Public Dialogue on Gene Editing in Farmed Animals (GEFA)

All Topic Guides (W1, W2, W3 & W4)

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Workshop 1: Topic guide

Timings	Content
10.00 – 10.15 am	**Session 1: Welcome and introduction to the dialogue** *Purpose: to introduce the format and purpose for the public dialogue; highlight the range of people we have involved and the scale of the process, and show the films from the pre-task* *Lead moderator to introduce themselves and the dialogue:* ''Hi everyone and welcome. It's really exciting to see so many of you here this morning. My name is Darren, and I'll be helping to run this public dialogue on genome editing in farmed animals. We've been asked to carry out this dialogue on the behalf of the Biotechnology and Biological Sciences Research Council (BBSRC), the Nuffield Council on Bioethics (NCOB), and Sciencewise. BBSRC is part of UK Research & Innovation, a public body who fund research and innovation. BBSRC supports research on plants, microbes, animals and tools and technology for biological research. The Nuffield Council on Bioethics are an independent body that informs policy and public debate about the ethical questions raised by biological and medical research. They are interested in hearing your views on the potential application of genome editing to farmed animals, which in turn will help contribute to discussions on how to develop and govern this area, across government and the science community. We don't expect you to have any knowledge about genome editing or farming. What we do expect is for you to take part in the discussions by giving your perspective and by listening and responding to the perspectives of other people. We don't expect you to have any knowledge about genome editing or farming. What we do expect is for you to take part in the discussions by giving your perspective and by listening and responding to the perspectives of other people. The key ground rule in this process is to be respectful of other people's views. We have brought together a very diverse group of people and it is likely that people will have different views. We want to hear and understand this diversity. There are 80 of you here today. Obviously, that's far too many to have a conversation as one large group, so shortly we will break into smaller discussion groups of 5-6 people. Each group will be led by a moderator.

Our job is to help us to have a good conversation and move us through various topics. As we move through the conversation you might feel you haven't had the opportunity to say as much as you have wanted. I would encourage you to use the chat function if you want to, and also the EngagementHQ community has an open forum for you to raise additional thoughts after the discussion.

We will be recording the session today, both in plenary and in the breakout groups. We will ask you to reconfirm your consent in the small group sessions.

We also have members from the Nuffield Council on Bioethics and UKRI joining us today. They will introduce themselves if they are in your group. They will be here to listen and observe, rather than participate in the conversation.

I hope that's all clear. We can pick up any questions, as well as introduce one another, in the small group sessions if that's OK.

Before we start our discussions, we thought it would be good for you to get a short introduction to some of the other participants taking part in the dialogue. You come from all walks of life, and reflect a wide cross section of society, including those from farming communities.

I'm going to play you a short film we've made using footage from your pre-task videos. I want to thank everyone for contributing to this. On the EngagementHQ platform, we've posted a longer 'Directors Cut' of the video showing a slightly wider range of voices. I'd encourage you to take a look after the session.

I'm now going to share my screen and play the film. Afterwards we will break into small groups and begin our conversation.

Show Stim #1 [2-3 mins]

[Share screen, check visible/audio]

OK – in a few moments you're going to be moved to a breakout room. Please click the button when it appears on your screen and you'll be transported there.

Finally, we know WIFI can suddenly drop, and you can lose your connection. If this happens, don't panic. Just re-click on the link to gain access to the main room. Our colleague Becca will then help you get back into your group discussion.

Hope that's ok and see you in a couple of hours.

Session 2: Food and you

ENSURE YOU TURN RECORDING ON PLEASE

10.15 – 10.45 pm	*Purpose: to provide participants with a sense of how people relate to food and farming, leading into discussion around the relationship between people and farmed animals*

Welcome everyone to the group. We will do a round of introductions, in a moment, but as mentioned, we're planning to record this session.

Just to confirm that everyone is still happy with this? *[Moderator to gain verbal consent. All participants have previously provided written consent.]*

If we can briefly go around the virtual table and introduce ourselves that would be great. Feel free to add any preferred pronoun to your Zoom name.

Perhaps if you can say your name and tell everyone, if you could be any animal, what animal would you be and why.

I'll start… XXX do you want to go next?

- So, I'd like to get your reflections on what you saw from the video in the main session, specifically what resonated with you? What was different to your own views and experiences? *Probe and draw out:*
  - People's relationship to food
  - People's relationship to farming
  - Views on farmed animals

- We saw in the videos that meat features as a part of many people's diets. How do people feel about eating meat, fish or dairy? *Probe*:
  - Experience of eating meat, fish or dairy?
  - Any difference in feelings or experience toward consuming meat or fish
  - Cultural significance of eating meat/fish/dairy
  - Changes to patterns of meat consumption, including choices not to consume meat/fish/dairy or to reduce consumption (both recent and historical)
  - Price of food; cost as an influencing factor on choice
  - Impact on health
  - Sustainability
  - Does anyone prioritise criteria like wild, organic or free-range in any of the food they purchase? If so when, what types of produce and why?

- Thinking in more depth about farmed animals, what do people understand about:
  - where their food comes from
    - [probe international]
  - how animals are kept
  - how animals are bred |

	• To what extent are these issues important or not to you? Why? • What sorts of questions might you have around the current way in which we produce meat/fish/dairy?
10.45 – 11.30pm	**Session 3: The meat, fish, and dairy we eat** *Purpose: to explore the meat and fish that's currently consumed in the UK, where it comes from, how animals are reared, the role of breeding technologies in this context, and pressures on the food system from farming animals* I now want to show you a short film showing the meat and fish we eat in the UK, where it comes from, how it gets produced, and how the animals are kept (focusing on the most common ways). We will also touch on how animals are bred in this context. ***Moderator to show Stimulus Set #2. [4-5 mins]*** • What are your thoughts on what you just heard? Did anything in particular stand out to you? Anything surprising or concerning? I now want to dig a little deeper into this. • Tell me more about how you feel about the amount and type of meat and fish we eat? • How does this relate to the points we raised earlier in our discussion? [NB probe on points from food and you session, including health and sustainability] • Was anything missing from what you saw that you might like to learn more about? [Probe dairy] • Thinking about the wider impact of rearing meat and fish, what might you like to see in terms of the amount and type of meat we eat? • Tell me more about how you feel about, how farmed animals are kept? [Probe fish if not mentioned] • How does this relate to the points we raised earlier in our discussion? [NB probe on points from food and you session] • Was anything missing from what you saw that you might like to learn more about? • Thinking about the wider impact of rearing meat and fish, what might you like to see in terms of how farmed animals are kept? • Finally, tell me more about how you feel about farmed animal breeding?

	- How does this relate to the points we raised earlier in our discussion? [NB probe on points from food and you session] - Was anything missing from what you saw that you might like to learn more about? - Thinking about the wider impact of rearing meat and fish, what might you like to see in terms of how farmed animals are bred?
11.30-11.35am	We're going to have a 5 min comfort break. Feel free to stretch your legs and grab a cup of tea. But please be back by 11.35 at the latest. Thanks
11.35 - 12.20pm	**Session 4: Introducing GEFA** *Purpose: to capture awareness and top-of-mind understanding of gene editing, to introduce the topic, get initial responses to any hopes or concerns around its potential use in framed animals, and identify emerging questions for participants.* - Can I just do a quick poll, how many of you have heard of gene editing before being invited to participate in this research? - Regardless of whether you have heard about gene editing before or not, I'd like everyone to use the chat function to write a quick description of what they think gene editing involves. Don't worry about it being technically right – we're just interested in what you think it involves. *Moderator to pick someone who said they had heard about gene editing before.* [NAME] do you recall where you heard about gene editing? Probe on sources of information. ***Moderator to show Stimulus Set #3 on an introduction to Genome editing*** - What are your initial thoughts about what you just heard in that brief introduction to gene editing? - Does it make sense to you? How would you explain it to a friend? - What questions do you have? Is there anything you'd like to understand more about? - We're going to play a quick game now where I'm going to show you some pictures. I want you to pick one that you most closely associate with genome editing in farmed animals. *Moderator to show stimulus set #4* ○ Tell me about why you picked the picture ○ What does it mean to you? - What are your initial hopes or concerns about the technology or how it might be applied to farmed animals?

