UK Research and Innovation

Briefing: Animal welfare, net zero & the food transition – trade-offs & opportunities

Based on an AFN Network+ webinar, held 23.05.25

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About the speakers & this briefing

About this briefing:

This briefing is based on a webinar discussion with Gareth Arnott and Francesca Johansen, given to the AFN Network+ community on the 23rd May 2025. It is collated and written by Nina Pullman, food systems writer for AFN, and edited by Jez Fredenburgh, knowledge exchange fellow for AFN; the transcript has been lightly edited to paraphrase in parts. You can also watch the webinar.

About the webinar topic:

The conversation about a food system transition is becoming louder – but animal welfare is not always getting much of a hearing. What then, might a food system transition mean for the animals in the farmed system? What opportunities might there be to enhance welfare? But what, too, might be traded off in a transition, and would these be morally or practically acceptable? How might the focus on net zero as a goal, impact animal welfare, compared to a more holistic but less focused transition?

The speakers cover the following points:

- An overview of trade-offs and opportunities for animal welfare with a focus on net zero, or more widely food system transformation
- Impact of different food system transitions on animal welfare & net zero (intensive & efficient versus extensive & regenerative)
- Moral questions around what trade offs are acceptable/ not
- The link between human health/wellbeing and animal health/wellbeing
- Gaps in research/ questions raised

About Gareth Arnott:

Gareth Arnott is a Professor in animal behaviour and welfare within the School of Biological Sciences at Queen's University Belfast. He leads the BBSRC-funded Animal Welfare Research Network and is a member of the UK government's Animal Welfare Committee.

Gareth is a behavioural biologist whose research interests span from fundamental behavioural ecology through to applied animal welfare. He has pioneered an approach of using principles from behavioural ecology to address applied animal welfare issues, including aggression. Gareth has worked on a number of farm animal welfare topics across a range of species.

About Francesca Johansen:

Francesca Johansen is a Research Officer in the Pig and Poultry Development Department at Teagasc, Ireland. Her work is currently focused on creating a framework for sustainability assessment where animal welfare is considered on an equal level to environmental, social, and economic sustainability.

She submitted her PhD thesis on dairy cow behaviour and welfare in spring of 2025, and has previously also worked with extensively managed beef cattle.

Summary of key points

Gareth Arnott and Francesca Johansen discuss the importance of animal welfare within the sustainability and food transition debates, as well as the trade-offs and opportunities in the journey towards net zero.

Key points from Gareth Arnott:

The definition of animal welfare should include physical and mental states

- Animal welfare includes physical health, but it should also cover psychological wellbeing.
- Psychological wellbeing is harder to manage in animals and is often missed as a result, but it should include mental states, emotions and sentience.
- A paper by Marion Dawkins has been key in defining animal welfare as a combination of physical health and psychological wellbeing.

A more sustainable farming system has some win-wins for animal welfare

- A good farming system that effectively manages animal health, and results in less animal loss, also benefits overall carbon budget and efficiency.
- There is also a productivity win as healthy animals grow better and are typically more productive.
- Healthy animals require fewer medications and antimicrobials, which helps tackle another key sustainability challenge for farming around antimicrobial resistance.

Focusing purely on carbon will result in trade-offs on welfare and efficiency

- An obvious way to reduce emissions is to make farming more intensive (the efficiency argument), but this has animal welfare trade-offs. An example is broiler chickens, an intensive system that is very efficient at producing protein.
- There is a growing understanding around balanced breeding, the challenges around leg health and other conditions in the broilers that have resulted from intensive systems.
- In the future, there are plans for the dairy industry to achieve higher yields from animals producing more milk. This would be a win in terms of the carbon unit of milk and productivity, but there are concerns about the welfare of that animal.
- In certain countries, feedlot cattle can be a really efficient way to produce beef at scale, but intensifying that system would bring major challenges for animal welfare.

Methane reduction additives may cause some harm to farm animals

- There are numerous techniques being trialled to reduce methane emissions from ruminants. There are also a range of useful approaches to monitor ruminant methane emissions, including a green feed system and some automatic milking systems with sensors to detect methane. It is now possible to phenotype animals for their methane production.
- However, ruminants evolved to produce methane for a reason, as part of their pathway to turn indigestible material into an energy source. At what point of reducing methane emissions is there a detrimental effect on the animal and its gut?
- There are limited studies following performance and health indicators around methane reduction, usually constrained by short funding periods.
- Future research in this area should not lose sight of potential animal welfare implications of methane reduction.

Studies show links between human wellbeing and animal welfare

- A study in Canada surveyed dairy farmers on levels of stress, anxiety and depression. Researchers also mapped cattle body condition and lameness on farms, as basic physical measures of welfare. Data showed a correlation between farmer stress and levels of lameness in the cattle.

- There is an approach called 'one welfare' that suggests that the wellbeing of farmers and producers is linked to animal welfare.
- Research doesn't yet show the directionality, causes and consequences of that link, but this is an area that warrants further study.
- If farmers are working alone, mental welfare can be poor. As a result, they may be struggling to cope and this may have negative implications on their animals.
- The flip side is if a farmer is working in an environment that they enjoy, that has a knock-on benefit for animal welfare and lower staff turnover.

Animal welfare has historically been an intangible part of agriculture, but there are opportunities to quantify it

- Animal welfare has been described as a latent or intangible factor in agriculture. It is possible to put financial evidence around the benefits of good animal welfare.
- Morally and ethically, it may not feel necessary to justify the need for animal welfare, but in a world of competing demands, metrics can help.
- There are learnings from ecosystem services and biodiversity markets, where economists have started to value those areas. It is possible to do that for animal welfare.
- There are product quality opportunities around better animal welfare. For example, animals that are less stressed in transport produce better quality meat. It would be helpful to evidence some of the product quality benefits for animals that are raised in higher welfare standard conditions.

Key points from Francesca Johansen:

It's hard to measure trade-offs when sustainability measurements are not standardised or easy to compare

- It can be very difficult to create an overall sustainability score, which can involve comparing a carbon price to mental health.
- Sustainability is usually split across four pillars of environment, economy, social and animal welfare. Only six out of 23 current sustainability assessments examined by Francesca as part of a study looked at all four aspects at the same time, and only one of those has them on equal footing.
- It is difficult to consider trade-offs under the current system of assessing livestock systems for sustainability. It may mean that animal welfare does need more attention.

It may be possible to improve all aspects of sustainability within the constraints of one farming system

- Scientist Harriet Bartlett compared the costs and trade-offs in four different areas of pig production: land use, greenhouse gases, antimicrobial use and animal welfare, across one unit.
- Land use looked at the area of land required to produce one kg of dead weight meat over the course of one year. Greenhouse gases looked at the mass of CO2 equivalent emitted in the production of one kg, antimicrobials looked at the milligrams required for one kg and animal welfare looked at the number of life years required.
- The study found that as land use increased, so did greenhouse gas costs. Overall, systems would perform well in animal welfare and antimicrobial use, or land use and greenhouse gas emissions.
- That said, five of the 74 systems studied were in the best performing 50 per cent for each aspect, which means that trade-offs are not always the case.
- This study suggests that each individual system may have the potential to improve within their parameters, and maximise sustainability gains within one system.

