using filters to remove methane from the air. It is only really shown in laboratory situations. I have not seen real-world demonstrations of this sort of technology, and it is not ideal in the open barns we tend to have in the UK at the moment to be able to do that—but that maybe takes methane out of the air. Whatever we do with feed supplements or better management practices, we will still be left with methane emissions, so taking it out of the air might be something we need to work more on. We need to develop that industry and those experiments.

Lord Frost: You are saying that we do not need to change land use, the number of animals or these more radical things. If there is a remaining problem, may the technology be able to solve that problem too?

Dr Rebecca Fisher: The technology cannot yet. I do not want to say we do not need to. There is also a need to look at diets and see whether there can be reductions in what we are eating and in methane. I certainly do not think we should get rid of all cows.

Lord Frost: No—I am just interested in the scope of the problem. Do others on the panel agree with this?

Phil Bicknell: There are actions that we can take now as farming businesses and as an industry to improve emissions, and some of those are within our gift. They will get us part of the way there. There are technologies that are in the pipeline that will deliver the impact. As much as I agree with Professor Gilliland that there is not a silver bullet, I think some of the potential of methane inhibitors is probably as near as we can get right now when we are starting to look to that.

One of the benefits that is ignored to some extent is that, if we get more efficient in production, there is the potential to produce the same amount of food with fewer animals. If you start to think about the efficiency or the emissions associated with milk production, for instance, it is in a completely different place in terms of reducing emissions per litre or per kilo of milk solids than where we were 30 years ago because we are doing it with fewer animals but producing a greater amount of milk. Some of those yield gains and some of those efficiency improvements will start to get us there.

I am similarly wary about anything that is looking at emissions in isolation, particularly starting to think about this in terms of livestock numbers. The sceptic in me particularly says that we potentially risk importing our food and, therefore, exporting our problem. That is a concern.

The Chair: We are up against the clock. Can I check with our panellists that you will be with us for another 10 minutes if necessary? Thank you very much and I do apologise. Back to you, Lord Frost.

Lord Frost: Do others on the panel—Professor Frame and Professor Gilliland—want to come in on that question?

Professor David Frame: I think that land use here in New Zealand is part of the equation and, in fact, it is one of the sticking points, because we have a two-speed agricultural system. It seems like a small price, but dairy is, on the whole, considerably more profitable than sheep and beef. The concern is that a highish price on methane could drive out of business a lot of sheep farmers and beef farmers and then they would become carbon forests, which would create rural poverty. I do not think anybody wants that. I am optimistic that technological solutions will help us to some extent; better farm management practices have a proven record of lowering emissions. There may be some on-farm planting and other things using exchange rates—I mentioned trees and cows earlier—that are promising.

None of the IPCC scenarios consistent with 1.5 degrees had methane emissions going to zero—they had a interquartile range of minus 24% to 47%. There are people out there who say that we should end animal agriculture, but to those people I would say, "If you think people get upset when you stick another 50 cents on their petrol price, you should see what happens when you tell them what they are not allowed for dinner".

Professor John Gilliland: My own farm is already beyond net zero, but I still have methane emissions. It is really important that we clarify what is the definition of net zero. We use all the toolbox as such. On our farm we have done some land use change, and I am well recorded: I was one of the pioneers in energy crops. I got badly burnt there and I am now going back into food production, but I am going through a halfway house. I have silvopasture on my farm and, when we do analysis of the total carbon stocks, it is the hybrid of animals and trees in the same place, rather than either all animals or all trees. When we did this analysis in university research last year, the shock that my soil carbon and soil biology had collapsed under my 250-year-old oak trees hit me hard. I did not see that coming, and I only found out because we went and measured.