	We spoke to a few people who are specialists in this area and got their perspective on hopes and concerns for this area. We'd like to show you this final video and then get your thoughts. *Moderator to show Stimulus Set #5 Hope and concerns for GEFA [3 mins]* • What are your initial thoughts about what you just heard in the film? • What resonates with you? • Was there anything you disagreed with? • What questions do you have? Is there anything you'd like to understand more about? We're going to learn more about genome editing and different potential futures of food and farming in the coming workshops. • Based on what you've heard, what types of people would you like to hear from? • Are there any specific issues you'd like us to cover in more depth? We'll now go back to the main room and discuss next steps.
12.20-12.30	**Plenary and next steps** Thank you all for your time this morning. It was wonderful to meet you all and hope you had a great session. We're not going to have time to hear back from everyone, but to give people a feel for what went on in other groups, I'm going to pick a on a few moderators to give feedback on specific parts of the discussion • [NAME] – can you tell me what was said in the food and you session in your group. • [NAME] – can you tell me what was said in the meat we eat session in your group. • [NAME] – can you tell me what was said in the intro to GEFA session in your group. Ok fabulous thanks. The next workshop will be on 11th June, where we will transport into the future of food and farming. Before then we will be setting you a short task in the next few days, where we will ask you to get some of your friends and family to participate in the discussion. Detail will be posted on the EngagementHQ platform.

Please also continue to add your thoughts on what you've heard and what you'd like to explore in more depth in the platform too.

Thanks again and have a fab rest of your weekend.

Workshop 2: Topic guide

Timings	Content
10.00 – 10.30 am	**Session 1: Welcome, recap W1 and more detail on dialogue purpose and GEFA [Plenary]** *Purpose: reintroduce the format and purpose for the public dialogue; highlight what we heard from W1, note key questions, recap the pre-task* Hi everyone and welcome back. As I'm sure you'll recall, my name is Darren, and I'm helping to run this public dialogue on genome editing in farmed animals, on behalf of BBSRC, the Nuffield Council on Bioethics and Sciencewise. This is the second of four workshops, and today we're going to be looking at some of the challenges facing our food and farming system in the coming years, how we might respond to this, and begin to consider whether and how GEFA could play a role in this context. Before we get round to discussing this in our small groups, I want to recap what we heard in workshop 1 and answer some of your questions. Firstly, thank you all for your participation in the first workshop. It was a really interesting discussion. The top 5 things we heard were as follows: 1. We are distant from the food and meat we eat. This was described by some as a 'willful ignorance' – i.e., people didn't really want to know or have to deal with the knowledge. Even for those in rural areas, there was a recognition that smaller, family run farms are not where most of our meat comes from. 2. Our relationship to animals/meat is ambivalent and in tension. At the heart of this was how should we align our respect for animals and their welfare, with their place on our plates. Resolving this 'meat paradox' is at the heart of this dialogue. 3. Quality, nutrition, higher welfare farming, and happy animals were all linked in people's minds. There was a view that the current food system probably hadn't got this balance right: and there was too much meat consumption and waste, underpinned by intensive farming, poorer quality food and lower animal welfare. While cost was a big factor for people, a 'less, better' approach to eating meat was highlighted in many groups as a route forwards. 4. There was reasonable awareness of the terms 'genome editing' and in particular 'gene editing'. And your definitions were also pretty good:

essentially defined GEFA as editing the genes of a farmed animal to bring about a desired characteristic.

5. While views did vary across groups, and include those who were completely opposed, overall people were open minded about the potential use of GEFA. However, this came with a host of questions including:

- what is the purpose?
- where will it lead?
- are we at the point where we really need it?
- is it safe?
- what are the costs?
- how can you contain its use?
- what will happen to conventional farming?
- what if it goes wrong?
- how will it be done in a transparent way?
- what is happening internationally?

We will cover some of these questions through discussion today and in the coming weeks. And it's important to say that for some of these questions – for instance what's the end game, do we need it, where will it lead – it is your views through this dialogue that will help contribute to the answer.

But there were two questions we'd like to focus on now.

- The first was to give a bit more detail on the purposes of the dialogue and how it will inform decision making.

- The second was to provide a bit more detail on GEFA, to help clarify what the technique does, and to hear from a scientist who is a specialist in this field. We will also be hearing the perspectives from other specialists throughout this morning.

Before we do this, I also want to say that many of these concerns were reflected in the pre-task, where you spoke to friends and family on the issue. We've had a great response to this, with over 120 replies. We don't have time this morning to cover this, but will post findings onto the EngagementHQ platform next week.

OK, so turning to our two questions…

I'd now like to invite Pete Mills from the Nuffield Council on Bioethics, who is one of the funders of the dialogue, to discuss a bit more about its purpose and how it will inform decision making. Please write any follow up questions into the chat – if we don't have time to answer today, we will get back to you on EngagementHQ

[Pete to speak, no more than 2 mins]

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Thank you.

[take 1/2 quick Qs, depending on time]

I now want to invite Huw Jones provide a bit more detail on genome editing Huw has specialist technical knowledge on GEFA.

Again, please write any follow up questions into the chat – if we don't have time to answer today, we will get back to you on EngagementHQ

To cover (3-4 mins):

- Relatively more precise than previous techniques, using enzymes to target and break DNA.
- Can be to edit gene function
- But also can be used to introduce a customised DNA sequence
- This could also include foreign DNA
- Genomes are complex and certain traits not just coded by a single gene, may be off-target effects.

[take 1/2 quick Qs, depending on time]

Thank you so much.

In a moment, we will break into smaller discussion groups on 5-6 people. Each group will be led by a moderator.

Our job is to help us to have a good conversation and move us through various topics. As we move through the conversation you might feel you haven't had the opportunity to say as much as you have wanted. I would encourage you to use the chat function if you want to, and also the EngagementHQ community has an open forum for you to raise additional thoughts after the discussion.

We will be recording the session today, both in plenary and in the breakout groups. We will ask you to reconfirm your consent in the small group sessions.

Last, but by no means least, in addition to Huw, we are really delighted to have five other specialists here today. They will move in and out of the groups, and offer perspectives to help enrich our discussions. We have recruited them in response to perspectives you said you'd like to hear from.

They are:
- Penny Hawkins, from the RSPCA. Penny would you like to say hello please.
- Craig Lewis, a scientist working in the private sector and who chairs the European Forum of Farm Animal Breeders. Craig, can you say hello please.
- Chris Brown from the supermarket ASDA. Chris, can you say hello

please.

- Pat Thomas, who runs the campaign group Beyond GM. Pat, can you say hello please.
- David Rose, who is an academic working on sustainable agriculture. David, can you say hello please.

We also have members from [BBSRC, Nuffield Council on Bioethics, Sciencewise and the evaluators joining us today. They will introduce themselves if they are in your group. They will be here to listen and observe, rather than participate in the conversation.

I hope that's all clear. We can pick up any questions, as well as introduce one another, in the small group sessions if that's OK.

Finally, we know WIFI can suddenly drop, and you can lose your connection. If this happens, don't panic. Just re-click on the link to gain access to the main room. Our colleague Sofie will then help you get back into your group discussion.

We will now move to the rooms. Please click on the button when it appears on your screen and see you in a couple of hours.

10.30 – 11.30 pm	**Session 2: Challenges facing the food system and farmed animals** *ENSURE YOU TURN RECORDING ON PLEASE* *Purpose: to provide participants with an understanding of some of the challenges facing our food system, and consider specific implications for farmed animals and eating meat.* Welcome everyone to the group. We will do a round of introductions, in a moment, but as mentioned, we're planning to record this session. Just to confirm that everyone is still happy with this? *[Moderator to gain verbal consent. All participants have previously provided written consent.]* As mentioned, we will have specialists joining us at various points today. We don't want to make this a Q&A, as its your perspectives on these issues that we're interested in. From time to time, we will invite specialists to contribute their thoughts and help us consider different aspects of the debate. We would encourage you to challenge specialists, test their arguments and the values underpinning them. Like last time, we are not expecting everyone to agree (including with the specialists) and we have selected a wide range of people to take part. So please be respectful of one another's views, and let's have a great discussion. If we can briefly go around the virtual table and reintroduce ourselves that

would be really helpful.