There are soil health benefits to improving animal welfare

- Nuffield scholar Claire Whittle looked at how regenerative agriculture can improve livestock welfare, adding to work that already shows how it benefits soil and ecosystem health.
- One of the farms she visited was Jillamatong Farm in New South Wales, Australia, which had a history of drought and soil erosion. In terms of animal welfare, they struggled with eye infections and mastitis due to flies.
- The farmer made some regenerative farming changes to facilitate 'natural'

behaviour, including adding vertical paddocks, so that cows had a choice of altitude. It almost completely cut out antibiotic use, because cows were able to use the wind higher up to avoid flies.
- In addition, this study also found that occupational wellbeing for farmers led to more positive welfare for the animals.

Key points from the audience Q&A:

The link between animal and human welfare has implications for the food system transition

- There is scope to look at the link between human and animal welfare in terms of food system transformation, and framing it in terms of better lives for farmers.
- Understanding that link should be inherent in designing farming systems going forwards.

The trend for dairy beef has potentially negative impacts for farmer and animal welfare

- There are now incentives to finish cattle earlier, via premiums and rewards, as that is more efficient from a carbon point of view.
- The cautionary note is there will be a tipping point in terms of how this trend is pushing the animal, and the impact on conditions like acidosis.

Eating less but better meat is good for welfare in theory but needs to come alongside changes to trade policy

- Eating 'less and better' quality meat is good for animal welfare in theory. But it can mean different things to different people - 'better' could mean better for the environment, or better for welfare.
- In addition, the demand for meat and meat products is going up globally. This will be filled in some parts of the world by more intensive farming.
- Trade policies need to be included in this transition, by stating what is acceptable in terms of society and sustainability.

Cultivated meat is not yet at a scale where it is a gain for animal welfare

- Cultivated meat is not yet cost effective or present enough within the mass market to offer a benefit for animal welfare.
- Meat alternatives also come with their own challenges around sourcing of ingredients, cost of production and nutrient levels.
- In five years, the cultivated meat market may have expanded to the point it could become part of the animal welfare and meat discussion, but at the moment it is a premium and specialist product.
- Most modelling around how alternative proteins and cultured meat will become part of diets is based around replacing processed meat in ready meals, rather than a joint of beef on a Sunday.

Webinar transcript

Animal welfare scientists and researchers Gareth Arnott and Francesca Johansen discuss how animal welfare is assessed alongside other sustainability measures, and how it could be better incorporated into a holistic food transition and net zero. The transcript has been lightly edited in parts to paraphrase.

Speakers: Gareth Arnott (GA), Francesca Johansen (FJ), Jez Fredenburgh (JF) (Chair).

Animal welfare doesn't often get much of a hearing within the wider food transition debate

JF: Welcome and thanks very much for joining this AFN Network+ webinar on animal welfare, net zero and the food transition trade offs and opportunities. I'm Jez Fredenburgh, I'm going to be your chair today. I'm based at the School of Environmental Sciences and the Tyndall Centre at the University of East Anglia, where I'm the knowledge exchange fellow for the AFN Network. Also with me is my colleague John Haslam, based at the University of York. So onto today's topic. The conversation around food system transition is becoming louder, but animal welfare is not always getting much of a hearing. I think if you're in the food system transition conversation, it's not one that's coming up for a lot of people.

So what then might a food system transition mean for the animals in the farm system? What opportunities might there be to enhance welfare, but what too might be traded off in that transition, and would these trade offs be morally or even practically acceptable? How might the focus on net zero as a goal impact animal welfare, compared to a more holistic but less less focused transition?

So to dig into this, I'm very pleased to welcome Dr Gareth Arnott from Queen's University Belfast, and Francesca Johansen from Teagasc, Ireland. Dr Gareth Arnott is a reader in animal behavior and welfare within the School of Biological Sciences at Queen's University Belfast. He leads the BBSRC-funded Animal Welfare Research Network and is a member of the UK government's animal welfare committee. Gareth is a behaviour biologist whose research interests span from fundamental behavioral ecology through to applied animal welfare. So Gareth, I can hand over to you.

Agricultural sustainability and animal welfare are often considered to be an unsolvable problem

GA: So I've done the academic thing and changed the title that I'm slightly going to talk about, but essentially it is the topic, but I'm being slightly provocative, so animal welfare and agricultural sustainability, and I've used this term 'a wicked problem'. And I'm sure many of you have come across this term, where the term wicked problem is used, typically to describe an unsolvable problem and one that's really intractable and hard to solve. And it's come from the area of management and policy and it has been applied to the whole area of climate change. So I've posed the question, and by the end of my couple of slides, we can decide whether we think it is or whether we think it's not, and have a discussion.

But before that, I'm going to start by way of a slight disclaimer. So essentially at heart, I'm a behavioural biologist. These are research areas that I work on. So from fundamental behavioural ecology of animal contest behaviour, right through, then the applied issues around dairy cow welfare, dog welfare, some of the stuff around anthropogenic stressors influence on animal behaviour. And then, more recently, some super interesting work on the links between the microbiome and animal behaviour. So that's my happy comfort place.

This talk today, I feel a bit out of my depth. Having said that, this is an area, the whole area of agricultural sustainability and where welfare sits, I think is one that we all need to be part of the discussion and be part of

the debate. So I was really pleased to have the opportunity to talk to you today, and I guess just a bit of context as to where that came from.

At the moment, I lead the Animal Welfare Research Network, and about a year ago, in June of last year, UKRI and BBSRC organised a networking event. And that was where I got to meet the Agri Food for Net Zero people involved in running that network. We had a really great discussion. And that's where the idea for this webinar came up because we realised, it's very easy for us to be consumed in our own areas dealing with their own perspective. So I think it's really important we start to have these talks among ourselves. So that's the impetus.

I'm sure most of you on this call will be familiar with sustainability and agricultural sustainability. So we talk about the three pillars, so we have the environmental and all that goes with that, and then economic and then the social elements to sustainability. And usually, then, it said that animal welfare can be seen to sit within the social pillar. Now, actually, when I started reading and preparing for today, I came across a number of really interesting articles that actually say animal welfare shouldn't sit within.

We shouldn't be conflating the terms agricultural sustainability and welfare, and really, welfare should be its own separate agenda that we drive for its own reasons. Now I guess at heart, I would probably agree with that, but I'm a pragmatist as well, and I think it makes sense for it to sit and be part of the discussions around sustainability, really importantly, because I think otherwise, we're in danger of it slipping off the agenda.

So part of the remit to have these discussions is that I would argue that it definitely should be part of the sustainability definition. I think it does naturally fit in with elements of social sustainability and what's acceptable. As we get to the end, I'm going to also argue that it should fit firmly, and it does fit naturally within economic sustainability as well. And that actually is where I think there are opportunities to be realised more there.

