

Science, Innovation and Technology Committee

Oral evidence: Innovation and global food security, HC 1245

Tuesday 20 January 2026

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Members present: Dame Chi Onwurah (Chair); George Freeman; Dr Allison Gardner; Kit Malthouse; Samantha Niblett; Dr Lauren Sullivan; Adam Thompson; Martin Wrigley; Daniel Zeichner.

Questions 66 - 140

Witnesses

I: Professor Paul Behrens, British Academy Global, University of Oxford; and Dr Belinda Clarke, Director, Agri-techE.

II: Tom Allen-Stevens, Managing Director, British On-farm Innovation Network (BOFIN); and Peter Sekwena Setimela, Legume Seed Systems Lead AID-Project, CIMMYT Zambia.

Written evidence from witnesses:

- [Agri-techE](#)

Examination of witnesses

Witnesses: Professor Behrens and Dr Clarke.

Q66 Chair: Welcome to this second session in the Select Committee's inquiry into innovation and global food security. We are not all always aware of the science that lies behind the food we eat, but science and innovation play a fundamental part in the global food system. Food security is increasingly a driver of migration and conflict. Through this inquiry, we want to understand the role science plays in the global food system, what more it can do and what more the UK can do in that regard. Today, we will explore the innovations that can support global food security, including AI—that is artificial intelligence in this context, not artificial insemination—and digital technologies, and the challenges around making sure that new technologies can be put into use by farmers in this country and globally.

I start with an overview, big picture question for each of our two witnesses this morning. I ask them to introduce themselves when they speak.

Let us start with Dr Belinda Clarke. If you picture an agricultural and food system that could deliver global food security by, say, 2050, what are the main differences from what we have today? What is the role of science and innovation in getting us from here to there?

Dr Clarke: Thank you very much for the question. My name is Belinda Clarke. I am a scientist by very deep background, a long time ago. I now run Agri-techE, which is an independent membership organisation bringing new technology, research and those who are active in the innovation ecosystem together with farmers and growers. We started in the east of England. We are now national in the UK and have members across 13 different countries globally.

I like thinking about this question, fast forwarding to 2050. It is not very far away. My vision is as follows. First, I would like to see routine deployment of precision-bred crops across the world. It is patchy and fragmented now. The UK is leading the march in the deployment of precision breeding, in not just plants but also animals, insects and microbes for soil management, and industrial biotech. Secondly, I would like to see deployment of the Internet of Things and the tools associated with precision agriculture, again routinely. Some of that is hardware; some of it is software. A lot of it relies, as we have just heard, on digital tools. Every farm would be deploying digital ways of farming.

I also hope and expect that by 2050 we will be much smarter in our circular economy thinking and deployment, and have a much better use of—again, a lot of research is starting to emerge on this—high carbon-capture cropping and alternative uses of management of so-called “waste” but valorisation of by-products. I know my colleague will probably come on to this but there will be a reduction in the number of



animals in the farmed systems. I think that is inevitable, though I would die on the hill that we need some animals to help maintain a healthy farming system. I hope that gives a picture of where I would see the farming system globally. Of course, it would all be empowered by science and technology for the digital tools and software needed to really leapfrog, certainly in some of the emerging markets, the infrastructure and access to markets and credit.

- Q67 **Chair:** Thank you very much, Dr Belinda Clarke. That has given us an overview and I note that you emphasised high-tech solutions around precision breeding and AI, with some mention of lower tech and sustainability solutions. I think the Committee will want to come on to talk about those.

Professor Paul Behrens, what is your vision for 2050?

Professor Behrens: Thank you so much for having me here today. I am Professor Paul Behrens from the Oxford Martin School, University of Oxford.

When we think about this vision for the food system in the future, we have to imagine what toll climate change and environmental impacts are making. We have to be clear that there are no non-radical food futures. Everything has to be around both the fact that climate change is unravelling faster than we thought in terms of the impacts on food systems but also taking into account that what we are doing is feeding people nutritious food. There are those two systemic issues. When I look at climate change, just to give you one example, the chance of multiple breadbasket failure is now going up. The estimate for corn is that what would have happened once every 16 years is increasing to once every three years at 1.5° of warming and once every two years at 2° of warming.

- Q68 **Chair:** Sorry, you said multi—

Professor Behrens: Breadbasket failure. This is a significant drop in yields across the world, across multiple breadbaskets in the same yield, because extreme weather events hit them in that year.

- Q69 **Chair:** And that has huge impact on the nutritious food that people need.

Professor Behrens: And it has a huge impact on food. The most direct thing that I think we should consider, and which we underestimate, is the inflationary impact on food prices. That is incredibly socially destabilising. Research on that seems to suggest that we would have from 1 to 3 percentage point increases annually on the price of food by 2035. These are usually underestimates because they do not include things like soil degradation, pest and disease spread, infrastructure damage and some extreme weather events, all of which are increasing. It is with that in mind that I think about the future—a future in which, by the end of this century, we may lose about a third of total agricultural land. Even though the temperate areas of the planet might be able to produce more, that is



more than made up by the declines across the tropics. That is where we are heading.

Then, when I think about the food system as a whole and whether it is feeding us very well, we see a preponderance of obesity and overweight. We see the dietary risks of health additives being one of the largest drivers of mortality around the world. Everything points in the same direction for me: that is, the increase in the consumption of plants. It is far more efficient. We have less and less land to produce agriculture. Animal agriculture requires much, much more land. For example, animals will essentially waste around 85% to 95% of the calories they are fed, and use up to several hundred times more land than plants. I see a future where we have a large amount of land saved through these dietary transitions, which is then turned to biodiversity protection and climate absorption of flood risk, wildfire and droughts. I also see a role for technology in the form of things like precision fermentation, maybe some vertical farming for micronutrients and especially a lot of precision-bred crops, as was just said by my colleague, in order to be more resilient to that future we face.

Q70 Chair: Thank you. Just to pick up on that, both of you emphasised the need for less meat in our diet. Professor Behrens talked about a significant increase in plant-based nutrition. This is a global issue but the UK is a rich country. When you talk about a more plant-based diet, are you speaking globally? Are you expecting populations in Africa to eat more plants and less meat? Or are you speaking about the developed world?

Professor Behrens: It is a great question. In work we have done, making an expert solicitation of agricultural and climate scientists around the world, they and I think that there is no reason why regions in sub-Saharan Africa would have to cut down animal agriculture. In fact, it could even increase. The key issues are in the high-income nations, and also in upper-middle income nations. We are talking Brazil, Argentina and the uptick in consumption in China, for example. It is not just the high-income nations that we might think about in the G8 or those groups who would need to cut down their consumption.

Q71 Chair: Thank you. So, we have to consider this in terms of the existing population food sources, as well as how they evolve in relation to climate change and technology. We have had evidence, for example, that Africa as a continent needs to produce 99% more food by 2050 if it is to feed its population. Coming back to both of you, how can UK research and policy best support agricultural innovation in improving food security within the UK and globally?

Dr Clarke: I think this is where the exciting potential for innovation and technology is making itself known. A lot of that is around digital solutions. In the UK, for example, we—farmers and the supply chain—are now able to deploy new insights and understanding of the supply chain to increase productivity. I know that George Freeman is spearheading the 30:50:50



initiative, which I am sure you all know about. There is real understanding of the critical importance of increasing productivity. Technology absolutely underpins that, around crop yield forecasting, weather resilience and climate-smart agriculture.

Everything that applies in the UK is equally applicable in emerging markets as well. The smartphone really democratised access to technology, information and data. In Africa, they were able to leapfrog a lot of the fixed telecoms infrastructure by using mobiles. It has opened up all sorts of e-commerce opportunities, understanding supply chains and access to markets. That is the kind of engine that gets the flywheel moving, if I have got my metaphors correct, to generate more food with lower environmental impact. I am passionate about the UK's capabilities in the development of these technologies, and then the export and deployment opportunities in other markets. We are already seeing that. A number of really successful UK agri-tech companies are moving beyond the shores of the UK.

Q72 Chair: Thank you, Dr Clarke. I am surprised to hear you say that everything that applies in the UK could equally apply across the world. Speaking as a telecoms engineer, I would say that while we have seen greater access to technology through mobile phones, I am not sure it has democratised it entirely, given regulatory frameworks and some of the technological infrastructure. Can I ask you again: do you have any concerns with applying technology that works in the UK across the world?