If you can then say your name again, where you're from, and one thing from the first workshop that has stuck in your mind.

If you have a preferred pronoun, please do change it on your screen name.

I'll start… XXX do you want to go next? [Nominate each person]

Thank you all very much

We're going to think about some of the challenges facing the farming system and what this means for the meat and fish we eat.

Over the next hour, we're going to talk in turn about four challenges that face the farming system:
- its impact on the environment
- issues related large business and the control of agriculture
- the impact of diet on our health
- animal welfare and sentience

I'm going to play you a video highlighting some of these challenges, and then we will take each one in turn and discuss them.

Once we've talked about each in turn, we'll come back to get your reflections on all of these challenges.

If, as you're watching the video, you have questions, please do note them down in the chat function.

Moderator to show Stimulus Set #1. [5 mins video]

- What are your thoughts on what you just heard? Did anything in particular stand out to you? Anything surprising or concerning?

I now want to dig a little deeper into some of the things we've heard. So, to start…

[Moderator to take 10 mins per theme]

   1. ***Environmental impacts and growing populations***

I'm just going to show a slide that highlights the key point for the video.

Moderator to show Stimulus Set #2, slide 1.

"Environmental pressures such as climate change, water scarcity and pollution are reducing yields, causing biodiversity loss, and contributing to rising food

prices and food insecurity.

Our current food systems produce around 17% of global greenhouse gas (GHG) emissions – the main driver of climate change.

Of this, the use of cows, pigs and other animals for food, as well as livestock feed, is responsible for 57% of all food production emissions, with 29% coming from the cultivation of plant-based foods

Cattle farming is especially carbon intensive, responsible for over 60% of the livestock sector's emissions and driving rapid deforestation in the Amazon and elsewhere. Pollution from intensive livestock and poultry farming is also putting enormous pressure on rivers.

By 2050, the global population it is expected to reach almost 10 billion - which means there will be approximately 3.5 billion more people to feed than there are now. World hunger is now on the rise, with almost 10% of the global population struggling to get enough food to eat. As population grows, productive land also tends to be built over."

- To what extent are people aware of this as an issue
- To what extent do you consider the environmental impact of the food and meat we eat
- Who should be responsible for dealing with this?
- Should the environmental costs of eating meat be reflected in the price or should it be something that society as a whole should bear?

2. Big agriculture and the price of food

Moderator to show Stimulus Set #2, slide 2.

"A large proportion of the world's food comes from industrial agriculture.

For example, only 1% of all farms in the world control 65% of the world's agricultural land.

Additionally, three companies control approximately two thirds of the global seed and pesticide markets.

Industrial agriculture can result in unsustainable practices and can act as a barrier to effective regulation

Half of the world's habitable land is used for agriculture. More than three-quarters of this is used for livestock production, despite meat and dairy making up a much smaller share of the world's protein and calorie supply.

One of the biggest causes of forest loss is the expansion of agricultural land for animal feed production, such as soya.

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In the UK, around 60% of arable land is used to produce animal feed instead of food for human consumption.

There are significant economic pressures for different players across the food system. Supermarkets operate on very tight profit margins. Increasing competition between UK supermarkets on price is squeezing farmers domestically and abroad.

Food poverty and food bank use in the UK are spiraling upwards, limiting choices and worsening food outcomes. The use of foodbanks has increased from around 1 in 10 people in March 2021 to nearly 1 in 6 in March 2022

- To what extent are people aware of this as an issue?
- To what extent do you consider where your food comes from and how it is produced?
- Should we leave food production to be shaped by market forces? If not, what should we focus on incentivizing or discouraging?
  - Probe in relation to discussion on price/food poverty

3. Diet, food waste and health

Moderator to show Stimulus Set #2, slide 3.

"Increased consumption of over-processed food (which usually contain ingredients that you wouldn't add when cooking homemade food) and poor diets has severe health impacts globally. Worldwide obesity has nearly tripled since 1975.

In the UK, ultra processed foods are considered to make up over 50% of household diets, despite being very low in nutritional value. This poses a range of health risks for individuals and places increasing strain on the NHS.

Food waste is a longstanding problem. Approximately 931 million tonnes of food waste were generated in 2019. This is the equivalent of 23 million fully loaded 40-tonne trucks, which if laid bumper-to-bumper would circle the earth 7 times.

Some 61 per cent of food waste comes from households, 26 per cent from food service and 13 per cent from retail. If food waste were a country, it would be the third largest greenhouse gas emitter after China and the US.

- To what extent are people aware of this as an issue
- To what extent do you consider the health impacts of food? And food waste?
- Who should be responsible for dealing with this?
- Should we look at alternatives to meat in processed foods?

4. Animal sentience

	Moderator to show Stimulus Set #2, slide 4. *"Attitudes to animals are also changing. Animal sentience - that is animals with the capacity to consciously experience positive and negative states like pleasure and pain – is being increasing recognised in scientific research and in law.* *A recent poll by the FSA showed that 60% of people stated that " the treatment of animals in the food chain" was a major concern, on a par with over processing of food.* *Meat consumption has dropped by 17% in the UK over the past decade. The Government's National Food Strategy recommends that meat consumption is reduced by a further 30% by 2030 to tackle its environmental and health impacts.* *We're also seeing new narratives about animals as ecosystem managers, whether that is sheep in upland areas or re-wilded beavers."* • What does animal sentience mean to you? How do you think it varies across farmed animals? • To what extent do you consider animal sentience when thinking about the meat or fish we eat? • To what extent is animal welfare a concern? • Who should be responsible for dealing with this? *Thinking across all the challenges facing the food system, what are your reflections?* OK, we're going to have a well-deserved comfort break now. Please be back in no later than 10 mins.
11.30-11.40	**Break**
11.40 – 12.40pm	**Session 3: Ways to potentially address these challenges, and the type of farming we'd like to see in the future** No single intervention can address all the challenges currently facing food and farming systems. We want to explore potential applications for genomic editing in depth in the next workshop. Before that, and to help contextualize our discussions, this session explores different 'visions' for future food production. Technologies can play different roles in these futures, and as part of this we will explore some alternatives to genome editing that could also have potential. These alternatives are not either/or it's possible envisage a world in which all of these could be realised in different ways.

Stimulus Set #3

1. Greater intensification of animal husbandry

This involves the very large-scale rearing of animals. Its focus is to maximize the amount of meat we can produce, with the minimal amounts of resources, and to do this in a way that keeps animals physically healthy and provides an affordable supply of meat.

It is technologically intensive.

For instance, technologies can be used to carefully control the animal's feed and environment. Technologies can also be used to ensure that animals are physically healthy, by monitoring their temperature, heart rate, level of activity, whether they have a cough and so on.

Genome editing could also be used to adapt animal genes for increased meat production, or produce more docile animals.

Example:
In 2020, Muyuan Foods Co Ltd built a multistorey pig breeding facility in Nanyang. It has 21 buildings which house 84,000 sows and their litters. Technologies are used to monitor animals, their feed and welfare. The sites are biosecure. With sophisticated cleaning and disposal system to prevent the outbreak of disease.

Driven by demand for low priced meat, the number of large-scale, intensive farms is increasing in the UK – while not on the scale of China, they house upwards of 40,000 chicken or 2,000 pigs. There are now over 2,000 such farms across the country. And it's important to note that we import a lot of meat – over £6bn worth in 2020.

- What are your immediate thoughts on this approach?
- What are the benefits?
- And the drawbacks?
- To what extent does it address some of the challenges we spoke about earlier?
- Genome editing could be used to support this type of system. We will explore applications in more depth later, but what are your initial thoughts on this?