Physical health and mental state should both be considered and measured as part of animal welfare assessments

I'm being remiss as well, because we're using the term welfare. And I guess straight away I should probably define what we mean by welfare. And of course, welfare can mean different things to different people. So I've highlighted here a paper that Marion Dawkins had written. Now this paper is actually, you'll see 2017 so it's now a number of years old, but it's a really interesting perspective. So Marion defines welfare and I like this approach. It tries to distill it down into something that's really tangible. So for Marion Dawkins, good welfare is, is the animal healthy and does it have what it wants? And that might sound flippant, but it's really not, because it covers the two broad areas.

So is it healthy? So that's your physical welfare and wellbeing, and does it have what it wants? So that's getting at the psychological welfare and wellbeing and you can pick your own definition. Different people have different takes on it. We can also get into the different ways that they assess welfare, whether that's the five domains, and whether it's the one. Welfare, quality and criteria.

But I think if we keep that basic message in our minds, it makes it quite a useful starting point for us, but just to emphasise we're talking about the physical, so health, but also, and really importantly, we're talking about the psychological welfare. And I think the latter is the one that can often get missed and slip off the radar. And part of that is a challenge on us as welfare scientists, because that's harder to measure getting at the mental states, emotional state, sentience, and effective state. These are challenging things to do, feasibly and practically. But again, I'll come to that at the end for some opportunities in that space.

In this nice opinion paper from Marion Dawkins, she outlines some potential conflicts, but I'm going to start on a positive – some wins for both animal welfare and agricultural sustainability. So if you think about it, if we think about systems that actually enhance welfare, and one of the iceberg indicators can be looking at mortality. So if we have a good system that manages early life welfare, and we get less animal loss, whether that's in pig production or lamb production or any of the species. So if we reduce that mortality, that obviously is a benefit in terms of our overall carbon budget and being more efficient. So I think that's an easy win-win,

but aligned to that if we create management and husbandry systems that are good for welfare and good for the physical element of welfare. So health, then that obviously is another win, because healthy animals grow better and are more efficient and are typically more productive.

Really importantly, then there's a need for less use of medications and antimicrobials and we're aware that a whole other massive issue, in addition to climate change around sustainability, is antimicrobial resistance. So I'm not going to spend too much time on this, because we can think about some of these win wins and that's a good thing. But what we should talk about is then some of the trade offs. And this is where some of the challenges arise more so. So there are some potential trade-offs in the transition to net zero in the agricultural system.

If you go at it from a purely carbon accounting, mitigation and reducing greenhouse gases, we can start to get into some challenging territory. So an obvious solution would be that we become more intensive. So I have the photograph there, the broiler house. I see it as both a positive and negative. We have a population to feed and the broiler production has become incredibly efficient. In many ways, that's a win for producing protein, but we are now aware, very aware of the some of the side effects that came along with that and that now feeds into the discussions which are, I would say, a reality around more balanced breeding, and being aware of the challenges around leg health and other conditions in the broilers that have resulted from the intensive breeding.

I guess what I'm saying here is we should probably try to keep in mind the lessons that we've learned from a focus on production solely in the past, and now there is much more holistic breeding and holistic measures. And I think that's a good thing. So as we transition to these net zero and, well, you could also argue, I've had a good discussion with a farmer friend of mine and and should we even be using the term net zero, because is that achievable in agriculture the way we produce animals? But that's a whole other discussion. The broad thing is, we should learn the lessons of the past as we try to develop systems that are doing better in terms of net zero ambitions, but also aren't losing sight of the animal welfare within it.

The future of dairy is likely to become more intensive to reduce the carbon price per unit of milk

If we think of examples like, and I guess this is where I get concerned, because I've been involved and heard discussions around, for example, the future dairy industry in certain parts is going to be producing more, using more higher yielding animals, producing more milk. Thinking about the carbon unit of milk. In other words, a really highly productive, high yield dairy cow, and then aiming to have longevity of that animal. And that may be a valid thing from a performance production, but there would be concerns there around the welfare and meeting the welfare needs of that animal.

I guess my plea is not losing sight of those and even the rationale for today's talk is to us all engaging in a conversation, to raise awareness that these potential trade offs exist. So I guess if that's even one of the take-homes of me being able to chat today: there are these potential trade offs, and then we can see it in other sectors. So in beef production, of course, in certain countries, we've got feedlot cattle, so that can be a really efficient way to produce beef at scale, but if we move to more and more intensive, that is a major challenge for animal welfare within it.

Then thinking about other sectors. So think about pig production, you know, average litter size and breeding for larger litters has been very successful, because now we can have very large numbers of live, born animals in an intensive environment. But what's the implications for welfare? And where is the spot that's acceptable or not so? And these aren't solely scientific questions. I guess that feeds into the social license of whether we think that's acceptable from an animal welfare point of view. And there are these examples across each of the sectors.

Methane reduction feed additives could harm animals if they go too far

So now one that's slightly, perhaps a bit more provocative as well, and so major focus at the moment is on reducing methane production from ruminants, of course, a major greenhouse gas. So there's been a lot of

research money and projects going around reducing methane and ruminants and I'm going to caveat this by saying I'm engaged in some work in this area. So it's not like I'm an outsider, passing opinion on this research. I am engaged in it and I'll come onto the role of that in a second, but there is this focus on trying to come up with strategies to reduce methane emissions. And I guess we could split it into two main strategies, which are around selective breeding for reduced methane production, and then the whole area of using supplements and additives in the diet to manipulate and reduce methane, right?

And on the face of it, that's really important. And I think the research is really important here. I'm highlighting, by the way, in these figures, just the different ways we can at the moment measure methane. So you've got the gold standard there of animals in a chamber, then we've got the likes of the green feed system, which is a super useful research tool, and we're using more and more. And at the bottom, I'm showing the SF six canister, and then some of the automatic milking systems as well are developing sensors to detect methane. So this is good, because more and more we can now easily phenotype animals for their methane production, and that's a great thing.

But here's the slight caveat. Because, if you take the argument to its extreme, ruminants evolved that rumen microbiome and ecosystem to produce methane, for a reason, part of their pathway to turn indigestible material into something that's useful and as an energy source, but having this byproduct of getting rid of hydrogen through this methane mechanism. So it's evolved for a reason. So at what point, if we go as far as we can, at what point is there some detriment on the animal? And to be honest, I don't know the answer to that, and I'm aware it's a very active research area, so I guess my question is, is there a point where there are effects on animal welfare?

I don't know the answer, but we should definitely check. And I'm aware, to be fair to any of the people doing research in this space, there often are studies following the performance and health indicators, but those studies are constrained to the extent we often only have the funding to study animals for a relatively short period of time. There's only so many things we can measure. So I guess what I'm saying is, let's not just lose sight that we should be checking in on the animal. And so it's a slight cautionary note that I think we should be a bit cautious about solely relying on this, and we should certainly be very careful about doing as much follow up and phenotyping and checking as we can, and looking at potential implications and welfare. I'll be keen to get people's thoughts on this, because it's an active, newly emerging area.