Dr Clarke: Obviously, if we are going to say technology in the round, it needs to be appropriate, deployable and serviceable. Satellite coverage, for example, is not—as I understand it—as comprehensive as we might want globally. That said, if we were going to focus on Africa and women farmers in particular—women produce a lot of the food in Africa—access to digital services is really starting to transform their ability to access markets, going back to that word “democratisation”. There is also their digital literacy, access to best practice, agronomy advice, guidance, and sharing best practice with their peers. I have been in Africa and seen people walking. Some 20 years ago, they used to walk 10 miles to go to a farmer field school. Now they have WhatsApp groups. That is obviously not the same as on-farm agri-tech, but, that said, I would struggle to find too many such examples. Obviously, you need access to fuel and big machinery. But the key in exporting our knowledge and know-how is the appropriateness of the context in which it is deployed. I would not wish to leave you with the thought that I advocate a cookie cutter model—far from it. But I think there is relevant deployment of a lot of UK technologies globally.

Q73 Chair: Thank you. Professor Behrens?

Professor Behrens: I agree a lot with that. One thing we have to bear in mind is that, as I mentioned before, regions in Africa towards the end of this century—and we will move through that to 2050—will find it extremely challenging to produce normal, open-field agriculture, which



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will struggle for lack of water, extreme weather events, drought and heat waves. What does that mean? Can we keep up with the innovation? To some extent perhaps we can in the short term, but long term it will become extremely challenging. That is what we face with climate change. We will see internal and cross-border migration due to this. What starts off as a food question becomes a human health and security question.

Some production is more climate secure than others. There may be the opportunity, as I say, for more precision breeding of crops which are drought and heatwave tolerant. Also, we have technologies for controlled-environment agriculture. We have things like precision fermentation, which I mentioned. Also, to some extent, there is vertical farming for some micronutrients. That will never really compete in terms of bulk macronutrients, but you could see a situation in future where, in real extremes, you have your macronutrients and proteins produced by precision fermentation and your micronutrients by vertical farming. This is a very challenging future that I and the science paint. It is not ideally where we would want to go.

Q74 **Chair:** You seem to be saying, Professor Behrens and Dr Clarke, that what UK research and policy aims to do in improving the UK's food security is applicable around the world.

Professor Behrens: Yes, absolutely. There is a reason why I focus a lot on high-income countries. It is because, first, we struggle a lot in the UK with nature. We are the seventh most nature-depleted country in the world. We have a lot of benefits to harness for ourselves. Such a transition would massively improve our productivity and reduce the cost of the NHS. Some estimates tend to even hundreds of billions of pounds a year. All of these technologies are exportable overseas, to upper, middle-upper and lower-middle income countries. This is exactly what the Danes are doing. They have a plant-rich action plan, where across the entire food supply chain they are basically encouraging more plants, all the way from educating chefs to investments into new technologies and grants for science and innovation. They are targeting massive amounts of exports. That is one reason they are doing it.

Chair: Okay, I am interested to see how encouraging chefs in Newcastle to take up more plant-based options will be effective. It is a political as well as a scientific decision. Kit?

Q75 **Kit Malthouse:** I just want to disentangle some of the things you mentioned. Obviously, the source of protein will be challenging over the next few decades, not just here but around the world. Are there any animal agriculture systems that rival plants for efficiency?

Professor Behrens: Ultimately, no.

Q76 **Kit Malthouse:** Not even fish?

Professor Behrens: Fish have large problems with trawling, given the amount of diesel required. Also, from an environmental perspective there



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is the biodiversity impact. Farmed fish has the issue of eutrophication of near inland waters. The only area that has some possibility would be mussels, oysters and those sorts of products, which are generally filter feeders and can be quite environmentally beneficial, and quite good for certain micronutrients as well.

Q77 **Kit Malthouse:** What about land-based insect protein?

Professor Behrens: Insect protein is, so far, mostly used for feeding to animals. That is just increasing the inefficiency of the process. Ultimately, once you take some food and put it through another organism, you have all the losses of keeping that organism alive and, in some way, you are destroying some of the calories and proteins.

Q78 **Kit Malthouse:** Yes. I just wondered if the same was true when you take into account the processing required at the other end, with plant-based proteins and fats. As you will no doubt have gathered, there is a huge furore about the amount of industrial processing to produce seed oils, for example, which is enormously energy-intensive. Given the full life cycle of getting from growth into me, taking into account that full cycle and energy requirement, I wonder whether it is quite so unequal.

Professor Behrens: That has been taken into account. These are very small compared with the environmental impacts on the farm. When we look across the supply chain, it is just over a third on the farm and about a third is through land use change. The remainder is everything: the other storage that might happen; processes; transport; refrigeration of the supermarket; cooking of it, et cetera. I do not have the figures to hand for the specific processing plant, but I believe that it is of the order of 10%, which is about the amount we might have for transportation.

Q79 **Kit Malthouse:** Basically, you would say, in shorthand, that a vegetarian future is inevitable.

Professor Behrens: I think it is inevitable one way or another, either by designing that future and harnessing all the benefits of it—

Q80 **Kit Malthouse:** Or it's being forced on us.

Professor Behrens: Or it's being forced on us, because what we will tend to see—this is more my opinion rather than something that has been shown in the scientific literature yet—is that the inflationary pressures on the animal system will come in two forms: animals struggling with climate change and the heat, and the feed required for those animals. Even if you are putting in AC or cooling systems in barns, for example, it is all extra money and investment in assets and it will just raise prices. I think you will see this differential increase between the animal prices and the plant prices. We have seen some of that already, but yes.

Q81 **Kit Malthouse:** Can I ask what you mean by precision breeding? Other people may know more than me, but when you refer to precision



breeding how artificial is that? Is that genetic manipulation? Is it just the old-fashioned way of finding a couple of animals you fancy and putting them together? How far does precision breeding go in its artificiality?

Dr Clarke: In the language we would use these days, precision breeding is a highly complex and technical process, but it does speed up finding two individuals and putting them together. I would define precision breeding by using gene-editing, which is the CRISPR-Cas9 technology. I think this Committee heard from Professor Cristóbal Uauy of the John Innes Centre as part of this programme. It is “artificial”. I think we could debate that for the rest of the day.

Q82 **Kit Malthouse:** Let us put it this way: it is non-naturally occurring.

Dr Clarke: Again, I think we would push back on what “naturally occurring” means. “Natural” has a whole series of pejorative interpretations. As to where we are now, certainly with regulation in England, it would be an intervention that could have arisen naturally. Scientists can make very precise base pair changes at the level of the DNA, which is very targeted, elegant, precise and now very fast. It is elegant technology, but it has sped up the potential.

Q83 **Kit Malthouse:** Why is that? Working up to my wider question, here we are with a largely plant-based diet, which will involve, as far as I can tell, fairly intensive farming, with crops that are manipulated in a laboratory to produce, yet we are saying there is a biodiversity, natural world, soil health thing going on. It feels to me, for want of a better word, that we have a kind of artificial food future coming that conflicts with the idea of wanting a natural environment in which we eat lots of healthy food that is wonky vegetables and all the rest of it. How does that conflict work?

Professor Behrens: The plant-rich shift opens up the space for that system: for that biodiversity, flood water absorption and carbon sequestration. The reason is that the system currently takes up such an amount of space in land. In our research, if the UK were to move to a very plant-heavy diet—I am still talking of a beef burger once every two weeks, a chicken fillet once a week and a quarter-pint of dairy a day, that sort of diet—if we were to shift from the current diet to that diet, we would spare an area almost the size of Scotland. We would reduce our emissions—

Q84 **Kit Malthouse:** I am sorry to interrupt because we are on limited time, but part of our inquiry is about sustainability. In order to make that sustainable, we would be designing our agricultural products and systems in such a way as to eliminate things that are naturally part of biodiversity—for example, insect predation on plants. We will breed plants that are resistant to blackfly so that we can have a reliable rape oil crop.

Professor Behrens: Not at all, because you have saved land such that you can use it in different ways. If you want a fully organic system, you can have that. You can have any sort of intercropping, multi-cropping or



any production system you want that is incredibly biodiverse—much more than the current systems—and still save land. The result would be a system that enables what you are talking about, which would be incredibly biodiverse and very resilient. If you have saved that land—under our modelling if you do that—you also become far more self-sufficient.