Stimulus Set #4

2. Waste reduction and agro-ecology

This involves small scale food production systems, with lower stocking densities of animals. Its focus is to support the biodiversity of the land we farm, improving soil and plant quality, encouraging birds, spiders and so on for pest control, and keeping farmed animals healthy.

Technologies can play a role in these systems. For example, robotics for weeding and picking could help us manage much more complex and diverse farms. Or virtual fencing can be used to stop animals damaging trees.

Agro-ecology systems aim to use less soya, and more grass and insects for animal feed. To support this, gene editing could be used to produce crop and insect-based food. Genome editing could also be used to help animals be more tolerant to heat or cold.

An example of an agro-ecological system is a silvopastoral system. There are typically farms in which trees are planted at wide spacings into grazed pastures. The systems have also been shown to increase numbers of species of ground insects and numbers of species of birds compared to conventionally grazed pastures. Lower stocking densities would mean less meat production overall, which in turn would potentially increase the cost of meat for consumers.

- What are your immediate thoughts on this approach?
- What are the benefits?
- And the drawbacks?
- To what extent does it address some of the challenges we spoke about earlier?
- Genome editing could be used to support this type of system. We will explore applications in more depth later, but what are your initial thoughts on this?

Stimulus Set #5

3. ***Novel foods and meat alternatives***

This involves replacing protein from meat with alternatives sources.

For example, this could include lab grown meat, eating protein from insects, using algae, bacteria or using plant-based proteins such as soy or pea.

Plant-based meat and edible insects can replace traditional meat as a good protein source from the perspective of nutritional value. Cultural resistance is declining as costs continue to fall relative to traditionally reared meat, and flavours and textures improve.

Lab grown meat is the only method to produce actual animal muscle-based meat; with the final product more 'meat-like'. However, technical difficulties, especially in mass production and cost, remain to be overcome before it can be commercialized.

Genome editing could be used across a range of these examples, from the production of lab grown meat to findings ways of making plant or insect-based proteins more palatable.

For lab grown meat, genome editing of animal cells is being looked at to make the process of production cheaper and quicker. For instance, there are patents out from a US company (Memphis Meats) to create genome edited chicken and beef.

- What are your immediate thoughts on this approach?
- What are the benefits?
- And the drawbacks?
- To what extent does it address some of the challenges we spoke about earlier?
- As mentioned, genome editing could be used to support this type of system. We will explore applications in more depth later, but what are your initial thoughts on the potential use of genome editing to produce animal cells versus its use to rear a living animal?

Stimulus Set #6

4. ***Discouraging meat consumption, by reflecting its full costs or paying for less intensive meat production***

Eating less, better quality meat was noted by several groups in the dialogue as a potential way of addressing issues in the food system.

While meat consumption has dropped by 17% in the UK over the past decade, the National Food Strategy (an independent report to government) recommends that meat consumption is reduced by a further 30% by 2030. This level of reduction is unlikely to happen on its own. One way to do this is by reflecting the 'costs' of production in the price we pay – in terms of greenhouse gas emissions, environmental impacts from feed animals or animal welfare.

For example, a recent paper looked at the greenhouse gas emissions from different animal farming systems. Though contested, they suggested carbon and meat/dairy taxes in the region of 40% beef, 15% on lamb, 8.5% on chicken, 7% on pork and 5% on eggs.

Rather than taxes, higher welfare standards and lower stocking densities could also increase the price to consumer.

- What are your immediate thoughts on this approach?
- What are the benefits?
- And the drawbacks? [Probe other ways to address meat consumption]
- To what extent does it address some of the challenges we spoke about earlier?
- What are your initial thoughts on the potential use of genome editing to reduce the environmental impact of farmed animals, such as reducing their carbon footprint?

	The session is about to end now, and we will be taken back the main room. I want to thank you all for your time this morning, particularly given it's a challenging subject matter. It's been great speaking to you all.
12.40 - 12.55pm	**Session 4: Reflections and next steps** I now want to invite our 6 experts to each give a couple of minutes of reflections on what they've heard and things you may wish to consider in advance of the next workshop, which will focus on potential applications of GEFA. - Penny Hawkins - Craig Lewis - Chris Brown - Pat Thomas - David Rose - Huw Jones Thank you. The next workshop will be on 25th June, where we explore some potential application areas for genome editing in farmed animals in a little more detail. Before then we will be setting you a short task in the next few days, where we will ask you to think about the type of food and farming system you would like to see in the future. Details will be posted on the EngagementHQ platform. Please also continue to add your thoughts on what you've heard and what you'd like to explore in more depth in the platform too. Thanks again and have a great rest of your weekend.

Workshop 3: Topic guide

Timings	Content
10.00 – 10.30 am	**Introduction (plenary): Welcome, introducing and setting up the day** *Purpose: outline agenda for the day; introduce specialists, highlight how we are using statistics and evidence for the stimulus, and set up the break out sessions,* Hi everyone and welcome back. My name is Darren, and I'm helping to run this public dialogue on genome editing in farmed animals, on behalf of BBSRC, the Nuffield Council on Bioethics and Sciencewise. This is the third of four workshops, and today we're going to be looking at five application areas where GEFA could potentially play a role. These are: o Animal health and welfare o Environment and conservation o Farming and productivity gains o Human health o Different consumer needs is relation to eating meat, fish and dairy products To help us in our discussions, we will be joined today by 9 specialists, and some of them were also involved in W2. They are: 1. Chris Proudfoot: an academic scientist working on GEFA at the Roslin Institute 2. Liz O'Neill: from the campaign group GM freeze 3. Craig Lewis: a scientist working in the private sector on animal breeding and genome editing 4. Pat Thomas: from the campaign group Beyond GM 5. Julian Baggini: a philosopher working on food and meat consumption 6. Jonathan Birch: a philosopher working on animal sentience 7. Jef Grainger: a senior official, working for BBSRC who fund research in this area 8. Rob Fraser: an emeritus professor, working on agricultural economics. 9. Huw Jones: an academic scientist working on GEFA at the University of Edinburgh We also have observers from BBSRC, Nuffield Council on Bioethics, Sciencewise and the evaluators joining us today. They will introduce themselves if they are in your group. They will be here to listen and observe, rather than participate in the conversation. Before we get round to discussing these application areas, I want to touch on the facts and figures we are presenting to you.

Data sources may differ depending on what scale (such as the time period or countries) they are referring to, and what specifically they are measuring. This gets very complicated when measuring things like greenhouse gas emissions from cows, for example. When comparing data, it important to pay attention to what it says it is describing.

Quite a lot of the information we will present today is adapted from the Nuffield Council's report on genome editing. We have also used a few other sources to help provide context.

For transparency, we will post the sources of our data and information the Engagement HQ platform.

Finally, before we start, I want to say a few words for context.

It's a choice whether to consume farmed animal products. Even with reductions in the consumption of animal products, animals will continue to be farmed. As we discussed last time, there are different ways to farm animals, that are specific to cultural/environmental contexts – for example, from intensive to extensive farmed systems. Each style has benefits and disadvantages, and it's too simple to say that extensive systems are always better for animal welfare.

In low- and middle-income countries in particular, farmed animals are an essential source of income, food and nutritional security. In the UK, farming animals is important economically and culturally to rural communities and provides food and nutrition to the population.

Genome editing, as well as lots of other approaches, have the potential to improve the way animals are farmed in terms of animal health and welfare, wider sustainability, nutritional quality, climate and disease resilience.

We touched on some of these wider options at the last workshop, so today we will focus more on potential applications of genome editing.

Before we break into small groups to discuss this, a few housekeeping reminders.

Our job is to help us to have a good conversation and move us through various topics. As we move through the conversation you might feel you haven't had the opportunity to say as much as you have wanted. I would encourage you to use the chat function if you want to, and also the EngagementHQ community has an open forum for you to raise additional thoughts after the discussion.

We will be recording the session today, both in plenary and in the breakout groups. We will ask you to reconfirm your consent in the small group sessions.