Farmers with higher animal welfare have better wellbeing and job satisfaction

Okay, so then we come onto another really, really important part of sustainability, which is linking the farmer welfare and the animal's welfare. So like, as I say, anyone and all of us involved in farming or that know it's a really challenging occupation. From a purely physical, challenging point of view, and unfortunately it's one of the most risky occupations out there, from that sense. But also, more and more for risk factors around mental health and welfare. So I'm a big advocate of this one welfare approach in that we need to make sure we keep in mind that human welfare and the human producers of animals and agriculture is linked to animal welfare.

Actually, just yesterday, there was a speaker came to Queen's talking about the future of our planet, and gave a talk that put up a number of quite stark environments, and one of them was in Kenya, where there'd been major drought and showing photographs of, unfortunately, the farmers and their livestock that have been lost. And in those environments, literally, your welfare is absolutely directly tied to your animal welfare, because that's your financial resource and your livelihood. So that's at the extreme end, but of course, at the less extreme end, and in our more intensive production scenarios, it's still a major issue.

So the two studies have highlighted, and this is a newly emerging area, a need for more research. There was a study done in Canada, and it was surveying dairy farmers in Ottawa that were using robotic milking systems, and basically they had a mental health questionnaire validated that survey levels of stress, anxiety and depression. And they went on farm and they mapped cattle body condition score and lameness, so that basically physical measures of welfare. And in the paper, they showed that there was a correlation between stress and anxiety, and levels of lameness on the dairy farm.

So in other words, there was a link between, unfortunately, struggles with farmer mental health, and then also with animal welfare. Now that's a correlational study. We don't know the direction, directionality and all the

causes and consequences of that, but I think this is the research we also need to be getting more into as we go forward.

The bottom one was a super interesting study done in Norway, and I was very impressed at the level of work and statistics that went into this one. So essentially, they had surveyed a number of dairy farms across Norway and again, validated questionnaires. But then this one gathers excellent farm records on I think every herd is recorded, and it showed in the table the absolute number of measures, which was very comprehensive, but they basically from those measures, these were things like cull rates and like mastitis, incidence, fertility, other disease and welfare indicators, they distill down out of the data one animal welfare indicator, which was basically an overall score for how the herd was doing.

And again, they find a link between farmer stress levels and a lower animal welfare score. So it's highlighting to some degree, again, at the extreme end, unfortunately, if you're on your own, mental welfare is really poor, you're probably largely going to be struggling to cope with yourself and then, and may therefore be neglecting your animals. There's lots of work on that from the companion animal sector and so anyway, we need to keep this in mind, because it's a really important part of sustainability. The flip side of this is, if you get it right, and if you're a farmer and they're working in an environment that they enjoy, producing the animals within it and farming within it, then that has a knock on win and a benefit for animal welfare, and also a benefit for sustainability in terms of less staff turnover and things like that.

There are opportunities to prove how animal welfare benefits sustainability, and opportunities around product quality using metrics and data

That actually brings me onto the opportunities. So historically, animal welfare has been described as one of these latent or indirect or intangible factors in agriculture. So I guess my plea is, we can start to put slightly hard-nosed financial evidence on the benefits of good animal welfare. Now and again, I'm aware people would debate with me that, you know, philosophically and morally and ethically, you shouldn't need to do that in order just to protect animal welfare. And I agree. But equally, we live in a world where there's a lot of different competing demands, and this is a wicked problem. So as part of it, I think there's going to be benefit for us to put in some metrics on the benefits of this animal welfare, and we're now starting to see research that is trying to do that.

And actually there's a lot to be gained from the work around ecosystem services, around biodiversity, where the economists have started to come up with ways to put metrics on ecosystem services and biodiversity. I think we need to be doing that for animal welfare. So here's some that you could put metrics on. So if you improve disease resistance, and you obviously reduce medication, that is a financial benefit. We've got health benefits if you produce animals in a scenario where there's less zoonotic risk potential and less potential for the spread of the next pandemic, that's a major financial vaccination.

Shall we say, if we think about the costs of a pandemic, I've put consumer premium. So when you do surveys with consumers, they'll tell you the willingness to pay is going to be higher for animal welfare. But unfortunately, whenever you actually test this for real, there's often a disconnect, and we can understand the reason for that.

We're currently in a cost of living crisis for many people, and while they'd probably like to pay for higher welfare, when they're at the checkout that's when reality, so that's why I've put a question mark. Having said that, of course, there will be premiums that we can and some people will definitely be prepared to pay a premium. So I think there's opportunities there I've put around product quality. There's classic examples at the extreme, where if you transport animals under really stressful conditions, let's think about beef cattle, then you can get literally super poor meat quality in terms of dark, firm and dry and all those other things. But there's a need for more research in this area.

Can we evidence some of the product quality benefits better for animals that are raised in higher welfare standard conditions? And finally, and I mentioned that one in the last slide around animal caretaker satisfaction. So if we can get the environment right that people want to work in those husband husbandry

systems that look after animal welfare, I think that's going to have a benefit and a financial benefit in terms of less staff turnover, in terms of being able to recruit good people that stay.

How do we help with that? Well, key helpers of that are the role of technology. So going forward, there is going to be more and more roles for technology to play in trying to support assessing welfare, managing welfare, and doing something about it. We shouldn't lose sight of the stock person at the centre, but we should have tools to help make their life easier. You could argue that from a welfare point of view, we don't actually want an animal that has all these sensors attached to it.

Technology will help, but we need to not lose sight of the fact there is an animal at the centre

We're now in a position where we can use fancier, more sophisticated, better integrated technology with less sensors to tell us the same thing. And I'm thinking here as well about harnessing the benefits of machine learning and artificial intelligence. So recently, as part of my role leading the animal welfare network, the BBSRC very kindly funded technologies for welfare seeding award, and that enabled us to fund pilot projects that had the Lincoln industry partner and an academic to try to address a real world animal welfare issue, and they will be coming to fruition soon. I'm going to advertise where you can hear about them if you're interested. But that's been a brilliant initiative, and I think we need to see more of that as a slight caveat and cautionary note without losing sight of the fact that there's an animal at the centre of things, and that technology can only take us so far.

And so we need the technology to be practical and feasible, and that's a challenge to the research community, and just on that. In March, we hosted a workshop held jointly with another network, the AI bio network. And that was all around, can we use artificial intelligence to improve welfare? And so you can hear more about that down the line if you're interested as well. And so, is it a wicked problem? I think it depends on your perspective. So do you see the glass half full or half empty? I try to be an optimist, so I'm seeing the glass is half full. So therefore, I don't actually think we've got a choice this is happening. We need to try to make the best of it and be clever about some of our solutions. So it probably is a wicked problem, but we've no choice but to deal with it. It's the problem of our time, and I think we need to be clever.