I recommend the committee looks at one thing. Last December at COP, the FAO produced two documents, both of them very good. I want to mention one specifically: delivering SDG 2 and 1.5-degrees temperature rise. SDG 2 is delivering zero human hunger for the world by 2050. I think it is a really good document because it ties human hunger and health with climate change and food production. It is the start of a process. It is a three-year journey, and volume 1 was produced last December at COP. I encourage the committee to have a look at it because it is giving leadership on this complex journey to 2050, not only in how we cap temperature rise at 1.5 degrees but how on earth we feed globally the population at 1.5 degrees and deliver zero hunger with no malnutrition. That clearly highlights that animal-sourced foods and plant-sourced foods will have to sit synergistically together, and it lays that out. I strongly recommend that report to the committee.

The Chair: Thank you. You have made that point well. We will move on. I will say though that, in fairness to the Climate Change Committee, it does not talk about removing cows altogether. It certainly talks about reducing cattle by about 20%, in line with the health guidelines—a reduction of meat consumption by 20%. It should also be pointed out that producing beef requires a much greater level of input than producing vegetable and plant-based foods. I am sure there will be opportunities for people to come back on that if they need to.

Q81 **Lord Duncan of Springbank:** Will the witnesses comment on what is the trend on agri-methane at the moment? What are we seeing and what is the forecast of that? Where are we seeing the greatest growth in agri-methane? We have spoken to a degree about those who have been willing to sign up to various commitments in the UK and so on, but I am not sure that I fully understand where the real threats rest at a global level. There are two parts: what is the trend and who is responsible for it? I am happy to have it answered by any and all.

Dr Rebecca Fisher: Within the UK we have seen a decrease in agricultural emissions by about 15% since 1990.

Lord Duncan of Springbank: I am okay with the UK because I think we are, as we have discussed, making significant progress, but I want to

understand what is the global trend, since it is an atmospheric.

Dr Rebecca Fisher: Globally, methane from agriculture has increased. I do not think there are any signs of decrease yet.

Lord Duncan of Springbank: Do you know what the trend figures are? What increase are we talking about?

Dr Rebecca Fisher: I do not know the numbers off the top of my head, but global methane concentrations are rising, and total emissions are rising. Some of that might be from warming wetlands and wetland emission increases, but some are likely from an increase in agriculture. There are more people and there are more ruminant animals and more methane emissions. That (methane) needs to come down to meet our global methane pledge and Paris Agreement targets.

Lord Duncan of Springbank: My difficulty is in trying to understand what, if we are bringing ours down by 15% but the global trend is increasing substantially, where are we in that on balance. That is what I am trying to understand.

Dr Rebecca Fisher: I think a key point is that countries like the UK and others can demonstrate that trends can happen. They have done this in other sectors as well, so there is more than just that 15% decrease. It is important that the same techniques are used in other countries.

Lord Duncan of Springbank: Yes—if there is comparable farming.

Phil Bicknell: The emissions associated with beef production will be half of the global average when we look at the UK. That is why there is the risk of effectively offshoring and potentially making the situation even worse.

Professor David Frame: I have the advantage of being on the web: global methane emissions from agriculture rose roughly 12% between 1990 and about now, 2020. I believe most of it is in the developing world, where populations have risen rapidly as well. In the conversation about metrics, people have said that choosing a warming-based metric would penalise the global South because its emissions have been growing, but actually it accurately maps the warming implications of who is doing what. It seems a strange argument to say we should not use accurate data for warming and who has created temperature change because it might be inconvenient for the politics of climate change. Your question reinforces the need to have a temperature-based way of looking at this, however else we want to do it as well.

Agricultural methane is unusual in that it is one of the very few things where, in most sources of emissions, at the point where human beings harness the energy, you release the emissions. When you import a litre of petrol and you burn it in your car, when you drive a kilometre or two you then release the emissions at the point of harnessing it for human behaviour. Methane is totally the opposite. Before you thought of the

animal is when the methane emissions occur, and once the meat is there whoever eats it does not internalise those emissions.

This is exaggerated by the fact that methane is a highly effective greenhouse gas, so there is a slight emissions cross-boundary issue with food, and it would be quite tempting to offshore all those emissions to developing countries and then blame them even when we eat the meat. I think that would be a bad outcome if it leads to higher levels of emissions overall globally.