Today is the longest of all the workshop and we will be running until 3pm. Given this, we will have an hour break for lunch. Please do be punctual when

	returning for the afternoon session. I hope that's all clear. Finally, we know WIFI can suddenly drop, and you can lose your connection. If this happens, don't panic. Just re-click on the link to gain access to the main room. Our colleague Sofie will then help you get back into your group discussion. We will now move to the rooms. Please click on the button when it appears on your screen and see you in a couple of hours.
10.30 – 11.15 pm	**Session 1: Animal health and welfare** *ENSURE YOU TURN RECORDING ON PLEASE* *Purpose: to discuss the potential application of genome editing to support animal health and welfare* Welcome everyone to the group. We will do a round of introductions, in a moment, but as mentioned, we're planning to record this session. Just to confirm that everyone is still happy with this? *[Moderator to gain verbal consent. All participants have previously provided written consent.]* As mentioned, we will have specialists joining us at various points today. We don't want to make this a Q&A, as its your perspectives on these issues that we're interested in, though we're happy to try and answer any technical questions today. From time to time, we will invite specialists to contribute their thoughts and help us consider different aspects of the debate. We would encourage you to challenge specialists, test their arguments and the values underpinning them. Like last time, we are not expecting everyone to agree (including with the specialists) and we have selected a wide range of people to take part. So please be respectful of one another's views, and let's have a great discussion. If we can briefly go around the virtual table and reintroduce ourselves that would be really helpful. If you can then say your name again, where you're from, and one thing from the last workshop or pre-task that has stuck in your mind. If you have a preferred pronoun, please do change it on your screen name. I'll start… XXX do you want to go next? [Nominate each person, include specialist]

Thank you all very much.

Given what you just said, and building on previous discussions, what are the important features that we should try and build into future food and farming systems?

- Probe: health, affordability, sustainability, animal welfare

So as mentioned, we are going to explore five different potential application areas of genome editing. We will review three areas before lunch, and then two more in the afternoon.

Remember, no single intervention can address all the challenges currently facing food and farming systems. We want to explore whether genome editing may have a role alongside other approaches.

The first of these will explore the potential application of genome editing to support animal health and welfare.

I'm going to play you a video highlighting this and also show you some thoughts of specialists in the field.

If, as you're watching the video, you have questions, please do note them down in the chat function.

Moderator to show Stimulus Set #1. [3 mins video]

Audio as follows

Session 1: Animal health and welfare

Health (being well) and welfare (doing well) while connected, are not the same. It is possible for a farmed animal to be in good health and experience poor welfare.

When thinking about animal health, infectious diseases are of concern in farming.

A lack of biological diversity in farmed animal breeds, together with rearing them in confined conditions, risks increasing the transmission of disease (though indoor systems can provide better biosecurity). In this context, animals that are reared outdoors are also at threat from disease present in wild populations, which can mean that practices to increase animal welfare can impact negatively on health.

Given a limited range of vaccines for many animal diseases and associated costs of developing treatments, there has been a focus on adopting management practices to control disease and prevent infection – such as keeping animals indoors during outbreaks. The cost or absence of treatments for many diseases also means that culling animals (both farmed and wild) can also be used – for instance, during the avian flu outbreak in 2021 around half a

million birds were culled.

Genome editing offers the potential to help control such diseases.

For example, porcine reproductive and respiratory syndrome (PRRS) is one of the most significant swine diseases in the world. It can cause pneumonia and respiratory distress in pigs, which affects both their welfare and health. In sows, it increases the number of stillborn piglets (mortality rates can be very high), promotes abortion and lowers litter sizes.

In an experiment, genome editing was used to block the pathogen by changing parts of a gene that codes for a protein, called a receptor, to which the virus attaches on the surface of cells in the pig's respiratory system. One problem is that the receptor also plays a role in other immune responses that are important to pigs, so the technique was altered to enable more specific changes to the receptor. Experiments showed that the resulting animals were resistant to infection, while maintaining these wider biological functions.

Beyond disease prevention, genome editing could also be used for specific animal welfare purposes and to prevent the need for certain farming practices, such as the culling of male chicks.

In laying systems, males do not have economic value since they cannot lay eggs, and the breeds adapted to egg laying do not produce as much meat as the broiler breeds. Chicks are therefore sexed after hatching and male chicks are culled, commonly by maceration. Genome editing can be used to place a marker to identify males, which fluoresces when a laser is shone through the egg. This allows eggs containing male embryos to be disposed of immediately after laying, thereby preventing the need to cull fully grown male chicks. This example of genome editing would involve the use of DNA from another species – in this case a protein found in jellyfish to enable the fluorescence.

Genome editing could be also used to avoid the practice of castrating farmed animals. For example, pigs are castrated to stop unwanted pregnancies, reduce aggressive behaviour, to prevent a distinctive odour in pork known as 'boar taint', and to affect weight gain and the ratio of muscle to fat. The US firm Recombinetics have used genome editing to produce piglets that remain in a state of prepuberty for the duration of their lives, removing one of the main incentives to castrate them.

Recombinetics also developed research exploring how to use genome editing to prevent the formation of cow horns. This would avoid the need to physically remove calf and cattle horns, which can cause stress in animals. Of the five bull calves born in the experiment, two were viable, with the other three humanely killed after birth. The surviving bulls were able to sire hornless offspring.

I'm going to show you a slide that summarizes the information we've just seen

	Moderator to show Stimulus Set 6, slides 1&2. • What are your immediate reflections, what stood out, why? • How do you feel about the different potential applications of genome editing on the following areas? o Pig virus o Culling male chicks o Castration of pigs o Hornless cattle • What questions do you have? o What might be the potential benefits of GE? o What might be potential concerns? • Overall, who would you say benefits by these types of application? For example, farmers, rural communities, society, big business, consumers? • What does it mean for the animals involved? • What role might genome editing have as part of our response to the challenges facing the food and farming system, taking into account the interventions currently or potentially available to us (for instance conventional breeding, different husbandry practices, or vaccines)? • To what extent would the use of the technology in this application area support the important features we discussed for future food and farming systems? *NB: invite expert reflections on a couple of occasions.*
11.15-11.45	**Session 2: Environment and conservation** We're now going to explore the potential application of genome editing to support the environment and conservation. *[if new expert present – welcome them to the group]* Like last time, I'm going to play you a video highlighting this and also show you some thoughts of specialists in the field. If, as you're watching the video, you have questions, please do note them down in the chat function. ***Moderator to show Stimulus Set #2. [2 mins video]*** ***Audio as follows*** **Session 2: Environment and conservation** *As we explored in the last workshop, whilst farming has many benefits, it can also have a range of impacts on the environment. In the context of farmed animals, livestock farming is associated with greenhouse gas emissions and producing livestock feed has been associated*

	with deforestation and biodiversity loss.
	As part of a suite of tools, genome editing has potential to help reduce this impact.
	One possible application of genome editing is to help produce ruminants (such as cows and sheep) with lower methane emissions, which has been shown to be an inherited trait.
	Alternatively, rather than modify the livestock themselves, genome editing could be used to support the production of animal feed with a smaller environmental footprint.
	A further impact of eating farmed animals is that it's an inefficient way of consuming proteins and calories, as farmed animals consume a lot more food than they produce.
	There is the potential to use genome editing to increase this efficiency, meaning we'd need to use fewer natural resources to grow less food for animals. This could involve changes to the crops producing the feed, or changes to genes influencing the growth of farmed animals and fish. We will touch on the issue of animal growth in more detail later.
	I'm going to show you a slide that summarizes the information
	Moderator to show Stimulus Set 6, slides 3 & 4.
	- Immediate reflections, what stood out, why? - How do you feel about the different application areas? - Genome editing a ruminant to produce lower methane emissions? - Changes to livestock feed? - Increasing the 'conversion efficiency' - What questions do you have? - potential benefits? - potential concerns? - Overall, who would you say benefits by these types of applications? For example, farmers, rural communities, society, big business, consumers? - What does it mean for the animals involved? - What role might genome editing have as part of our response to the challenges facing the food and farming system, taking into account the interventions currently or potentially available to us (for instance feed additives or alternatives to meat)? - To what extent would the use of the technology in this application area support the important features we discussed for future food and farming systems?
	NB: invite expert reflections on a couple of occasions.
11.45-11.55	**Break**
11.55 – 12.25pm	**Session 3: Farming and productivity gains**

We're now going to explore the potential application of genome editing to support farming and productivity gains.