And my plea would be in the discussions around sustainability, let's please not lose sight of animal welfare and where it sits within that. If you're interested in learning more, our annual conference is going to be in Bristol on the 10th and 11th of September. The theme is New Frontiers in Animal Welfare Science. And within that, we're going to have a breakout session on this issue, so we're going to have a chance to discuss it in more detail, with representatives from BBSRC that are interested in funding some of the research in this space. So with that, I'm going to say thanks again for the opportunity to chat, and I look forward to our discussion after.

JF: Thanks so much, Gareth, that was really good. I've got loads of questions. We've got a few coming through. So Francesca Johansen is a research officer in the pig and poultry development department at Teagasc in Ireland. Her work is currently focused on creating a framework for sustainability assessment where animal welfare is considered on an equal level to environmental, social and economic sustainability. So taking what Gareth was saying earlier, one step further.

Comparing animal welfare to other sustainability metrics is difficult under current assessments

FJ: So my background is in dairy cow welfare and to a certain degree, beef welfare as well. I started this role where I am now roughly a year ago, so it's a fairly new area for me, and the area that I focus on within this space is sustainability and welfare assessment. And it's worth noting that, because there are relatively few articles looking at all of these things at the same time, I'm going to be relying very heavily on work that others have done. And, they're all really great scientists, and everyone's working very hard in this space. As I'm sure you all know, livestock farming and sustainability is a really, really complicated topic, and it can be challenging because there are so many different aspects and deciding how you're going to even try and start to understand assessments can be really, really challenging.

But I've pulled out animal welfare as its own thing, because that's going to make it easier for me to discuss my slides. So if you're trying to come up with an overall sustainability score it can be very difficult to compare across all of these so, what kind of metric would you use to think about how you'd compare a carbon cost to mental health? And just thinking about those things can be really, really difficult. And most of the research that has been done is looking at these impacts in isolation. So it'll be looking at environment and animal welfare, or environment and economics or something like that, and maybe not all together. And that's not to say that the research that they've done isn't very good, but we need to try and get everything a bit more integrated.

So to be able to understand potential trade offs and impacts, it's really important that we understand how to measure these things, because if you don't know, then how you are supposed to make any assumptions. So work that I'm currently doing at Teagasc is looking at what sustainability assessments currently are out there, and to what degree are they including all of these different aspects? So we've got your environment, economy, social and animal welfare pillars.

And this is just a sample of 23 assessments that we have collected as part of surveys we've been doing in the EU. All of the ones that focus quite strongly on animal welfare tend to have gaps in these other pillars and vice versa. So the ones that are covering quite a lot of the other pillars do have gaps in animal welfare. Only six of the 23 assessments that we found actually look at all four aspects at the same time, and only one of those has got them all on equal footing.

So what does that mean for our ability to consider trade offs, if this is the way the livestock systems are currently being assessed in terms of sustainability? Does that mean, as everybody's been saying so far, that animal welfare does need to shout a little bit louder to be heard? So just to say that it is a convenience sample based on survey data, but it does cover assessments from all over Europe and the US. So we've got six that are multinational consortia, and four from Denmark, France, the UK, etc.

It is possible to compare sustainability aspects across one equal unit

So it is reasonably representative, but still a convenience sample. So I'm going to talk through a few papers now. So just to give an example of a paper that actually is trying to compare across different aspects, that's this one here. So it's Harriet Bartlett, she did her PhD in this topic at Cambridge, and she's currently at Oxford, I believe, and she seems to be doing really, really interesting work in this space. So definitely someone to look up and follow. So as I was saying earlier, one of the issues with this kind of assessment is, how do you compare it across all these different attributes as one unit?

So what they did in this study was that they managed to compare the costs and trade offs in four different aspects of pig production. So those aspects were land use, greenhouse gasses, antimicrobial use and animal welfare, and they managed to compare them all across like the same unit. So the land use was looking at the area of land required to produce one kilo of dead weight over a course of one year. Greenhouse gases were looking at the mass of CO2 equivalent emitted in the production of one kilo of dead weight, and antimicrobials, looking at the milligrams required to produce one kilo and animal welfare was looking at the number of life years required to produce one kilo of dead weight.

And this was weighted by the quality of life scoring. So if they had a poorer quality of life, it would cost them more to produce that one kilo. And the really interesting thing about this is that they looked at lots of different systems across the UK, so 74 different breed-to-finish systems. So that means that a system could be one farm if it all happened in one place. And it could be several farms if there was one farm for breeding, one for finishing, etc. And there were lots of different types. So they had RSPCA-assured, Red Tractor, organic, free range woodland, and categorised as none where they didn't follow any of those standards.

So generally speaking, they found that as land use increased, so did greenhouse gas costs. So there's a coal variance there, where the more land you use, the more CO2 or greenhouse gases you're also using. And then as animal welfare increased, antimicrobial use decreased. So the animal welfare costs would reduce and so would the antimicrobial use. So generally speaking, systems would perform well in animal welfare and antimicrobial use or land use and greenhouse gas emissions. But that's not the full story. So five of those 74 systems were placed in the best performing 50% for each of those different aspects. Which means that even though we assume the general picture was that there are trade offs, it's not always the case.

And interestingly, all of these five systems came from different production areas. So some of them were RSPCA-assured where they were outdoor, bred and finished on straw. Some of them were outdoor woodland, and some of them included indoor breeding and finishing, which is really, really interesting. And interestingly, these systems also all had types of RSPCA, woodland and Red Tractor. All had systems which were placed in the lowest 50% in at least one aspect. So that means that there's no unique characteristics to be found by this paper that says that a farm is very bad at these dimensions, or very good at these dimensions, which also means that labelling isn't really telling us what we need to hear.

So what does that mean for people that are trying to purchase more sustainably? Does that mean that each individual system has the potential to perfect themselves within their system parameters, and how could we maximise sustainability gains within one system? So I'm asking a lot of questions throughout this presentation, just hoping to spark discussion, not because I know the answers necessarily, either.

A new Nuffield paper has looked at the links between regenerative farming and animal welfare

So then just to focus a little bit on one system, specifically. Claire Whittle is a Nuffield scholar who's recently published her Nuffield report, which is looking at regenerative agriculture, and if it can improve the health and welfare of livestock. So the theory behind it was that we know there's a lot of work done suggesting that regenerative agriculture can improve soil and ecosystem health, but can it also improve animal health and welfare? So it's one of those situations where we all feel like it should, and it does, but there's not a lot of real world studies done really exploring this. Which doesn't mean it's not true necessarily, it just means that we need to document it properly.

So just in terms of definitions, they use the Groundswell Agriculture definition, which is any form of farming, food or fibre, which at the same time improves the environment. And she suggests that that means farming for profit rather than yield, so trying to reduce inputs rather than trying to increase outputs. And there's some suggestions that this regenerative farming might prioritise naturalness, which means that the animals have more opportunities to perform natural behaviours that they wouldn't maybe be able to do if they were in a feedlot or in a dairy shed. So what she did was she visited different farms throughout America, Scotland, England and Australia.