Q85 Kit Malthouse: What do you think is the resistance to this system?

Professor Behrens: Currently, there are two main threads of resistance. The first is that in any transition some people win and some people lose. It has to be said that there is resistance mainly from large-scale agribusinesses—the Tysons and the Cargills—because they do not want to see something like this. Academic papers have shown how they have consistently misled and run campaigns to misinform the public. That is one key side of it. The other side is that food is a very personal and cultural decision that people make every day. Food systems and food decisions have changed dramatically over the years and continue to change. We may not have heard of avocado on toast or quinoa 10 years ago. This was a country that ate mostly turnips; nowadays, you cannot even buy turnips in most supermarkets.

Q86 Kit Malthouse: We are being told not to eat avocados now because they are destroying the planet, too. Dr Clarke, are some of these big agri-tech companies your members, or not?

Dr Clarke: Some of them are, yes.

Q87 Kit Malthouse: Is what Professor Behrens says about them misleading us correct?

Dr Clarke: It would be slightly disingenuous to imply in this forum that it was in any way deliberate. I do not know the details. We can all remember that back in 2000 some very unfortunate things happened around genetic modification. So, with respect, I would push back a little bit on your use of the word “manipulation” and the slightly ideological positioning of precision breeding as being unnatural. We have to be very careful in that narrative.

Q88 Kit Malthouse: What word would you use?

Dr Clarke: I would use “precision”, “targeted” or “defined”. We know the endgame we want. When somebody is breeding a new plant, they know the endgame for which they are looking. The tools of precision breeding enable a much more direct route to get to that endgame. There will be a lot that do not work. It is not that you just get up one morning and make a precision-bred variety of wheat that is resistant to everything. It does not work like that. Things still have to be tested and trialled, so I am nervous of a narrative that implies that somehow big business is holding all the strings. To be clear, big business is the enabler of a lot of this technology being available to farmers.



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Kit Malthouse: I am not at all science-resistant. I just wanted you to respond to what the professor said. Thanks very much.

Chair: Thank you. I am sure we will return to these issues that are raised.

Q89 **George Freeman:** One thing this Committee is concerned with is value for money and how we turn this £20 billion a year public R&D—small compared with China and the US, but a lot of money for a nation that is struggling—into industry, investment, growth and hope around the country. I want to ask Belinda about the agri-tech sector in the UK. I have three specific questions, one of which is about data. First, we are trying to work out whether government, or anyone in a key sector like this, knows the public R&D per year and how much private money we are getting in alongside it. The Secretary of State recently admirably said that, for her, that was a key indicator of whether we are winning.

Secondly, what is the adoption problem? I was at CropTec last week. One hears a lot about us being a brilliant incubator, as in so many other sectors, but our agricultural industry is not big enough, healthy enough and investing enough to pull through. We are really interested to know whether you think the problem is in Innovate UK or industry. Where is it in that translation piece?

Thirdly, as a UK trade envoy, what is it we have to do to help these amazing companies go global? As you know, the global leaders traditionally in investment in R&D are Brazil and the Netherlands. I was trying to look at the data, and perhaps you can help us. When I started in 2010, we were at £231 million a year in agricultural research; in 2020 it was £306 million. We got it up. Other Departments spend quite a lot. I think it is about £400 million in total, but no one in the industry really knows which pots. I read that we are fourth in agricultural private investment, but that might just be because we have Syngenta, the world's No. 1 plant health company, based here. I read that we have secured £12.5 billion in private investment since 2014, which is amazing. Can you help us here? How should we think about this as a sector and those structural challenges. Starting with the data, do you have any on adoption and how do we help it to go global?

Dr Clarke: I know this is close to your heart, George. Data governance remains challenging, not just in the UK but globally, and where you have international supply chains as well. It is fair to say that that is still work in progress. Farm Data Principles, if you have not come across that, is an industry-led, industry-driven initiative to try to bring some rigour and governance around data. What we still lack is a unified data architecture.

Q90 **George Freeman:** Just on Government expenditure—we have had Ministers and other folk here—do you know what the UK agri-research figure is per year, or over the next CSR?

Dr Clarke: I do not. I would be careful about putting too many barriers around agri-tech. As a slightly semantic point, if we are going to talk



about the agri-tech sector, I understand why we define it thus within government but it means that we risk undervaluing it, because we have technologies from other sectors. If we are to talk only about the traditional ones, organisations like Syngenta, BASF and Bayer, who knew that some of the big aerospace companies have agronomists, for example? They would in no way describe themselves as agri-tech companies, but they are active in agriculture, so we are in danger of under-reporting in terms of the scale of the sector.

Q91 George Freeman: I understand. As a trade envoy, I do need to be able to say to people, "You may not know this, but in the UK we spend £200 million, £300 million or £400 million a year on agrifood-related research and pull in £1 billion to £2 billion." Even rough numbers would be helpful. It is interesting to note how many Government officials do not have those numbers. You would know them if they were out there.

Dr Clarke: I agree. The question we are constantly asked by Government colleagues is: can we come up with the numbers? There are some slightly fuzzy edges. It is not the case that we can just define the 20 companies and five research organisations working in this space and add them up; it has some very blurred edges.

Q92 George Freeman: This is a Whitehall question for you. Which Department leads on agri-tech? When I was at DSIT people said to me, "We don't do agri-tech, although we funded all the research." Is it DEFRA or DBT? Who is owning this as an industry in Whitehall?

Dr Clarke: Obviously, the ADOPT programme sits with DEFRA. It is very notable—Minette Batters noted this in her recent farming profitability review—that farming businesses sit within DEFRA; other businesses sit within DBT; so we already have this disconnect between the enabling technology providers and end users. That leads to all sorts of under-reporting problems. Personally, I would go back to the original agri-tech strategy where there was collaboration between different names for different Departments around international development, trade, business and DEFRA. To your original question, Chair, that would be the farming system I would like to be supported in the UK in 2050. It helps that we have agri-tech as one of the frontier sectors in the industrial strategy. I think we are still hoping and expecting to see some impact from that.

George, in answer to your question about the adoption challenge, it is many. We have a fragmented system. I noticed that the National Farmers Union report last year on innovation and investment revisited the conversation about a "what works centre" for agriculture. That conversation has been going on for many years. Many people are finding it hard to disagree with having a triaged system that is almost like NICE for the NHS, where farmers can get independent advice about literally what works on their farms. On your point about adoption and scaling, farmers are waiting to be sold to by technology providers. They do not have that independent voice and advice. Companies themselves are struggling to scale, which is a wholly different conversation.



Q93 George Freeman: As chair of the all-party parliamentary group for agri-tech and a mid-Norfolk MP, I should say I see a lot. For colleagues who have not, it is extraordinary. In my day, when I worked on a farm the tractor cab was a canvas thing with a piece of plastic for a window and could go fast or slow. These days, they look like airline cockpits; they are incredibly high-tech. You have AI and satellite-guided bits that work out which part of the field needs spraying. All the data is automatically captured and fed back to your desktop agronomy. It is not as if there is a technology shortage. It seems to me there is an extraordinary wave of technology. Our farmers, when they can afford it, are using it. It feels as if the problem is more upstream—that somewhere in government or in the agricultural sector globally people are not looking at the UK and saying, “What an amazing integrator of everything from gene-editing to data. Let’s globalise it.” What do you think those structural barriers are, and how can we help?

Dr Clarke: If you look internationally at our colleagues overseas, in particular New Zealand and the Netherlands, they have very structured and energetic activities going out to the rest of the world and forging those partnerships, waving the flags for what their market has to offer. For example, in the middle east, where vertical farming is a very hot topic at the moment, providers are out there every week. They are saying, “What can we do? How can we make this work?” We need a more concerted effort for the UK on a global stage. There is real potential for UK plc to be the global testbed for new technologies. We have different soils; we have innovative farmers; we have ways in which the UK is already punching above its weight in its earlier stage R&D. We need to be able to pull in that investment and export the technology. Part of that is enabling our emerging and growing agri-tech companies to scale, and they are really struggling.

Q94 George Freeman: On Innovate UK, we have seen Tom, the new CEO. Do you have any advice for us on what we should be pushing Innovate UK to do to help tackle this problem? This is really its job.