Lord Duncan of Springbank: My concern is that there will be anticipated growth in certain parts of the world where we will see, and we must therefore accept, that greater methane will result from population growth and demand. Although we are making headway here in the developed agri-economies, elsewhere we would have to anticipate substantial growth in methane just through development.

The Chair: I will ask a supplementary to that. Is it the case that most people in the developing world eat far less meat than we consume in the developed world?

Lord Duncan of Springbank: I do not think that is a germane point here.

The Chair: Okay. Do you want to make another point?

Lord Duncan of Springbank: The point I am making is we still have to anticipate the growth in methane from agriculture, full stop, in the developing areas. Whether it be for your argument or mine, it would still be an anticipated growth.

Lord Trees: To follow on that, there is an increasing demand for meat in the developing world. Is there time, Chair? We have discussed quite a lot about slurry and so on, but shall I press on briefly?

The Chair: If you have a question, yes.

Q82 **Lord Trees:** There are two. A very quick one is that there is mention in our brief about adding acidification of slurry. Could someone comment on that and how useful that would be? That could be done individually at a farm level. The second issue is that, although the harvesting, anaerobic digestion and so on seem very positive, the problem is that we are talking about thousands of small and medium enterprises. To what extent have there been co-operative ventures and integration of that? Should there be more encouragement for that sort of integrated approach, sharing major capital developments like anaerobic digesters?

Phil Bicknell: With AD plants, it is important to bear in mind that the feedstocks that are going into them are more than just slurry and animal manures, so that is something to consider. Where we have seen some large-scale investment, it has probably been using alternative feedstocks, rather than moving around what is a bulky, messy, smelly and dirty product: animal waste.

This has been particularly reinforced over the last couple of years, as we have seen fertiliser prices spike. Some might view livestock manures as a waste product. Actually, they have a big nutrient value as well. The economics of moving that around and the value it has for individual farms start to make it quite complex and probably start to be a bit of a barrier. In UK farming, we know that co-operation maybe lags behind some other parts of the world, so I do not think that we have started to see that quite yet.

Interestingly, from our perspective—particularly focused on the value of manures more generally, not related to methane emissions but around making better use of pig and poultry manures as a fertiliser—we are starting to see the economics stack up and the collaboration come where you have a high concentration of farms that have that product. I think there is inevitably a scale to it. For me, that means there is a limit and I think that the ability of traditional family farms to get involved will be capped somewhat.

Lord Grantchester: I will quickly jump in, picking up Lord Trees's point about the acid addition that is said to reduce it by 90%. That looks absolutely massive. Why is that not easy the answer that Government policy is using?

Phil Bicknell: That is one of the areas that is picked up in the report that I will send. The other one that jumps out, from memory, is that there was work around using plasma technology. That needed huge amounts of electricity, so there was a cost to it, but I will send more information to the committee on that.

Professor John Gilliland: Can I put in a little health warning on the acidification of slurry, please? Acidification of slurry works particularly well in reducing ammonia more than methane, but there is a consequence. The consequence is that we already have, particularly in livestock agriculture, soils that are way below optimal soil pH. We have not done any long-term trials of the consequence on the soil microbiome of further lowering the soil pH when we apply the acid-treated slurry. This is one of the problems. If we do not look at the whole system, sometimes we make decisions that have perverse outcomes. We are seeing that, as soil pH drops, the soil microbiome is collapsing. It is the vehicle that we need for carbon removal, so it is really important.

There are biological additives out there for slurry that do not have as good a reduction of methane or ammonia, but they are far better for the soil microbiome. My plea in this is that we look at the totality of the technologies and not take just one part of it. I have been very vocal on this. I have yet to see any long-term trials of the negative consequence of applying acid-treated slurry for the soil microbiome. I am a passionate soil person.