[if new expert present – welcome them to the group]

Like last time, I'm going to play you a video highlighting this and also show you some thoughts of specialists in the field.

If, as you're watching the video, you have questions, please do note them down in the chat function.

Moderator to show Stimulus Set #3. [2 mins video]

Audio as follows

Session 3: Farming and productivity gains

The UK produces about 75 per cent of the food it consumes. Of the remainder, around 70 per cent of the food, feed, and drink imported to the UK comes from the EU. The global food system means that the UK can import certain food types which cannot be easily produced here. However, this can also expose the UK food system to risks and shocks.

The Government aims to support farmers to broadly maintain levels of domestic production, and drive productivity gains through innovation.

There are many such innovations, and we discussed some of these last time like the use of technology to monitor livestock on farms. Also in the strategy, genome editing is mentioned as a tool to potentially improve productivity.

For example, genome editing could be used to support breeding by creating "surrogate sires". In this process, male pigs, cattle or poultry are genome edited to make them incapable of producing their own sperm, allowing sperm cells taken from "elite donor animals" to be transferred into the testes of the edited animals.

More generally, genome editing could potentially play a role in conventional breeding, helping to edit genetic characteristics to produce specific traits.

A further potential application of genome editing could be to increase an animal's tolerance to environmental changes. For example, scientists in New Zealand have also used genome editing to lighten the hides of characteristically black-and-white dairy cattle in order that they may better tolerate changing climatic conditions.

Research is also targeting other markers of resistance, for example the potential to transfer the genetic characteristics of Pacific salmon that make it resistant to sea lice, to Atlantic salmon.

I'm going to show you a slide that summarizes the information

	Moderator to show Stimulus Set 6, slides 5 & 6.
	
	• Immediate reflections, what stood out, why?
	• How do you feel about the different application areas?
	    ○ Surrogate sires
	    ○ Animals tolerant to a changing climate
	    ○ Salmon resistance to sea lice
	• What questions do you have?
	    ○ potential benefits?
	    ○ potential concerns?
	• Some of these applications, such as surrogate sires and environmental resistance, may be helpful to farmers in developing economies. To what extent, (if at all) does that consideration shape your views on its potential use?
	• Overall, who would you say benefits by these types of applications? For example, farmers, rural communities, society, big business, consumers?
	• What does it mean for the animals involved?
	• What role might genome editing have as part of our response to the challenges facing the food and farming system, taking into account the interventions currently or potentially available to us (for instance using precision farming technologies we discussed last time to monitor and support an animal's health, wellbeing, and nutrition requirements)?
	• To what extent would the use of the technology in this application area support the important features we discussed for future food and farming systems?
	
	NB: invite expert reflections on a couple of occasions.

12.25-1.15	**Lunch**
1.15-1.45	**Session 4: Human health** Welcome back – I hope you all has a nice lunch We're now going to explore the potential application of genome editing to support human health*.* *[if new expert present – welcome them to the group]* Like last time, I'm going to play you a video highlighting this and also show you some thoughts of specialists in the field. If, as you're watching the video, you have questions, please do note them down in the chat function. *Moderator to show Stimulus Set #4. [3 mins video]*

Audio as follows

Session 4: Human health

There are significant risks to human health posed from diseases and infections that are passed on from animals (these are called zoonoses). For example, the recent COVID-19 outbreak was caused by a coronavirus present in animal populations, and a large percentage of known human pathogens are from zoonoses.

The emergence and transmission of zoonotic diseases is facilitated by livestock farming due to the increased frequency of contact between animals. Zoonoses also have a disproportionate impact in low-income countries, as people live close to the animals they tend.

A range of tools can be used to manage zoonoses, including biosecurity, breeding for resilience, vaccination, and other measures, such as herbal supplements to boost immune response and improve disease resistance. All these approaches have advantages and drawbacks.

Genome editing can also potentially play a role.

For example, brucellosis is a highly contagious bacterial disease caused by ingestion of unpasteurized milk or undercooked meat from infected animals, or from close contact with their faeces. It can lead to abortion and infertility in humans. The disease is common in the Mediterranean, Africa, and Asia. While vaccines do exist, they have side effects, and genome editing could potentially be used to inactivate genes coding for factors that play a critical role the bacteria's cell replication.

Influenza is another possible zoonotic disease where genome editing could be applied. Research is being undertaken helping to introduce influenza-resistant genetic characteristics in poultry and pigs.

In addition to zoonoses, the use of antimicrobials in livestock and fish farming sectors is a cause of antimicrobial resistance in bacteria, posing a threat to human and animal health. While steps have been taken to limit their use in recognition of this (for instance, the use of antimicrobials to promote growth is prohibited in the UK and EU) they are permitted elsewhere.

Genome editing could be used for the development of engineered antimicrobials, targeting antibiotic resistance genes in bacteria, and prevent the need for using wide spectrum antibiotics.

I'm going to show you a slide that summarizes the information

Moderator to show Stimulus Set 6, slide 7 & 8.

- Immediate reflections, what stood out, why?
- How do you feel about the different application areas?
  - Zoonoses prevention, such as brucellosis and influenza [compare to discussion for animal diseases]
  - Preventing anti-microbial resistance
- What questions do you have?
  - potential benefits?
  - potential concerns?
- Overall, who would you say benefits by these types of applications? For example, farmers, rural communities, society, big business, consumers?
- What does it mean for the animals involved?
- What role might genome editing have as part of our response to the challenges facing the food and farming system, taking into account the interventions currently or potentially available to us (for instance feed vaccines or restricting imports from countries using antimicrobials to promote animal growth)?
- To what extent would the use of the technology in this application area support the important features we discussed for future food and farming systems?

NB: invite expert reflections on a couple of occasions.

1.45-2.15	**Session 5: Consuming meat, fish and dairy products**

Session 5: Consuming meat, fish and dairy products

For our final area, going to explore the potential application of genome editing to support different consumer needs is relation to eating meat, fish and dairy products. This may include increasing production to help things like affordability, or addressing some of the health impacts from our diet.

[if new expert present – welcome them to the group]

Like last time, I'm going to play you a video highlighting this and also show you some thoughts of specialists in the field.

If, as you're watching the video, you have questions, please do note them down in the chat function.

Moderator to show Stimulus Set #5. [2 mins video]

Audio as follows

Session 5: Consuming meat, fish and dairy products

Meat and dairy provide many of the proteins and nutrients that are an essential part of our diets. Providing people with access to affordable meat products is a significant focus of the food and farming system.

Beyond helping to create "surrogate sires" (discussed earlier), one potential role of genome editing is to try and directly influence the reproduction and growth rates of animals. This has already been successfully applied to different fish species.

In addition to growth rates, improving the nutritional quality of meat is another potential application area of genome editing. As noted in the last workshop, there are a host of diet related public health concerns. For example, alongside highly processed carbohydrates, the consumption of red and processed meat has been associated with higher risk of type 2 diabetes, cardiovascular disease, certain types of cancers (pancreas, stomach, prostate, and colorectal) and premature death. Genome editing could potentially be used to improve the health and nutritional quality of meat – for instance, it has been used to improve lean meat production in pigs.

A further area concerns food allergies and intolerances, which have potentially serious health implications. For example, milk and egg allergies affect around 2% of babies and young children in the UK, though are less prevalent in adults.   In experiments, genome editing has been used to create cow's milk and chicken eggs which lack the proteins that produce an allergic response.

I'm going to show you a slide that summarizes the information

Moderator to show Stimulus Set 6, slides 9 & 10.