Dr Clarke: It is.

Q95 George Freeman: We are spending a lot of money on research. The challenge is innovation. Do you have any suggestions for how we can help?

Dr Clarke: It is hard to think how Innovate UK could do things differently. It is easy to think of ways of criticising. What is happening now is that lots of companies that are good at writing grant proposals are getting funded. We need a conversation with UKRI, Innovate UK and BBSRC. I would also bring EPSRC into this conversation. We know there is a balance between fundamental research that is so important and has underpinned a lot of the UK’s activity, and the applied research and how Innovate UK helps to develop that. I would advocate—I know this goes against Haldane and all sorts of things—that we need sector missions and plans. Then, from that understanding of the size of prize for our



agricultural outputs, whether it is retail, out of home, export or Government procurement, that comes from training, research and innovation.

- Q96 **George Freeman:** The good news is that my successor, Patrick Vallance, has, in my view admirably, set out three principles: blue sky, which is there to win prizes and be world class; R&D, which drives growth; and strategic sovereign international geopolitical security investment. The Haldane principle is being rewritten, in my view rightly. I think the door is open for the agri-tech sector to make that case.

Dr Clarke: Absolutely.

- Q97 **Adam Thompson:** Thank you for joining us. Following on from the discussion you just had with George, looking at the international and innovation picture, do you think there are any particular lessons we can learn from the international picture when we talk about innovation ecosystems?

Dr Clarke: I am very persuaded by the Australian model where groups get together. It brings together the industry, research as well as government to talk about what the industry challenges are. It comes back to mission-led R&D. It is very hard to argue against that. They have CRCs—forgive me; I cannot remember what the acronym stands for—across a number of agricultural outputs: plants, livestock, including even niche crops. I think they also have one for precision fermentation. That is where you get the right people in the room together, deciding the research that needs to be done. In the UK, we have had some examples of that. BBSRC would run research and technology clubs which were bringing the industry together, setting the challenges and defining what the research needs were. Then academics would bid into that. I am persuaded by the Australian model. It is not necessarily perfect or entirely cookie cutter for the UK, but setting the North Star for what we want to achieve and everything else falls under that.

- Q98 **Adam Thompson:** Are there any innovations beyond that Australian model? Let us say we port that over here. Is there anything you would change in that?

Dr Clarke: Obviously, context is everything. We are looking at much smaller geographical markets. If there is a criticism, because of the scale of the country and market it is difficult for some of those to work together. AHDB came together to try to reduce the silos between the different sub-sectors within agriculture. It is hard to do that as you get big and you have very many of those. In the UK, we would be well placed to be able to have those much leakier silos between the innovation pieces for beef and pork, dairy and even crops.

- Q99 **Adam Thompson:** Paul, what are your thoughts on this?

Professor Behrens: First, I want to clarify what I meant earlier when referring to vested interests. These are largely US and Brazilian interests



that are providing the misinformation; it is JBS as an industry association surrounding meat, rather than some of the crop industries.

As for the countries that do this well, the Dutch horticultural sector is extremely science and innovation-dependent; it is extremely developed. There is no reason why we could not have something similar here. This is a national strategic output that they have driven through the years. The other key one is the Danish plan. They now have unity of purpose around eating more plants. They do not mention anything about reducing meat. It is not about reducing meat; it is about eating more plants. They are putting hundreds of millions of euros into developing that unity of purpose towards that outcome. As a country at the sharp end of existential angst around climate and environmental problems, that was where they looked. There is investment in 15 high-protein crops identified as suitable for the Danish climate; there is investment in seaweeds and the blue foods just mentioned; there is investment in facilities, including shared facilities, where people can experiment and develop. That is a really good example. The Swiss are now developing their own nutrition action plan which is starting to look very similar.

Q100 Adam Thompson: Going back to some of the points made earlier in which I was interested, you advocated a global move to a vegetarian diet, but a few minutes later you said there was a possibility it could be a beef burger every fortnight and a piece of chicken per week. To clarify that point, do you think there is a sustainable future where everybody on the planet is still eating a bit of meat, but much less than they are now, or do you really think that a vegetarian globe is inevitable?

Professor Behrens: Absolutely. To be clear, I do not even advocate for a vegetarian diet; I am advocating for reductions. There is scope for having animals in the mix of agriculture. It is just that it has to be much less than it is today. Where that scope is varies across the scientific literature. The least I have seen is about a 30% to 40% reduction across Europe; the most I have seen is a 75% to 80% reduction. You can go even lower if you want to from a health and environmental perspective.

Q101 Adam Thompson: Thank you for clarifying that, Paul; I really appreciate that.

I want to look at the farming profitability review as well. Belinda, the conclusion of their review was that in the UK too much funding went into research that was not aligned with business needs, or did not necessarily have practical application. Is that something with which you agree?

Dr Clarke: Certainly the feedback we have from farmers and end users is yes. Do I agree with it? I used to sit on the council of BBSRC. There is a constant conversation about the balance and who decides what research is done. Going back to the mission idea and what has been going on with AHDB as well, the levy board had a vote. There is now no R&D funded by the levy board into potatoes and horticulture. That is leaving a vacuum. We are looking at a change in the way research is mandated and funded,



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and what research is done. There is a different conversation about who decides how that meets the needs of industry and business, and addresses the growth agenda.

Q102 Adam Thompson: Touching on the point George made a few minutes ago, particularly focused on Minister Vallance's renewed interest in blue sky, shall we say, do you think that if we focus completely on profitable research, as it were, there is a risk that agricultural research leaves behind some areas because they are not likely to be profitable, even though they could be in the future? Is that a problem? If it is, how might we address that?

Dr Clarke: That is a major risk. One thing on which UK excellence was predicated was our excellent research base, punching above our weight. Agricultural research has always been the slightly poorer relation of medical research, for reasons we probably all understand. Again, the importance of that fundamental research engine and pipeline still being fed is absolutely critical. There is a balance to be struck in ensuring that there is also application and demonstration of impact of that research in such a way that taxpayers can see the return on investment and that the conclusion is not just that we need more research.

Q103 Adam Thompson: How can we as legislators ensure that balance is correct?

Dr Clarke: We need a different system for mandating and deciding what research is done. It should not be based on who can fill in a proposal most effectively. I am sorry to be so boring about sector missions, but the sector mission gives us the envelope within which you then start to have all those conversations about what are the priorities within, say, the lamb sector. When George Freeman goes round the world as a trade envoy talking to people about apples and pears in India, as mentioned in the Batters review, what tools can we give him based on the research that has been done to support that agenda? It needs to be more strategic and joined up. I am conscious that these are buzzwords, but this is not rocket science.

Q104 Dr Sullivan: To follow on from that, at the moment to apply for grants you write a report or proposal. What would be the alternative to that?

Dr Clarke: Golly! There has to be some justification obviously of the business case and why you are the best research group or company to do that piece of work. Of course, there has to be an application process and ongoing monitoring. The review and assessment process is not perfect. I do not wish to throw darts at any particular organisation necessarily, but reviewers tend not always to be briefed as well as they could be, having the expert knowledge or understanding the drivers. Why are we funding this piece of research? Is it because it is very interesting fundamental research, or is it because farmers in Norfolk will be keen to see it happen? I know that funding agencies have experimented with different ways of asking people to apply for funding, with videos and all sorts of



alternatives. Without a more strategic direction of travel as to what “good” looks like, it is quite difficult to come up with alternative mechanisms.

Q105 **Dr Sullivan:** Paul, what do you think?

Professor Behrens: Of the grant mechanism? Ultimately, we have a lot of costs in producing and going through the grant process. There are models, for example in New Zealand, where you have two and three-stage processes and you put down your thoughts in a briefer context, which then allows for a quick filtering process. Then you can move towards greater depth. On the difficulty with blue sky and deployment, of course we need both. We cannot underestimate the importance of some of the blue sky research, for example things like nitrogen-fixing cereals, cereals that will be more resistant to climate change, and even some of the photosynthetic efficiency improvements of crops.

One other area I would like to highlight is that in the energy system essentially we saw technologies come down in cost and innovations continuing to accelerate through deployment. So, once we are at the stage where we can start to deploy things, we should deploy and learn through that. That then brings up questions about farmers’ capacities to afford these technologies and their bandwidth to take on more debt to finance them.