So I'm going to focus on one of the farms she visited, and that's exploring links between environmental sustainability and animal welfare. So when she went to Australia, she visited Jillamatong Farm in New South Wales, and that farm had a history of drought, soil erosion, and in terms of animal welfare, they struggled quite a lot with eye infections and mastitis, because the cattle will be even bothered so much by flies. So the farmer decided to try regenerative agriculture and made some changes.

So they implemented a damming system, which turned the erosion of water into this river or dam. And they added vertical paddocks. And by that they mean that, instead of having the paddock around the mountain, every single paddock went up the mountain, so that there was a choice of altitude for the cows. So if they wanted to, they could go uphill, because they thought that flies disliked wind.

What they found was, they did manage to capture water, and they did have subsequent plant growth. But they also found that the cows exhibited much more natural behaviour. They were able to have much more agency and travel up and down the altitudes as they wanted. He also found that he almost completely cut out his antibiotic use, because the cows were able to choose themselves when to go high up and get that wind to remove the flies.

And as an added bonus, he also managed to increase his biodiversity, because the cows were bringing seeds and nutrients from the bottom of the valley up to the top. So that's a really interesting example of maybe trying to work or perfect within those system boundaries that I was talking about earlier. So another thing that Claire highlights or reflects on in her report is the value of a good stock person or a manager, because ultimately, any changes or implementations on farm are coming from a stock person. It's all very well for us to know a lot about animal wealth, it will be about being able to implement these changes as well. So it's really important to think about the role of humans on farm and in sustainable decision making.

And I know Gareth touched on this earlier, so I'm not going to take a very long time to talk about it, but basically, they found that occupational wellbeing, if the farmers had positive occupational wellbeing and low stress, the animals also had more positive welfare. Farmers that reported quite high loneliness and pessimism tended to have been negatively associated with animal welfare. So that's just a really interesting starting point to say that if the social aspect and the animal welfare aspect in that regard are connected, what other pillars could mental health be connected to, or what other things could this be a win for? And that's something that we don't know yet, just something to think about.

There's a lot of really exciting research happening in this space at the moment, and there should be more coming soon. So I'm working with the European partnership on animal health and welfare, and they're starting all of their case studies in the coming months, which will be exploring all the different pillars. So hopefully there'll be even more literature to talk about if there's a repeat of this webinar next year.

Questions from the audience

JF: Is there a way of linking the food system transition to better lives for farmers?

JF: Brilliant. Thanks so much. Francesca, it was really interesting. One thing that really comes up, that both of you have really touched on, is the link between animal welfare and farmer wellbeing. Essentially, I'm just wondering what you think about the opportunity there, for when we're talking about food system transformation? We're talking a lot about how that is framed at the moment, and I'm wondering if you think there's an opportunity to link this transformation to better lives for farmers themselves?

FJ: I do think that there's definitely scope for that. But it is very difficult to say definitively, because there's not a lot of research in that space, but just based on what I know and inferences that you can pull, I would say that there definitely is scope for that. But then we do also have to think about the fact that the way farming is at the moment, there's a lot of mental health challenges and loneliness currently being reported. So that's definitely something that needs to be considered if we're going to try to get to these solutions in that space.

GA: Yeah, I would agree with that. I think we're at a window of opportunity where in the past, these things weren't even on the radar, but that's the positive that now we're getting an insight. And the way animals interact, and the way human farmers interact with animals that they're managing, we now know is super important for our own welfare. So that should be inherent in how we design some of the systems going forward. If it's such a bad system that the stock person wants to spend as little time as possible in the house, that's an issue and there are scenarios where that is the case. So that should be a red flag.

So it's good that it's on the agenda. I think it's great to see more research coming out in this area. And to be fair to the research councils, you can see that there's also good discussions around facilitating cross council funding for things like this, because this cuts across the animal side of things, and then the social side and social scientists.

JF: It strikes me that in all these discussions about what is a just transition, there's something in there about, not just a just transition for farmers economically, but in terms of their own wellbeing, and how that links to their livestock and their farming systems and quality of life.

JF: Are we seeing implications of dairy beef on farmer and animal welfare, while having a reduced footprint?

FJ: So dairy beef is definitely an interesting area. And I know there's quite a lot of my colleagues here at actually working on breeding metrics for dairy beef, which is really interesting. I don't know if there's any links to human welfare currently, unfortunately, I can't answer that, but I do know that in terms of animal welfare, just practicalities, it's definitely better that we're not culling these young calves that wouldn't otherwise have a place. So maybe not as expansive an answer as you were hoping for.

GA: Just to follow up on that front, the question is, now more and more sources of beef are coming from dairy origin beef. And I guess that's probably a good thing, but the caveats are, and I'm not passing judgment, but

there are now incentives to finish cattle earlier, and there's premiums and rewards so there is a shift to finish earlier, that's better from a carbon point of view. But I guess again, the cautionary note is, be careful slightly, and there'll be a tipping point somewhere.

And you need to be careful about how you're pushing the animal, managing things like acidosis. And so maybe that's what the question is getting at, there could be a limit, you know, it's a ruminant that's going to take so long to finish and of course, it's great to do the animal science around it and the performance and all that. But, just be careful about where the finish time is.

JF: Do you think as we have more discussions around nature and our disconnection from it, we might start to shift the way we see livestock as well?

GA: I think you're right. I always think this term I'm going to use sounds slightly dodgy, but it's not. EO Wilson, famous biologist and founder of sociobiology, he used the term biophilia. So biophilia in that we all have an inherent need and desire and enjoyment in nature and biodiversity, and I guess it makes sense from our evolutionary past. So we should not lose sight of that and the benefits of that, and the natural capital around that, but this isn't going to be a one size fits all, and that's where I'm going to pass back to Francesca in that the paper she presented from the research done by Bartlett, I think there's a really nice message in that different systems can still achieve good outcomes for welfare.

So I think that's key, that it's going to need to be a portfolio of what's best for this situation? Also the case study Francesca presented about the regenerative farm in Australia, that's fascinating. So I think we need to do the science to learn how you can use broad principles, but then for people to take that knowledge and apply it at a local level. What do you think, Francesca?

FJ: And that is what I was trying to convey with my case studies, with excellent work by Harriet and Claire. But yes, I do think that there is a lot of scope for the return to nature aspect of things. But we do also have to remember that we are trying to produce food, so it needs to be balanced.

JF: What role do you feel meat and livestock reduction plays in contributing to increased welfare?

FJ: I do think that eating less meat is just a practical and pragmatic way that's something that everyone is going to have to do, most likely, no matter what. I don't know if it does necessarily contribute that much to animal welfare, per se, because the animals are still being produced. So is it a question of coming back to economics? If we're producing less meat, are we able to produce it to a higher standard with a premium, or is it a case of it's not produced as much, and is it going to reduce those conditions? So it's not really something that we can answer. It's something that we can try and make sure does happen,with policy making and things like that.