- Immediate reflections, what stood out, why?
- How do you feel about the different application areas?
    - Improving reproduction and growth rates, to improve the supply and potential affordability of meat
    - Nutritional quality of meat, to help people make better dietary choices.
    - Allergens [probe any concerns re babies and young children]
- What questions do you have?
    - potential benefits?
    - potential concerns?
- Overall, who would you say benefits by these types of applications? For example, farmers, rural communities, society, big business, consumers?
- What does it mean for the animals involved?
- What role might genome editing have as part of our response to the challenges facing the food and farming system, taking into account the interventions currently or potentially available to us (for instance dietary changes)?
- To what extent would the use of the technology in this application area support the important features we discussed for future food and farming systems?
- ***NB: invite expert reflections on a couple of occasions.***

2.15-2.35	**Session 6: reflections (small groups)** We will explore this more in the pre-task, but thinking across all of the application areas we've discussed today: • Which (if any) feel like the most promising areas for genome editing • Which (if any) would you have concerns about o Moderator to pull out any principles (e.g., supporting welfare, affordable meat etc.) • Do you have any questions based on what you've heard today? • What perspectives would you like to hear from in the next workshop, which will explore how the technology could be regulated and governed? ***NB: invite expert reflections, and what they've also hear in other groups.***
2.35 -3.00	**Session 6: Wrap up, feedback and next steps** I hope you all enjoyed the debate. I now want to invite our specialists to each give a minute of reflection on what they've heard and things you may wish to consider in advance of the next workshop, which will focus on the governance of GEFA. • Chris Proudfoot • Liz O'Neill • Craig Lewis • Pat Thomas • Julian Baggini • Jef Grainger • Rob Fraser • Huw Jones Thank you – please give a big hand for all the specialists who have given up their time to attend today. The final workshop will be on 9th July, where we explore some potential application areas for genome editing in farmed animals in a little more detail. We appreciate we've covered a huge amount today, and I'm sure you're still thinking through some of the things we've discussed. Before then we will be setting you a pre-task in the next few days, which will follow up on today's session after you've had time to reflect. Details will be posted on the EngagementHQ platform. Thanks again and have a great rest of your weekend.

Workshop 4 topic guide

Timings	Content
10.00 – 10.10 am	**Session 1: Welcome, agenda and introduction to the experts** *Purpose: Set out the purpose of the day and the role of each session; introduce the range of people involved and their background* Hi everyone and welcome back. My name is Darren, and I'm helping to run this public dialogue on genome editing in farmed animals, on behalf of BBSRC, the Nuffield Council on Bioethics and Sciencewise. This is our final workshop. Today we're going to do two things: • The first is to discuss our reflections from W3 and the pre-task • The second is to explore the governance of the technology. By governance I mean how genome editing in farmed animals might be directed and controlled. We will cover things like policy, safety, animal welfare, and how we may deal with uncertainty. We will look at what's currently in place and what could be in place in the future. We will explore how research is funded and overseen, and how government and regulators think about the control of novel foods and processes, as well as precision breeding technologies like genome editing. We'll also look at some examples of how other countries are looking at this issue. What we are keen to know is: • if you feel genome editing could play a role in addressing some of the food and farming challenges we've discussed over the past few weeks, what checks and balances may be needed around the technology, and what a good system looks like. To help us think this through, we're very pleased to have a range of experts with us today – you'll have met some of them before. They are: 1. Steve Morgan, who works for Defra, the government department who oversee policy in this area 2. Chris Proudfoot, who is an academic researcher working on GEFA 3. Pat Thomas, who runs the campaign group Beyond GM, and has set up a Bigger Conversation to discuss GE in society 4. Emma Walton, academic researcher working on infectious disease at the LSHTM 5. Anna Taylor who is the Chief Executive of the Food Foundation, an organisation that works on developing a sustainable food system. 6. Penny Hawkins who is the Head of the Animals in Science Department

	at RSPCA
	7. Chris Brown who Director of Sustainable Business at the supermarket Asda
	8. Phil Macnaghten, who is an academic working on the governance of emerging technologies, including genome editing. Phil can help bring an international perspective.
	We also have observers from BBSRC, Nuffield Council on Bioethics, Sciencewise and the evaluators joining us today. They will introduce themselves if they are in your group.
	I hope that's all clear. We can pick up any questions, as well as introduce one another, in the small group sessions if that's OK.
	In terms of agenda, we will spend the next 30 mins reflecting on W3 and the pre-task in small groups.
	At 10.45 we will then look at the current animal welfare regulations and regulations and protocols concerning research with animals.
	We will have a 10 min break from 11.25-11.35, before exploring future ways we could govern precision breeding and genome editing in farmed animals
	We will then come back at 12.15 to wrap up, before ending at 12.30.
	There's a lot to get through this morning, so please do be punctual when returning after the break.
	Finally, we know WIFI can suddenly drop, and you can lose your connection. If this happens, don't panic. Just re-click on the link to gain access to the main room. Our colleague Sofie will then help you get back into your group discussion.
	We will now move to the rooms. Please click on the button when it appears on your screen and see you in a couple of hours.

10.10 – 10.45 pm	**Session 2: Reflections and principles for GEFA**
	ENSURE YOU TURN THE RECORDING ON PLEASE
	Purpose: to reflect on potential application areas for GEFA and consider the principles for its possible development
	Welcome everyone to the group. We will do a round of introductions, in a moment, but as mentioned, we're planning to record this session.

Just to confirm that everyone is still happy with this? [Moderator to gain verbal consent. All participants have previously provided written consent.]

As mentioned, we will have specialists joining us at various points today. We don't want to make this a Q&A, as its your perspectives on these issues that we're interested in. From time to time, we will invite specialists to contribute their thoughts and help us consider different aspects of the debate. We would encourage you to challenge specialists, test their arguments and the values underpinning them.

Like last time, we are not expecting everyone to agree (including with the specialists) and we have selected a wide range of people to take part. So please be respectful of one another's views, and let's have a great discussion.

If we can briefly go around the virtual table and reintroduce ourselves that would be really helpful.

If you can then say your name again, where you're from, and one thing from the last workshop that has stuck in your mind.

If you have a preferred pronoun, please do change it on your screen name.

I'll start… XXX do you want to go next? [Nominate each person]

Thank you all very much

So, from the quick feedback you have just given, it sounds like [X issue(s)] were particularly resonant for you.

We're going to think about each area in turn now, building on feedback from all the dialogue and the pre-task.

[Show stimulus set #1: slides summary of themes from W3]

I'm now going to show a summary of the information that was shown in the pre-task

For each area, rapidly consider:

- What chimes with you?
- Where do your views differ?
- Anything missing?

Slide 1:
Animal health and welfare
- *GEFA to reduce animal disease and promote welfare seen to have potential*

- *Contingent on simple changes to genome and lack of suitable alternative*
- *Questioned how to reverse if problems were discovered.*
- *Belief new diseases could lead to a "constant tinkering" with genome**
- *Need to be sure it benefits the animal, not just the farming system*

Slide2: Environment and conservation
- *Mixed views on GEFA to mitigate the environmental impacts from farming animals.*
- *Ecological systems very complex, risk of unintended consequences*
- *Greater support for changes to animal feed than the animals themselves*
- *Explore alternatives: other animal feeds, eating less meat, wasting less food, buying local*
- *Given urgency of climate change, GEFA may need to be an option on the table*

Slide 3: Farming productivity and gains
- *Possibly greater potential for low- and middle-income countries, where meat demand and supply misaligned. But concern over governance in LMIC & potential exploitation.*
- *Scepticism as to whether small farmers (UK and abroad) would have access to the technology and how larger businesses may end up exploiting GEFA*
- *Elite donors potentially a quicker, precise extension of selective farming, but unforeseen problems could have big implications for progeny.*
- *Designing animals tolerant to changing climatic conditions potentially useful, more for reasons of animal welfare than farming productivity.*
- *Concern over security of animal welfare law to ensure applications won't be abused*

Slide 4 Human health
- *Saw potential in human health applications especially where other treatments limited, and the editing relates to a discrete part of the genome.*
- *However, we should also tackle the root causes of zoonoses (e.g., farming practice, wet markets etc.), rather than using gene editing to solve these issues.*
- *Genome editing to prevent zoonoses may precipitate the emergence of other diseases*
- *Genome editing to combat the overuse antimicrobials generally supported*
- *Simple edits to the genome (removing DNA) to prevent disease was seen as different (and less problematic) than adding traits* **[MODERATORS PLEASE PROBE ON THIS POINT – is there something that is seen as inherently more risky by adding or changing DNA than removing DNA? Does it mean traits like that gained through conventional breeding?]**

4. *Slide 5: Consuming meat, fish and dairy products*

- *Views on increasing production to manage food prices mixed, but scepticism as to whether consumers would really benefit.*
- *Tackling waste should be a focus*
- *Using genome editing to improve diet related health less potential, especially where consumers could exercise dietary choice to tackle the problem*
- *Greater support for its use to address food allergies*
- *Questioned why food allergies are on the rise, and whether genome editing could exacerbate the problem.* [**MODERATORS PLEASE PROBE ON THIS POINT – is GE associated with potential risks around food allergies and why? Is GE linked to ideas of processed foods?**]

We now want to explore some principles that may help us to consider future application areas for GEFA.