Chair: Your questions are partially for Innovate UK as well as perhaps for the Treasury and maybe even the National Wealth Fund. Thank you very much. We are over time but we have some important subjects to go into. I hope we can continue for, say, another 10 minutes. I will bring in Allison.

Q106 **Dr Gardner:** I have quite a long list of potential questions, so I will try to bring it down neatly. The evidence that we have received clearly outlines the many benefits that AI and digital tools can give to the agricultural system. I found it quite interesting that we had quite a significant amount of evidence regarding the risks and the concerns around that—issues such as big ag dominance and smaller farmers losing control of their data. Even the World Bank’s Agriculture and Food Global Practice raised the issue that this is dependent on data quality and availability, as always with AI, and that not every agricultural challenge requires AI; sometimes, simpler solutions should be considered. Balancing the benefits and the risks in your responses, when we talk about AI and digital technologies transforming agriculture, what does this mean in practice?

Dr Clarke: At the Oxford Farming Conference last week, the debate was that, in 90 years, farming will be a one-day-a-week job thanks to AI and digital tools. They lost that motion, but it brought out a lot of these issues. Regarding the data analytics, you are right that it is not yet consistent enough to be able to be reliable. AI is not yet where we would like it to be. However, the thinking is now that AI will enhance human input, not necessarily replace it completely. It will increase efficiency. It



will give new insights. There is a lovely example in America of some strawberry growers using AI weather data. The AI came up with an insight that no agronomist could understand, and it had taken into account wind speed. The agronomists, the humans, would have had no sense of what that was, but, on looking into it, it was affecting pollination rates. As ever, with new technologies come new risks and new responsibilities. I do not know how one would legislate for that. I can see that, using AI for machine vision, robotics, understanding, precision agriculture, better inputs and designing new crop inputs from the ground up, AI is going to transform our industry. It may be that we just have to work out how we do this responsibly.

Q107 Dr Gardner: On how we work out how to do it responsibly, we have seen AI used in other sectors, and there is plenty of evidence of how we can establish ethical and legal frameworks to support that. What financial, regulatory and governance mechanisms would be able to deliver the benefits of agricultural innovation? How would this be managed, particularly in trying to balance small and medium-sized farms against the bigger corporations to make sure that we have that balance of power?

Dr Clarke: For the whole data governance and AI, you would need an expert on that, somebody from Farm Data Principles. That is a bit beyond my zone of expertise to answer effectively.

Q108 Dr Gardner: You nodded, Professor Behrens. Do you have a comment on that?

Professor Behrens: I just add that we are mostly talking here about machine learning happening on the fields, and this is a data issue. Running the machine-learning algorithms is not a very advanced thing to be able to do. What is important is the data. Where a lot of this concern comes about is the hogging of data which allows for these models to be produced. If there are co-operatives for data holding, and regulation and legislation about how farm data is kept and pooled—it is the pooling of the data across multiple farms that is important, because you need a lot of data—these are ways in which we could encourage the innovation of the system so that data is more available across multiple different groups, and then you are not looking at a concentration, which is what a lot of people are worried about.

Q109 Dr Gardner: That is a good example of the FAIR principles, which are findable, accessible, interoperable and reusable. They are different types of FAIR principles from those I am used to as an AI ethicist. I am conscious of time, Chair. We touched on funding, how we can scale up and protect the farmers and food producers. I noticed in CropLife's submission that it said that the funding system for start-ups to develop these technologies favours proprietary subscription-based solutions and that regulation in this space is required. I do not quite understand. Is that a negative? Going back to this, I worry about vendor lock-in and big farm corporations locking in smaller businesses via these systems. Could you



comment on that funding system?

Dr Clarke: I think it is. Innovate UK funding requires as part of its assessment process what your proprietary protection is for your technology or innovation. It is considered to be a benefit when it comes to public funding. In the companies that we work with that have private funding, investors have been very keen on subscription models because subscriptions generate revenue. That is now starting to get some pushback from farmers, who are saying, "Actually, we don't want more subscription models." With the data sharing and data trust, we are not there yet. I am quite excited about what the potential for distributed ledger technology and blockchain could be. We had some examples of this with Unilever and the tea industry in Malawi. I think that was in 2017. There is the potential to be able to use data technology and blockchain much more effectively. Farm Data Principles has made great progress in a relatively short space of time, but it is struggling to gain widespread industry traction. If that was mandated, that would help.

Dr Gardner: I will leave it at that in the interests of time.

Q110 **Chair:** Thank you very much, Allison. Can I just clarify, Dr Belinda Clarke, that in your responses you are advocating the widespread take-up in this country and globally of AI and digital technologies—

Dr Clarke: I am.

Chair: —but your organisation does not have a position on how to make that ethical and fair?

Dr Clarke: We are an independent, not-for-profit membership organisation. We are not a lobbyist. I have opinions, but that is not part of our mandate as the company that I run.

Q111 **Martin Wrigley:** Bringing it all round in a circle and thinking about climate change and sustainability, we talk about big fields. I imagine this massive field in Norfolk with tractor cabs feeling like the Starship Enterprise when you get into them. I visit small farmers in Devon who are struggling on a day-to-day basis, and I hear of yields and crop failures, and the yield this year being the worst ever and all the rest of it, with wet parts of the year when it should not be wet and summers too hot. Are we making enough difference on the ground fast enough to have our farming industry survive beyond the big boys with massive bucks who can have the Starship Enterprise in Norfolk?

Professor Behrens: That is a very good question. Ultimately, we are not moving fast enough. Climate change is moving fast and outpacing our ability to cope with this and to help people deal with these changes. We know that the adaptation plans that the Climate Change Committee came up with are only partially implemented. Those adaptation plans are extremely important for farmers, as you just mentioned. We are not giving farmers as many options as we possibly could, given the way in which we know the food system will have to change over the next few



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years because of not just climate change but also biodiversity loss. I mentioned the land use issue. We currently cannot make many of the targets for land, biodiversity and the assumptions that we will be able to draw down carbon using bioenergy with carbon capture and storage, because we simply do not have the land for it. Again, it comes back to this question. In my view, what should eventually happen is that farmers would have a greater diversity of options in how they would like to engage in this new world being shaped by the climate change brought on us.

Dr Clarke: I would agree that the rate of adoption is not fast enough, but I do not think the scenario that you paint for the future is entirely addressable through adoption of technology. There are a lot of other issues around land ownership and availability. Giving small farmers access to all the technology they need is not necessarily going to mitigate against the scenario that you discussed, but we need to be much better at adoption. I pay tribute to the Farming Innovation Programme, which has been quite a visionary way of bringing technology to farmers, and the Farming Equipment and Technology Fund. It is clear that government has heard the need for and importance of upskilling farmers in their availability of technology. The second part of your question is a slight non sequitur around availability of tech.

Q112 **Martin Wrigley:** Okay. So what do we need to do?

Dr Clarke: To?

Q113 **Martin Wrigley:** To move forward; to save our farming; to have a viable industry that is adopting tech sufficiently and is doing things in the right way so that we are surviving. In Cornwall, we have just seen the most devastating storm in a long while. The rest of the country seems to have largely ignored it. Cornwall was ripped apart. I have just had a video from my daughter. Bits of my house are falling off because the wind is blowing so hard in Devon. Who would guess it from London?

George Freeman: In Norfolk, we are having field fires and flooding—even in Norfolk.

Q114 **Martin Wrigley:** Even in Norfolk. Look at water projections. Four of my main towns are projected to be largely underwater in 2050. We have some dire projections going forward if we do not move farming more quickly now, so what do we do to move it?

Professor Behrens: I am sure there are lots of different visions that would work for the future, but I will give one. By 2050, we will have shifted towards healthier diets for ourselves. It does not mean vegetarian, vegan or any of these things; it just means more plants. We will have saved a large amount of land, and that land now is producing food in very environmentally sustainable ways, organically—all the different ways you might want to implement food change. We will have less but better meat. That is able to absorb the damage from climate change, because we know that natural lands around these farming lands



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are better able to absorb the flood water risk, which is the biggest risk that we have in the UK, are more drought resilient, etc. Those fields can then be productive. On the side of that, we also then have the science and technology coming in. We have precision fermentation, which is agriculture in controlled environments, which is less risky in terms of climate change. We have some vertical farming that is producing micronutrients. We have a system where, if we need it because we have an acute food crisis, we could even start thinking about using fermentation or other facilities across the UK in breweries or other infrastructure to produce further food if we need it in that year. In this very scary future where we are looking at these climate impacts, you have a resilient agricultural system across the UK. That is one vision. You could have all sorts of disagreements with that, but that is one way in which you could try to make things work.