GA: Definitely a tricky one, and no easy answer. I've heard the phrase 'less and better'. And again, I guess that's good in theory. It's whether that can be realised and be economically, sustainably realised, and I hope it can, but equally, the real world flip side answer as well, as your network will be much better informed than me, the demand for meat and meat products is going up on a global scale.

It's a good thing to be eating less in our diets, but globally the demand is going to increase and we'll see how that demand is filled. And certainly in some parts of the world, it's going to be really intensive. And I guess then, just to get political, then that's where we need to be careful about the trade standards and what we accept and what is acceptable for us, in society and sustainability.

FJ: Just to add to that, I think there is an added level of complexity there, because less but better is a really excellent initiative, but that could so easily mean different things to different people. What does better mean to you? Does that mean environmentally better, or animal welfare better? And that's something that needs to be thought about as well. This whole webinar today is about trying to bring animal welfare into the conversation. So better should mean animal welfare-positive as well. But does it necessarily in all cases? I don't know.

GA: And what happens if 'better' competes with biodiversity? Biodiversity is also important. That's why we're welcoming these communications, that's what we need to be doing, and trying to help each other understand so we're speaking the same language.

JF: Who should pay for the economic costs of maintaining good welfare and sustainability standards?

GA: It's a Utopian wishlist to be honest. We should all be paying for that, it should be part of the social licence of producing animals. There has to be a standard and there is, of course, and that's the role of legislation, etc. But you know, we as a society need to decide what's acceptable and then work from there. And I guess it tried to be optimistic in that it set a decent standard as a baseline, and then aim for premiums on top of that. And that's where there will be some in society who will definitely pay that premium, so that should help subsidise parts of the rest of the system.

But I've heard some stat, I forget the figures now, but historically, before and at the early stages of the Green Revolution, the percentage of our income that we spent on food was very high, right and now, we're currently in challenging times around cost of living and inflation, and have come out of that. We've been paying more recently, but as a percentage of many people's income, it's still less than it was. So again, there's probably a sweet spot to be paying for the value of food. But equally I don't want to be misinterpreted, I understand the pressures everyone is under. I think the onus is on society to come up with clever systems, where a standard of welfare is inherent in the system. If you look back historically, we have done that. It's just where, and then that's the role of policy and government and advisors.

JF: Is it better to use systems thinking and food system framing to allow for better identification of trade offs, drivers and leverages?

GA: The short answer is yes. I like the whole area of systems thinking, and I 100% agree that it would have a really useful role. And I think some people are starting to try to get into that. Any ways we can harness to be more holistic in our assessments, I think is a really good thing, and that is one exciting opportunity. I will pass to Francesca now. You've identified that often the papers are studying the pillars in isolation. So what do you want to say with that?

FJ: Yes, I would say that as a framework, it's holistic enough, because you can broaden it or narrow it down as much as you want. There's some colleagues in the partnership I'm working in, and they're working in France, and they're looking at broiler production, and they've included systems out to a global level, so you can absolutely, add in as many things as you want. But then it comes with the challenge which I'm working with now, which is what indicators do you put in and how do you balance these amongst each other? So I think that there probably is some compromise between the sustainability framework as you want to use it, and then looking at systems thinking as well, to identify your system boundaries and parameters that you want to assess with a sustainability framework.

But then it's really challenging as well, because we've so many different ways of assessing sustainability. That's just a sample of 26 that we got based on a survey. There's so many and quite often, any study that's done will edit a little bit. So it does become really challenging, but I do feel like they're both just tools that can be used in appropriate ways. I don't think that one is necessarily better than the other. I think it's just a matter of balancing them appropriately.

GA: I have seen one of the comments there about cattle feeding on leaves of trees that reduce methane. That's interesting. So the other week, I was involved in examining a PhD thesis. And it was looking at cattle feeding on willow trees and leaves. And there is interesting stuff in that space. And it was finding something. So I think there is a whole piece there around those silvo-pastoral systems and how that feeds in with ideas around regenerative farming as well.

JF: I've just been going through we did a webinar with the Climate Change Committee a few weeks ago, and we've been writing up a briefing based on the webinar, and one of the questions that got posed by an audience

member was around why there wasn't more silvo-pasture included in the calculations. And they basically just said that it was because they don't have the evidence. So there's a real gap there for that system.

JF: Do you see a role for food safety, quality and operational health and safety professionals in driving animal welfare improvements? Examples could be monitoring burn spots on chicken carcasses because of poor management.

GA: Absolutely. So yes, and I think elements of that are happening, but yeah, I'd encourage the more the better. So there's a whole good research area around abattoir-based welfare indicators, and it is all those things you just said, so they can literally all be measured at the plant, and then traced back. And I'm pretty sure, well, I know that there are certain sectors where there are companies doing that work and almost using that as an audit trail. And if there are certain red flags, then that can go back to the unit where the animals came from.

A few years ago now, we did a really interesting project where the cattle had a room and temperature bolus in them, and I used it as an opportunity. So the bolus was in them for other reasons, and we're measuring the animals during their performance and production, but they were then transported to the plant at the end. And so we were able to use that data, and I saw a study opportunity. So basically, we published a paper to show that there was a link between the level of the temperature rise as an indicator during transport of stress-induced hyperthermia. And the animals that had the highest peak went on to have the worst meat quality.

And there was, there was interest. There would be mileage to follow up on it, because we presented at a conference, and there's interest in it. And it always occurred to me that could be quite a simple, non invasive - well, relatively none if the animal has a bolus - that actually companies could use, because if you had spotted those animals, which you could do with the real time temperature data, you could then give them a longer period in the layer each, for example, to calm down so you could actually do something about it. And so, to come back to the question, anything that can be done at all stages, including definitely at that food safety end, we should be doing.

JF: So it's a big issue around the loss of smaller local abattoirs, to be transported further to much bigger units, basically. And which brings us back to the whole question around more localised food systems and the resilience that that builds in. Obviously, I'm not a farmer. I've never sent livestock off to slaughter, but I imagine it feels more stressful if you're sending them off knowing that they've got a long drive ahead of them.

GA: A very quick story on that. So in October, we had Temple Grandin over to visit the University, and she gave a talk. And the next day we went with her to visit some meat plants, and this was in Northern Ireland, and she arrived, and one of the things you could see was the farmers coming in, literally with tractor and trailer. And she was so impressed by this, because she was like, 'where have they travelled from?' And the guys were telling her that many of them would have travelled just two or three miles up the road or very near. There's some major benefits to having that resource, of course, then there are challenges with that too, to make sure standards are maintained, and training, and all the rest of it. But yeah, there was an interesting observation.

JF: Surely farm animals fulfilling the role of habitat engineers will automatically have better welfare than those concentrated in confinement? Why is it so important that this is not just left as a feeling? Why do we need that evidence?