Overall, there was generally more support for applications that:
[**show emerging principles slide**]

1. support animal welfare and human health
2. work in specific, more controllable or manageable contexts rather than very complex domains such as the environment
3. Do not have relatively simple alternatives
4. Supported more productive farming in low- and middle-income countries
5. Focus on the removal of defects rather than adding traits

- Do you agree with these?
- Do you have any concerns?
- What's missing?
- Applications may have wider impact of other domains – so, in the example of animals tolerant of rising temperatures, improve welfare and productivity. To what extent does this matter?
- On the point of removing vs adding traits, what do we mean here?
    - Open then probe: changes akin to conventional breeding?
- The idea of simplicity has been raised in several principles – what is it about this term that has value in this context?

10.45 – 11.25 pm

We're now going to change tack a little and explore governance.

To do this, we're going to look at a couple of areas.

The first is to explore current regulatory and governance systems around animal welfare, and animals in research

We're going to show you a short video on this.

Show stimulus set #2, video 3 min 36 secs.

- What are your thoughts about what you've just heard?

- In the context of GEFA
  - What resonates?
  - Questions do you have?
  - What might be missing?

I'm now going to put up a few slides that summarize/build on these key points:

Show stimulus set #3, slides

Slide 1: Farmed animal welfare

There are statutory codes of practice for the welfare of different species. These include minimum standards towards the following five requirements:

- a proper diet and fresh water
- somewhere suitable to live
- kept with or away from other animals, depending on its needs
- allowed to express itself and behave normally
- protected from, and treated for, illness and injury

At a minimum, each individual farm animal should have a life that is worth living and a growing proportion should have a good life.

As noted in our discussion in workshop 2, some of these points are contested, and they are not always followed in practice. They also do not touch on changes forged by breeding.

- What does animal welfare mean to you?
- How do you feel about these safeguards? To what extent to you feel they are effective in governing animal welfare?
- Thinking about application areas of genome editing we discussed earlier, and the potential to create new breeds, are there any additional considerations that need to be given for animal welfare?

Slide 2: Animals in research

The laws on research using animals are set out in the Animals (Scientific Procedures) Act 1986 (APSA).

Permission to work with animals is granted by the Home Office by licence only under very specific conditions. The Home Office has an inspection system to ensure that rules are not violated.

Procedures are regulated for any research where an animal will experience "a level of pain, suffering, distress or lasting harm equivalent to, or higher than,

that caused by the introduction of a needle in accordance with good veterinary practice".

There are detailed recording and reporting protocols covering the severity of harm to genetically altered animals.

- How do you feel about these safeguards?
- What questions do you have?
- Thinking about the application areas of genome editing we discussed earlier, how should we balance harms to animals to the potential good for other animals or wider society?

Slide 3: BBSRC funding and ethics

- BBSRC requires all research involving animals to have approval from the local Animal Welfare Ethical Review Board before experiments start.
- International research in collaboration with UK scientists need equivalent standards in place.
- The research grant application has questions on experimental design, research ethics and formal ethical approval.
- The experts who review BBSRC grant applications can raise additional ethical concerns, and research is not funded until they are satisfactorily addressed

- How do you feel about these safeguards?
- What questions do you have?
- What sorts of ethical questions do you feel should be being asking of research involving genome editing animals?
- As we move from research towards more commercial breeding of animals, should such safeguards remain in place? Why?

11.25-11.35	**Break**

11.35 – 12.15pm	**Governing novel technologies and food safety**
	
	Next, we're going to explore current regulatory and governance system around emerging technologies and food safety.
	
	Show stimulus set #4, video 6 mins.
	
	- What are your thoughts about what you've just heard?
	- In the context of GEFA
	    o What resonates?
	    o Questions do you have?
	    o What might be missing?

I'm now going to put up a few slides that summarize/build on these key points

Show stimulus set #5, slides

Slide 1: Legislation and policy around genome editing in farmed animals

- The Regulations around genome editing and the precision breeding of animals need to enable responsible innovation and safeguard animal welfare
- Defra will take a careful approach and not implement measures in relation to the marketing of genome edited animals until an appropriate regulatory regime in place
- Defra will work with researchers, industry, NGOs and animal welfare experts to develop the details for the regime and consider risks to the welfare of the animal and its progeny as part of this
- Defra also intend to continue to engage with the general public on role of genetic technologies in the food system

- How do you feel about the way in which Defra are approaching the regulation?
- What questions do you have? Are there words or phrases that need to be unpacked?
- Is anything missing?
- Are there other safeguards Defra should be considering? How does it link to some of the principles we've discussed earlier? What sorts of voices should be included?

Slide 2: Novel Foods

When considering novel foods and feeds, including GM foods, the Food Standards Agency explores:

- Whether it has adverse effects on human health, animal health or the environment

- Whether it misleads the consumer

- Whether it differs from the food/feed which it is intended to replace to such an extent that its normal consumption would be nutritionally disadvantageous for humans/animals

- For context, it should be noted that GM feeds for animals are allowed in the UK

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- How do you feel about these safeguards?
- What questions do you have?
- Is anything missing?
- In terms of misleading the consumer, what are your views on the need to label genome edited animal food products? What might the consequences of this be?

- If a genome edited animal is safe to eat, and produced in a way that is safe for the animal and the environment, are there any other things we'd need to consider around its governance?
  - Probe welfare and acceptable breeding standards
  - Unintended consequences
  - Impacts on the food and farming system
  - Ownership of the technology and patenting an animal's genome

Slides 3 and 4: Different models for regulating genome editing and precision breeding

There are different potential models for governing genome editing in the context of farmed animals and precision breeding.

The Food Standards Agency is suggesting a 2-Tier model, along the lines of the Norwegian model discussed in the video.

Tier 1
Precision-bred food assessed as low-risk where:
  i. sufficiently similar to food and feed bred by traditional methods
  ii. the nature of the genetic change achieved by precision breeding is highly unlikely to have resulted in a significant change in composition, either directly or indirectly, to the part of the plant or animal that is eaten
- As traditionally bred food and feed is not subject to an authorisation process by the Food Standards Agency, these would be authorised rapidly.

Tier 2
- Precision bred organisms in which there is likely to have been a significant change in the composition of the product that is typically eaten.
- For example, alternations to the type or level of nutrients or allergens within the product to a level beyond that usually seen in products based on conventionally bred organisms.
- Here further evidence of safety and a more detailed risk assessment would be required prior to an authorisation   decision.
- This would take longer but should be quicker than authorising a novel food or feed.

It should be noted that, relative to the Norwegian model discussed in the video,

there is no explicit mention of ensuring that any production and use of GE takes place in an ethical and societally responsible manner, and makes a contribution to sustainable development.

- What are your views on this model?
- To what extent do they deal with some of the concerns you raised earlier around… [e.g. safety, unintended consequences, welfare, food and farming systems?]
- How does it relate to the principles we discussed earlier on future application areas for GEFA?
- Is there anything missing? [if not mentioned, link back to differences re the Norwegian model]