Dr Clarke: I would also go back to, "What future do we want?" If we are looking forward to 2050, is the expectation that everyone who is farming now will continue to be farming? That might be a flawed vision. There will be some who leave the industry, and that is probably right, proper and appropriate. Those who want to stay in the industry obviously need to be supported to be as productive and as environmentally sustainable as they possibly can be. "Public money for public goods" has a really key role in this conversation, but we need to start with what the vision of the food system is and then see where farming and land-use management sit underneath that. We need to support the industry that we have, but within the context of the vision that as a nation we want and expect to have.

Q115 **Chair:** Thank you. Thank you, Martin. Those are concerning comments with regard to employment within farming. We will let you go in a moment. To crystallise that, currently the UK produces 75% of its own food. Can you each say in 2050 what estimate of our food security would you make?

Dr Clarke: I think it has dropped to 68%. Was that not in the Batters review most recently? It is dropping. I do not think it is for me to say what it should be for the UK.

Q116 **Chair:** You said we want to set out our future and where we want to get to. Where would you like to see us get to?

Dr Clarke: In terms of the proportion of UK domestic food production?

Chair: Yes.

Dr Clarke: I would like it to be higher, absolutely. I would like the farmers who are farming to produce more food, in line with the outputs from the 30:50:50 vision. We absolutely need those who are farming to be as productive as they possibly can be. There is a farm opposite my house, and they had a tonne an acre—

Q117 **Chair:** So higher than it is now.



Dr Clarke: Yes, absolutely, and using the tools that we have been hearing about.

Q118 **Chair:** Do you have a figure for me?

Professor Behrens: It is hard to put a figure on these things because we work in global markets—but higher. The other thing that I would mention is that we have perhaps two to three weeks of food stockpiles in the UK. In Finland, they now have nine months.

Q119 **Chair:** You said that we should be having half a beef burger a week, but you cannot say what you think our food security should be.

Professor Behrens: You could say it should be 100%. That is one option that we can have, but there are costs that come with that economically.

Dr Clarke: And socially.

Professor Behrens: Yes, and socially.

Chair: Thank you. We have overrun. It has been fascinating listening to your vision for the agri-future and how science will play its role. Thank you very much for your contribution today.

Examination of witnesses

Witnesses: Tom Allen-Stevens and Peter Setimela.

Chair: Welcome to the second panel in our Select Committee session on science and global food security. We are joined by two new witnesses. I ask them to introduce themselves when they respond to the first question that is asked of them. I go to Lauren for the first question.

Q120 **Dr Sullivan:** Lovely. Thank you, Chair, and thank you both for joining us today. We are trying to understand experiences and views on tech in farming. First, can you briefly introduce yourselves, the work that you do, and tell us about any emerging technologies that you think are having a big impact on the farms that you work with? I will go to the people in the room first, and then I will come over to you. Thank you, Peter. Over to you, Tom.

Tom Allen-Stevens: First of all, thank you very much for inviting me. It is a huge privilege to come here to represent my members. I am a farmer in Oxfordshire. I also lead the British On-Farm Innovation Network. We have about 3,500 members, of whom about 800 are pioneering farmers. We are also involved in five Farming Innovation Programme major projects, four of which we are leading. We have about 100 farmers now doing on-farm research as part of those projects.

Two areas that I think are really exciting that we can lead on in the UK are precision breeding and AI. Thank you very much, by the way, for the enabling legislation that you helped get through with the Genetic Technology (Precision Breeding) Act. It is a fantastic piece of legislation,



and enables us to bring that technology out of the glasshouse and into the field. You had Cristóbal talk to you previously. The work that his lab is doing is absolutely mind-blowing in terms of the physiological aspects of wheat that they are manipulating and what they can do in those labs. I have been to see his technology. I have talked to Cristóbal. I go slack-jawed in amazement at what I see. I want that technology on my farm, and so do our farmers. Just to introduce you to them, they are pioneers; they are not just ordinary farmers. They are enthusiastic and curious about new technology and how that works on farm. That is not necessarily answering your question, Lauren, sorry.

Q121 **Chair:** Could you answer the question? We love your enthusiasm, but we are short on time.

Tom Allen-Stevens: Sure, absolutely. It is the physiological traits that are really exciting. With precision breeding, you can get to some exciting changes that can happen. We need to see how those work on farm. The other aspect of that is the traits that relate to soil. There is some really good work going on at the Crop Science Centre looking at the relationship between plants and arbuscular mycorrhizal fungi. Our members are so enthused about what is going on in the soil. We know so little about it, and we now have the opportunity with the new technology coming forward to understand so much more, and that is what is valuable. Can I talk about AI?

Chair: Briefly.

Tom Allen-Stevens: We heard quite a bit about AI previously. It has been estimated, by the way, that there are something like 10 million trillion trillion different combinations of decisions that need to be made to take a food product from seed to supermarket shelf, and farmers are responsible for quite a large part of that. There is no way a farmer can make the right decision in every aspect to get the most nutritious, healthy, environmentally friendly and so on food to market. AI can be so empowering in enabling those decisions to be made. Our farmers are gathering a wealth of data on their farms. The big thing that comes back to us is, "So what?" They need that data interpreted. At the moment, the only way they can do that is through experts, agronomists and so on, and that is time-consuming and expensive. The opportunity with AI is to automate that and make a lot of those decisions easy, empowering and so on. That is where the opportunity lies. Obviously, it is a nascent technology at the moment, but there is so much opportunity to empower farmers through AI.

Q122 **Dr Sullivan:** It is very exciting. Peter, do you have some other very exciting things that are happening?

Peter Setimela: Good afternoon, everybody. My name is Peter. I work for CIMMYT. CIMMYT is the International Maize and Wheat Improvement Center. We work on maize, wheat and dryland crops like sorghum and millets. I am based in Zambia. I work with smallholder farmers. What has



been really exciting in our area is developing those drought-tolerant crops such as maize, which is a staple food, and building some of the resistance to diseases. We have been fighting new pests such as fall armyworm, which came from South America into Africa and has been moving. It is only recently that we had a breakthrough. We have some tolerant varieties. Although they are not 100% tolerant, they reduce the use of pesticides and so forth.

In terms of drought, we found that, when we had an El Niño two years ago, the varieties that we developed were able to give farmers at least a 30% yield compared to the other varieties that were in the market. Based on that, they were able at least to give more food to the smallholder farmers we work with. At CYMMIT and CGIAR, there has been a lot of innovation, especially when it comes to gene editing, so that we can quickly develop varieties that are disease-resistant and pest-resistant, and to improve nutrition. Those are just some of the few exciting things that we are doing.

Q123 Dr Sullivan: Lovely, thank you very much, Peter. Thinking in the next 10 years—and I suppose the new technologies that you both described are moving incredibly quickly—are you both excited about the AI prospect, or is it the precision? Is there anything else that you are most excited about in the next 10 years?

Tom Allen-Stevens: Just reining back a little bit, the one thing that I would like to see greater recognition for is the role of the pioneering farmer within this. Everyone talks about productivity growth being very sluggish and so on, and that farmers do not take on new technology. It is not that they do not take on new technology, but it is a big step for them to make a change in their system. You do not know what the outcome of that is going to be. It is the role of the pioneering farmer to introduce that, but that role is not recognised, and that is the single biggest problem that we have in getting new technology on to farm.

Peter will agree with me on this: farmers learn best from other farmers. If they can see a productivity change working well on another farm, they say, "Okay, I'll try that on my farm." There is so much research to back that up. You still need those first farmers to make that step, and that is not recognised. There is no first-mover advantage in farming. There is no incentive for those farmers to make that initial change. That is the change that we need to make over the next 10 years—to recognise the role of those pioneering farmers. Go a step further as well: let's involve them in the fundamental research towards those technologies; let's look at precision breeding. Rather than waiting until there is a product on the market before you introduce it to farmers, involve them in the trait development of those precision-bred crops. That is what we are doing in two of our projects, and our farmers are really looking forward to getting precision-bred crops on their farms.