Q83 **Earl Russell:** Thank you all for a very interesting and fascinating session. I have certainly learnt a lot. To wrap up this session, my question is relatively simple. I want to ask you whether you think there are examples

of best practice from other countries in the world that could be implemented in the UK. Putting it the other way around, is there more that the UK could be doing to help perhaps in the developing world and other countries by sharing things we are doing here? I am open to anybody who would like to answer that.

Phil Bicknell: From my perspective, I say: let us not discount some of the areas where we are world-leading. That is part of the rationale behind the UK Agri-Tech Centre: how do we use some of our world-leading scientists, the know-how and the knowledge that we have in our academic institutions that work across the food and farming area, join that up with the problems that industry has, and provide the solutions? We should not forget some of the great work that is going on in organisations that have been namechecked already—the University of Reading, AFBI and Queen's University—and broaden that out to Nottingham, Harper Adams and Rothamsted. There is a huge amount of work going on that is trying to improve the sustainability of agriculture and address emissions. Anybody who has respiratory chambers will be booked up for months in advance. Lots of work is taking place.

We should also remember that farming policy and the direction that is taking has probably come in for criticism, particularly from farmers. One of the positives from my perspective is that we have had money going into research and development through the farming innovation programme that helps research and innovation take place. I think we have attributes that we can share with the rest of the world, and that is part of what we do through joining up with international aspects. In some areas, we are a little ahead of the curve because the interest from our consumers, our food processing and our food retailing industry has been around sustainability. We are perhaps looking at issues ahead of other parts of the world.

That said, there are areas that we can learn from. We certainly look at New Zealand in some of the examples. Inevitably, we look across at the Netherlands where, through Wageningen, there is a concentration of agriresearch. We look at some of the leading institutions in North America as well. My key thing is not to discount some of the great things that are happening in the UK and the significance of funding that is going into, and hopefully will continue to go into, looking at the long-term problems and challenges that agri-food faces. We need to make sure that we are investing in tomorrow's problems today to get ahead of the curve. For some of the 16% reductions since 1990 that we mentioned, how do we build that?

Earl Russell: That could also be a model that the UK could help other Governments replicate in their countries to understand their own farming mechanisms, which are obviously different.

Professor David Frame: On the methane vaccine, the issue of measurement is a common issue for the UK and New Zealand: how we make the on-farm measurements and how we corroborate the evidence. One of the main areas we can help with is policy thinking. We have done

quite a lot of policy thinking over the years. There is the level of pricing at the farm level or at the freezing works level, as well as how to set up a scheme. I know that the UK is some way from pricing methane emissions, but it is a natural extension of agricultural climate policy. The role of forestry and other biodiversity in helping achieve your targets in a way that is consistent with warming goals is something we can definitely help with. We have separated out the gases. That may not be how you choose to do things, but I think that the idea of sectoral integration of climate policy is sensible. Those are things we can offer.

The Chair: Professor Gilliland, you will have the last word and then we will wrap up the session. Please keep it brief.

Professor John Gilliland: My last word about best practice elsewhere is the economics of methane mitigation. For me, the best knowledge on this is in the Irish Republic. Teagasc and the department of agriculture issued last year their revised marginal abatement cost curves, which are about the economics of total greenhouse gas reduction, but particularly methane. The level of detail is stratified across so many different livestock systems, and it is fantastic. We could learn in the UK from what the Irish have done in that publication. For me, as a practising farmer, I can change my behaviour only if I still have an economic activity at the end. The economics, the marginal abatement cost curves, the tools and the assumptions from that need to be kept under review, and we need to be sharing with our neighbours and learning from them as well.

The Chair: Thank you. With that, all that remains for me to do is to thank the panel, not least for taking up more of your time than you had originally committed to. I remind you that we await further written evidence that you have committed to submit to the committee. One of the challenges we identified is the increasing demand globally for meat products, which is a challenge, so any further evidence that you can submit to the committee on that would be much appreciated. Thank you.