FJ: I think it's really important to know these things, because it ties into the whole economic aspect thatGareth was talking about as well. If you don't know that it's better welfare, then how are you going to charge a premium. How are you going to bring in better farmer job satisfaction, profitability and things like that. So that's really important to know, just in terms of practicalities. And I do think that we've done the farming systems a great disservice by saying that actually, it's been so long since we've had cows and trees that we don't even know.

That's very weird, and it feels very strange to say it, but it's true. So I do feel that it's something that's really important in terms of not just economics, but also for policy making. If we know more about how this is positive welfare, then it can kind of tie into the UK being a very high welfare and high animal welfare

production country that has high welfare standards. And maybe we can bring in the more silvopasture and regenerative farming-style initiatives on the basis of policy.

GA: And just one slight push back, I agree with all you're saying, but one slight thing to keep in mind. And maybe bring us back to part of the definition of Marion Dawkins. The animal has what it wants, not what we think it wants. Because, in other words, we can have an anthropocentric viewpoint that we think we know what's best. So let's definitely keep in mind to keep doing the research, to ask the animal, what do you prefer? What do you want? What will you work for?

FJ: There's a lot of comments coming up in the chat about how much cows love leaves. So I think that is a very small, mini preference test in itself that doesn't indicate that they do value it well.

GA: And when I examined that PhD thesis, the student hadn't had a chance to look at the animal behaviour, because there could generally be a positive reward for being able to graze in that way for many animals as well.

JF: Could the introduction of cultured meat and other forms of artificial or plant-based meat substitutes represent a net gain for animal welfare?

GA: It's hard to see in the short term how it would represent a gain for animal welfare. It's been on the radar now for a while, and there's been a number of startups and companies, so it probably is in motion. But I wonder, and I feel really badly qualified to talk on this, because I wonder how there's so many elements to that. There's also the social science. There will certainly be a demographic of society that will want to jump at that and use that, and that's great, and probably we all should be. But actually, you would imagine there's still going to be quite a major demand that people will say, no, I want real meat from a real animal. So the shorter, also pragmatist answer to me, is, I don't really see that having much of an impact, certainly in the short term.

We come back to that point about the global demand for meat. And this is your whole space about thinking about alternatives for food production, many of the alternatives as well come with their own series of challenges and product. Where do you get your raw materials? How much is it costing you to produce? Where's the power and nutrients? It's very convoluted and there are a number of elements, so I think it's a way to go, yet, maybe in five years, it'd be good to think about that question again as well, because maybe that area will have matured to the point where it is much more mass market. Whereas I think at the moment, even the stuff that's there, given the nature of it, tends to be very premium, I think.

FJ: It ties in with the question we had earlier about reductions in meat production anyway. I think it really depends on what niche it's filling. So is it going to be filling that high welfare premium niche, or is it going to be filling the poorer welfare production standards area? And I think that is a really relevant question to ask, because if it's filling the premium high welfare then maybe it's not going to have a welfare gain. And I'm also thinking that it's probably not the situation where there would be a gain anyway, it would just be a reduction in the cost, potentially. I don't see it having an actual net positive, just from reducing negative experiences, if you see what I mean.

JF: A lot of the modeling around how alternative proteins, cultured meat, that kind of thing is likely to come further into our diets, is all based around replacing the more processed meat, so particularly in ready meals, that kind of thing, rather than a joint of beef on a Sunday. In which case people are going to be presumably looking for high quality. That's where it could have a role in terms of that less and better. So if you have good alternative protein sources, and I think it's great if we can have more of those, yeah, then it could fit into that as well.

JF: Small farmers can't afford a lot of tech. So is adding in the AI element just going to create more of a gap in producers and more inequality?

GA: That's something that we discussed in that workshop, because that is one of the dangers, but I think one of the potentials of AI as it's developing, is to almost simplify the whole process. In other words, rather than needing an accelerometer on a neck collar, on the bolus and in some of the machine learning, if you can, if you

have an automatic machine learning camera, for example, that's monitoring the animals and in real time, giving you information about behaviour and potentially effective state and potentially health, it might, in some ways, actually make life easier.

At the minute, there's lots of technology out there, and lots of different data streams. We're almost in the real challenging stage, so to translate that into useful information and knowledge for the farmers where it needs to get to. The example I give is the heat detection stuff. Heat detection in dairy cows and accelerometers took off because it was answering a real world challenge for stockpeople and farmers. So I think some of the other technologies will come along and do the same.

All of us know that it's becoming slightly integrated, but you're right that we need to be careful again, on the farmer side of it, and try to bring them with us. And to be honest, that's where networks like your own and ours too, and everyone else, we have a role to try to keep getting those messages out there and dispel some of the myths around some of the technology.

JF: Farmers don't often see the economic benefit of their products being sold with higher welfare labels on them. So if that's the case, what would motivate farmers at scale to increase their welfare?

FJ: Producers do function at such a narrow profit margin that it can be really, really challenging to make those changes. And quite a lot of the changes that have been positive and welfare that we do see, ones that have made the new floor, in the sense that they just say, this is what you have to do now, which is absolutely, really, really challenging for producers.

I'm not really sure what you would do to implement more rewards at that stage. I mean, this is definitely something that is maybe more the area of someone who works for a supermarket, like some sort of supply chain deal. I do absolutely agree that producers have a really tough time of it, and we do appreciate that. So it's not easy for anyone who's trying to kind of improve animal welfare and do all these other things at the same time.

GA: I agree. And just to sum up, it comes back to the earlier question about who should pay and it is really, all of us, really, but there will be certain key players. Like that is where the role of the policy makers is important and the retailers. Does it mean the flip side of it is, if the retailer comes across in its supply chain an animal welfare issue, it can literally stop that overnight, which you've seen.

So that's the challenge to try to get and some of them do. Then some of them their whole selling point is around their higher welfare. It's trying to bring together the multiple stakeholders to have and then feed into the one welfare, a life worth living for the farmer, producing the animals. But those discussions were a lot less, at least now the discussions are starting to happen and hopefully that's a positive thing. And many people are trying to better understand where their food's coming from, and make some of those choices, so hopefully that will bring more more and more opportunity for their producers.

About the AFN Network+

The AFN Network+ (UKRI Agri-food for Net Zero Network+) is a unique network of 2,000+ academics, researchers, third sector organisations, policy makers, and agri-food industry professionals from farmers to retailers.

Together, we are working to identify key research gaps that may be holding the UK food system back from transitioning towards a net zero UK by 2050, while also enhancing biodiversity and healthy ecosystems, nurturing livelihoods, supporting healthy consumer habits, and minimising the environmental impacts of overseas trade. Our findings will inform the next decade of research investments in this area by UKRI (our funder and the UK research councils umbrella organisation).

Alongside our core research, we run in-person and online events, produce topical resources, and give out hundreds of thousands of pounds of funding a year.

The AFN Network+ is coordinated by the University of East Anglia, University of the West of England, University of York, and University of Leeds, and is a £5m, 3-year project funded by four research councils; the Biotechnology and Biological Sciences Research Council, Economic and Social Research Council, Engineering and Physical Sciences Research Council, and the Natural Environment Research Council.

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