Q124 Dr Sullivan: Wicked. When you are talking about that recognition for pioneering farmers, in an ideal world what would you want to see



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supporting those pioneer farmers?

Tom Allen-Stevens: First of all, funding. It goes without saying. No one pays farmers to do on-farm research. It is not a recognised thing. In fact, people have said to my face, "Farmers can't do research." I can tell you that they can do research. We do it. We do it successfully. They do it far more and, in some respects, far more effectively and efficiently than professional trials technicians. That should be recognised. Actually, to be fair, government has recognised that. With the Farming Innovation Programme, farmers are now being paid to do on-farm research through our projects. There is also the ADOPT fund. It is also giving them that sense of purpose that they are delivering a public benefit and a common good. I would say to the people in this room that it is your role. You can do that. It is your gift to do that.

One thing that we have struggled with—although DEFRA funds them to a large extent—is getting DEFRA involved in the projects. We have a conference next week, and we have struggled to get anyone from DEFRA to come to that conference, which I think is a real shame.

Q125 **Chair:** We will make sure that it gets that message.

Tom Allen-Stevens: You all have constituents who are doing on-farm research. I can put you in touch with a farmer to bring you on to their farm to see the work that they are doing.

Q126 **Dr Sullivan:** That is amazing. My last question is for you, Peter. What role are mobile and digital technologies having in Zambia?

Peter Setimela: We have to realise that, where we are, we have commercial farmers who have access to extensions. They have the internet. We have smallholder farmers who do not have smartphones and the technologies that farmers in the developed world have. Slowly, we have been moving to where we are now using mobile phones—not a smartphone but messaging. We have been sending messages to smallholder farmers. They can use their mobile phone to access markets. They can get information on early-warning systems to tell them what the weather is like. Using some of those mobile technologies during certain times of the year, the farmer can dial in, and through that the farmer can have different options. If he dials a certain number, it asks, "Which area are you in? What varieties are you interested in? What is the area?" Based on that, we can use some of those mobile technologies to give farmers information about variety and fertiliser choices, and so forth, for the area in which they are based.

Dr Sullivan: Fabulous. Thank you very much, Peter. Back to you, Chair.

Q127 **Chair:** Thank you very much. Apologies for my mobile phone, which was on "Do not disturb", but obviously knows something that I do not about the caller. Just to follow up on Lauren's questions, it is fair to say that we heard a very rosy picture of the contribution of technology—both precision breeding and AI—to food security in the UK and globally.



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Particularly, we heard how mobile technology is making such a difference in Africa. Could you both—and I will come to you first, Peter Setimela—say what the three key barriers are for farmers adopting precision breeding and AI?

Peter Setimela: One of the barriers is information. Some of the farmers do not have information, smartphones or the income to access AI as in other areas where you have big commercial farmers. They can access some of the AI. When you talk of precision agriculture and fertiliser, some of those barriers are more to do with gender. We find that within a household only one person has a mobile phone or smartphone. It is sharing of that mobile technology. Also, data is quite expensive in some areas in Africa. There is that limitation on data.

Q128 **Chair:** Following up on that, we have not heard very much from the previous panel with regard to issues around, for example, soil health and sustainable fertiliser. Do you find, Peter Setimela, that you can encourage greater productivity in areas such as soil health through innovation or technologies? What kind of innovation and technologies are they?

Peter Setimela: Thank you for that very important question. In Zambia, a subsidy programme was giving farmers fertiliser, but it did not matter which part of Zambia they were from. If they say, "Okay, each farmer gets two bags of fertiliser," that is a blanket recommendation across the whole country. Now, with AI and a bit of technology, you can have very simple tools that you can use to identify the amount of fertiliser required in a certain area. Slowly, slowly, farmers are having access to that, where they can get information about their field much quicker. Before, it used to take almost three months for a farmer, once he took a soil sample and sent it to the lab, to get the results. By that time, it is already too late for the farmer to use that information. Now, with AI and collaboration with other institutes, farmers can slowly have access to that information where they can get the results very quickly and use that information.

Q129 **Chair:** Thank you. That seems like an excellent example of a low-tech application of a high-tech service, AI, to provide the support for farmers that does not involve—what did you call it, Martin?—having a spaceship in your fields. Thank you for that.

Tom Allen-Stevens, what are a couple of key barriers to adoption of technology?

Tom Allen-Stevens: First, one thing that we are doing within one of our projects is trying to find out farmers' views on precision breeding. Interestingly enough, no one has actually bothered to find out how farmers feel. There has been no research done. The only surveys that have been done on it are what we have done previously, so we know pretty well how our farmers feel about precision breeding. The nervousness is naturally about market. Will they be restricted from supplying the market? Will there be the GM issue and so on around it,



which is currently still very relevant? Engaging them in precision breeding is really tough. We are trying to engage our farmers and all farmers in the discussion to put their views forward on precision breeding. They do not feel part of the conversation at the moment.

Q130 **Chair:** That is one of the barriers to taking it up.

Tom Allen-Stevens: Yes.

Q131 **Samantha Niblett:** We had an incredible session before your panel, as well as slightly scary in parts, talking about the reduction of land and the fact that we have to use technology in a very clever way. I want to talk about how government can support farmers. You mentioned already, Tom, the Farming Innovation Programme. It is a slightly loaded question, I suppose. I have some incredible farmers in my constituency of South Derbyshire. I have one farmer in particular, John Davison, who farms potatoes for Walkers. He has diversified into chicken farming and has an AD plant. One thing he said is that technology is so important for farmers but the ability to adopt is not made easy.

Some of my colleagues in the previous session talked about how we can make sure that farmers are at the centre of this. This is a lifestyle. Farmers have farmed for generations. Then we have the likes of Dyson, who has thousands of acres of land and looks at farming more as an extension of manufacturing. What do you think some of the risks are to farmers with technology and lack of ability to adopt technology, not least because of costs and some of the things that you highlighted already, Tom, around the fact that you need pioneer farmers? We have pioneer farmers, they are just not recognised by government. That is a rather long way of asking you: are there sufficient incentives in the UK for farmers to adopt innovative technologies? How can we make sure technology does not end our farmers?

Tom Allen-Stevens: First, the ADOPT programme that has been introduced is fantastic. There are one or two teething problems with it that need to be sorted out, but it is really good. One reason it is good, by the way, is because DEFRA sat down with the Farmer-Led Innovation Network, of which BOFIN is a part, and it co-created ADOPT with us. When it introduced and launched it, we were so surprised that it had actually taken on board all our recommendations. That puts the farmer right at the centre of the research programme, so it answers the first part of your question.

By the way, don't dismiss what Dyson Farming does. It does some incredible research on behalf of all farming. It now has its own research farm—it is mind-blowing—that is totally dedicated to research. Some of the stuff that it is doing that we can all learn from is brilliant. I would not dismiss what it does.

Going back to why farmers are reluctant to take on new technology, it is because our cycles of understanding what a change in farming does are so long. As an arable farmer, if I make a change or two within my arable



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system, it is not until harvest that I get the results of that. If I am a widget maker, I can make a change in the morning and I will know by the afternoon what the effect was. That is why farmers are so reluctant. They have to be certain. The AHDB has done a lot of research on this. The vast majority of farmers are theorist learners. They need to see it working. They need to have the confidence before they step into a new thing and before they will take it on to their farm. There is a lot of work going into how we encourage those theorist learners. There is not much activity looking at the activist learners, the risk-takers and pioneers who will make that first step in the first place. Those are the people we should support because they are the ones who will bring in the rest.

Q132 Samantha Niblett: As a quick extension to that, we also heard in the previous session that, in the main, all this stuff sits under DEFRA even though farming is in the industrial strategy under agri-techs, one of the frontier technologies. Do you see any obvious negatives with farming mainly sitting under DEFRA and perhaps not sitting so much under DBT? Would there be an advantage to it?

Tom Allen-Stevens: I am not entirely sure that I am really qualified to answer that, as long as there is a Government Department representing farmers and it has our back. In recent years, DEFRA has been doing a really good job of recognising farmers' role in research, innovation and so on, and recognising that pull-through of technology. On the question asked of the previous panel about the balance between fundamental research and applied research, DEFRA has played a very good driving role in saying, "No, you must get that research on to farm," and has been mandating it in the research programmes it has been funding. It is doing a good job. ADOPT is only £20 million-worth of funding. Let us have more funding in that. It is so oversubscribed. There are some brilliant schemes coming out in ADOPT. Let us get more money into that.

Let us get more farmers involved in the Farming Innovation Programme. One big aspect of the Farming Innovation Programme and the Innovate UK funding is the amount of bureaucracy involved. Any farmer who has tried to deal with Innovate UK directly has come across that bureaucracy, and it is a toxic environment for a farmer. I am not saying, "Don't fund the farmer," but let us have something in between Innovate UK and the farmer so that the farmer can get on with doing the job of innovating without having to worry about all the blasted paperwork and reporting that Innovate UK requires.

Q133 Samantha Niblett: It is not just unique to farming, I have to say. Thank you so much, Tom. Having spoken about government supporting you, Peter, how do you work with government, private sector and other partners to support uptake or scale-up of novel technologies?

Peter Setimela: Thank you for that. As CGIAR or CIMMYT, we develop the technologies, but we do not have a mandate or we cannot scale those technologies. This is where the private sector comes in. When we develop a new technology, we will license it to the private sector depending on



the technology or the crop. That technology or soil is now given to the private sector for it to multiply. Most of the time, you find that most of the small, emerging seed companies do not have breeding programmes or technology generation, so they depend on us to generate the technologies that they can now take and scale out to the farmers. In terms of seed, sometimes we provide them with breeder seed so that they can move faster to scale that particular technology. In terms of scaling, we help the farmers and we help seed companies to do the on-farm testing, because some of the small seed companies do not have the capacity. We also work with the Government, because the Government have the people and some of the infrastructure, so that we can move with them and work with them.

What is lacking in most of government is that you have one extension officer for 2,000 smallholder farmers. We have to find an innovative way—for example, with mobile technology or AI—to reach more farmers. It is important that we do this on farm so that farmers can learn from other farmers in terms of the technology to be scaled out.

One stumbling block is the funding. You find that most Governments do not invest a lot in research. They do not have the funds to go out and showcase those technologies. We depend more on donor support. We depend more on some of the donors who will help or they will pick a certain technology and say, "Okay, this is a good technology. Can we work together with the private sector?" Now we are pushing the private sector to say, "Okay, if you are actually making money or profit, can we work together so that we can reach more farmers?" Since it is the private sector, it is more profit-driven. It is more likely to reach out. We find that the technology becomes very expensive if it is only one company promoting that technology. If it is four or five companies, they can compete and it becomes much easier for them to reach because of the competition that the market is creating. The Government really want to reach out to more farmers, but the stumbling block or the barrier has always been funding, because there is always that competition for health, agriculture and so forth.

Samantha Niblett: Okay, thanks, Peter.

Q134 Chair: Thank you very much, Samantha. On the question that was asked of Tom, are local farmers enthusiastic about precision breeding and AI? Are they aware of it? What is the attitude of farmers in Zambia, and particularly smallholders, to these technologies?

Peter Setimela: Yes, commercial farmers are enthusiastic, in terms of precision and testing new varieties. The problem with smallholder farmers adopting the technologies is that, first, they look at food security. They say, "Okay, this is my field. If I grow so much maize or corn, will I be able to feed my family? Is it worth taking the risk of change? At the end of the season, am I going to have enough to be able to sell and be able to send my children to school?" Slowly, yes. For example, we have been able to give farmers AI where they can identify different diseases in the



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field. They have been able to send in information to identify certain insects that they could not identify before. Just taking a picture can now generate information about the pests and about certain things in their fields. For commercial farmers and precision agriculture, yes, because that helps them in terms of fertiliser, how much to apply, what to use and how much water to apply to their crops, because they are trying to save money so that the system is more profitable for them. In Zambia, we have smallholder farmers and we have commercial farmers. You find that that divide is like day and night.

Chair: Okay. We only have a few more minutes. Thank you very much for that, Peter. I want to focus on the ethics and potential inequalities of technology in agriculture. Daniel, would you like to come in?

Q135 **Daniel Zeichner:** Certainly. Are innovative technologies useful for and accessible to farms of all sizes? Is it only for the bigger farms? If not, what would be needed to be done to change that?

Tom Allen-Stevens: First of all, it is lovely to see you here, Daniel.

Daniel Zeichner: Apologies for being so late.

Tom Allen-Stevens: Thank you very much for the enabling legislation that we have just been talking about in terms of the Genetic Technology (Precision Breeding) Act and ADOPT.

To come to your question, my experience is that size is not a limiting factor—for pioneering farmers at any rate. We have some very small farmers as well as very large farmers who are helping us in our trials. It is not down to size. It is down to the enthusiasm and the thirst for curiosity that the farmer has as to whether they are engaged in new technologies.

Q136 **Daniel Zeichner:** Peter, what is your experience?

Peter Setimela: In terms of information for smallholder farmers, it depends on who is the household of the farm. You find that if a farm is owned by a man, he is more interactive and can get more information. If it is a woman farmer, you find that access to information is a little bit more delayed compared to men farmers.

Q137 **Chair:** Why is that?

Peter Setimela: Because men are more interactive. They interact with other people. There is that gender barrier within the farm systems.

Chair: We are running out of time, and that is a big subject that we may well want to follow up on, Peter.

Daniel Zeichner: It is. I suppose it shows that it depends on context, does it not?

Chair: On the context, yes.



Q138 **Daniel Zeichner:** What would give you reassurance that the balance of power between the small farmer and the big organisations could be corrected? I am looking at you, Peter.

Peter Setimela: Commercial farmers are more profit-driven. They want a way in which they can maximise their production, while a smallholder farmer is looking more at food security and saying, "Okay, if I have this, will I be able to feed my family?" In terms of the markets, you find that commercial farmers are more market-driven, while smallholder farmers have less access to markets. If you take the smallholder farmers, the quality may not be there for them to sell their produce to the market. So we have been trying to say, "Okay, smallholder farmers, can we aggregate your production so that we can help you find the markets?" Either through mobile phones or AI, they can now have some of the access to the markets.

Daniel Zeichner: Thank you. I have a final question for Tom if we have time.

Q139 **Chair:** We are running out of time, but we are very interested to know, given the concerns expressed by many, including Government Departments in their submissions to us, how we can ensure that small farmers can retain access to technologies and control of their data as technology is adopted.

Tom Allen-Stevens: The technologies that are coming through—we have heard about it from Belinda—are very enabling for small farmers. What you can do with a mobile phone on your farm these days is fantastic. One thing that we should bear in mind as technologies adapt, evolve and so on is that farmers are very wary of being held to ransom by technology. If precision breeding was rolled out only in hybrid crops, that would be a problem for a lot of farmers. A lot of farmers like hybrid crops and they like paying the premium for hybrid crops. They can see the benefits from that. There are a lot of farmers who do not. There should be that ability to access new technologies through your preferred route. If you look at the way hybrid technologies have been rolled out in the UK, there is still a big chunk of the market that is conventional.

It is the same with data. If you have a large combine company that ties up your data and does not give you access to it, that is a problem for farmers. Farmers do not mind necessarily paying a fair fee to get their data released, but they do not like to be held to ransom for it, and that is a crucial factor as we go forward. As we get more and more data coming out from farms, we do not like to feel that we are being held to ransom.

Q140 **Chair:** Peter, what can we do to ensure that particularly smallholders retain access and control of their data?

Peter Setimela: It is very difficult, especially for smallholder farmers, because they do not really keep records in terms of data. It is only when we have on-farm trials that we give them data to say, "Okay, this is how your crop has been performing in the past year and so forth." It is only



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the commercial farmers who keep data, because they are more interested in how much fertiliser to use and what works well in terms of insects or pesticides. Also, they are looking more at the market. Smallholder farmers who have less than one hectare do not really keep any data.

Chair: Thank you very much. I am afraid we will have to leave it there. It is an absolutely fascinating subject. We have raised both the opportunities from technology and science in this country and abroad, and some of the challenges and the concerns which we will need to go into in more detail. For the moment, I thank you very much for joining us here and for your contributions.