HOUSE OF LORDS

Science and Technology Committee

Corrected oral evidence: Engineering biology

Tuesday 14 May 2024

11.30 am

Watch the meeting

Members present: Baroness Brown of Cambridge (The Chair); Lord Berkeley; Lord Borwick; Lord Drayson; Lord Lucas; Baroness Neuberger; Baroness Northover; Viscount Stansgate; Lord Strasburger; Baroness Willis of Summertown; Baroness Young of Old Scone.

Evidence Session No. 8 Heard in Public Questions 86 - 97

Witnesses

I: Graeme Cruickshank, Chief Technology & Innovation Officer, Centre for Process Innovation; Professor Nick Talbot, Executive Director and Group Leader, The Sainsbury Laboratory.

USE OF THE TRANSCRIPT

1. This is a corrected transcript of evidence taken in public and webcast on www.parliamentlive.tv.

Examination of witnesses

Graeme Cruickshank and Professor Nick Talbot.

Q86 **The Chair:** I would like to welcome our witnesses to this eighth session of the committee's inquiry into engineering biology. The witnesses we have for this session are Dr Graeme Cruickshank, the chief technology and innovation officer at the Centre for Process Innovation, and Professor Nick Talbot, an executive director and group leader at the Sainsbury Laboratory.

The session is being broadcast on parliamentlive.tv and a full transcript is being taken. This will be sent to you shortly after the meeting, and we would appreciate it if you could make any minor corrections and get that back to us quickly. Also, if you think of any data or any other information that it would be useful for us to have—or, indeed, you think of anything that you would like to have said but did not get a chance to—we would be very pleased to receive that after this session as part of our formal evidence.

Thank you very much again for joining us. It would be helpful if you could give a brief introduction to what each of your labs or facilities does, particularly in relation to engineering biology and considering the particular area of research where engineering biology can be applied. What are the applications that you think, over the next five to 10 years, will be the most important ones that you will be involved with in your labs and facilities? What potential barriers do you see to these applications coming into widespread use? If you could keep it brief, that would be great.

Graeme Cruickshank: Good morning. Thank you very much for this opportunity to have a conversation. I am here representing CPI, which is a catapult centre; it is part of the High Value Manufacturing Catapult. This year, we celebrate 20 years. We are the part that aligns most closely to what I would call the chemical and biochemical-producing and using industries. This is not exactly correct but it is easier to think about us as what is left of ICI. We were part of the cohort that was ICI; we were born out of the Wilton Centre, retaining some of those ICI assets there. Therefore, the spectrum of activities and materials that we support includes ones that used to be in the ICI remit: ICI fine chemicals became Zeneca, which became AstraZeneca; ICI fertilisers became CF, ICI Agrichem, became Syngenta. So all those spheres of play are where CPI supports.

CPI is, therefore, the custodian of national assets, in particular the National Industrial Biotechnology Innovation Centre at Wilton and the National Biomanufacturing Manufacturing Centre at Darlington. They are the two sides of the coin that I heard some of my

colleagues talking about earlier. Wilton is the larger-scale, slightly less sexy end of the spectrum of future foods, feeds, agritech-type materials and larger-scale industrial biotechnology. Darlington is the slightly more glamorous and attractive pharmaceutical end of biotherapeutics, from traditional recombinant proteins and adenoviruses through to more exciting new modalities leading to RNA; in fact, we have the RNA Centre of Excellence, which is a GMP-compliant facility, on standby for the UK's assets.

Our job is to help people scale up their process; it is not to invent and it is not to sell. Our job is to try to do that hard bit in the middle. Someone mentioned the ugly sisters earlier. We are kind of Cinderella: we have to sweep up, clean up and tidy the dishes, but we do not get to go to the ball. But that is okay, because that is our job. Our job is to help anchor these innovations in the UK, creating value for the UK.

I mentioned two sides of the coin. In terms of traditional sustainable materials, we expect future foods, novel proteins and agritech from bio-derived systems—things like nitrogen-fixating bacteria rather than creating fertilisers that run off the fields—to be the way we will generate the foods of the future. Equally, in the pharma or biotherapeutic space, we expect a range of new modalities, reaching into microbiome and phage-type capabilities, to be the force du jour in the not-too-distant future. I think that summarises who we are.

Professor Nick Talbot: I am from the Sainsbury Laboratory, which is at the Norwich Research Park. It is funded by the Gatsby Charitable Foundation—Lord Sainsbury's charity—a range of other agencies, government funding through the research councils, and European funding through the ERC.

We focus on plant diseases, so our research is tightly focused on trying to understand how plants succumb to disease and what we can do to cure them of that, using technologies such as advanced genetic technologies. Predominantly, what we are trying to do is introduce durable resistance into crop species. We do that based on an understanding of plant immunity then bringing in genes from wild relatives of those crop species or from other varieties; this produces durably resistant crops. There is huge potential in doing this: we can already produce plant lines with multiple resistant specificities. We do that for important crop diseases in the UK such as potato late blight, for instance. My colleague, Jonathan Jones, has produced a whole variety of different resistance genes that lead to durable resistance; indeed, he has produced a strain of Maris Piper potato that would prevent the UK having to spray 20 to 50

times per year in order to try to control late blight, which currently happens at a cost of £50 million to UK potato growers.

We are very much in the area that Lord Willetts described as non-medical biotechnology. We have the challenge of trying to deploy new crop varieties based on these technologies. Of course, that has been very difficult in the environment that we have found ourselves in, but this has changed quite dramatically based on the Genetic Technology (Precision Breeding) Act, which provides an opportunity for us to deploy those technologies more rapidly than before. Therefore, over the next five to 10 years, there will be a large opportunity both to deploy the existing crop varieties that we have generated and to take advantage of the spectacular advances in engineering biology. We are now developing a predictive understanding of how plant immunity works. We can use machine learning and artificial intelligence to redesign immune receptors in plants so that we have a predictive capacity to respond to any new emerging disease; that is the focus of some of our spin-out activity and the new company creation that we are trying to build at the Sainsbury Laboratory. So there are large and substantial opportunities for us in that space. I can talk later about some of the challenges that we face, but those are the opportunities that we recognise at the Sainsbury Laboratory.

The Chair: Are there any particular regulatory challenges that either of you would highlight and which you think need to be addressed because they are stopping those developments coming forward? You mentioned new legislation that will make things easier. Are there other things that need changing?

Professor Nick Talbot: For us, it is the secondary legislation that will be necessary to implement the recommendations of the precision breeding Act that gives us the most concern, in a sense, because there is an opportunity for it to take advantage of the scientific rationale upon which the then Bill was generated and to clear a path for the deployment of new varieties. We see that as probably the biggest imperative for us to try to make good on the type of activity that we are involved with. On the example I gave you about potato late blight, we are working with a UK spin-out, Bio Potatoes. We are now at a point where we are generating varieties and scaling up their production for larger-scale field trials, but the secondary legislation is critical to being able to go beyond the field trial stage and deploy those varieties.

Q87 **Baroness Young of Old Scone:** Can I take that forward slightly? I do not know whether you two are the right people to ask but it will be interesting to see your reaction. We heard, when we talked to

regulators in a previous session, that none of the ecosystem regulators were part of the regulators group that is currently operating sandboxes and stuff like that to try to develop better ways forward in engineered biology regulation. Do you think that there are adequate protections and safeguards for the impacts of some of the products that you are envisaging on ecosystems as opposed to on human health, for example?

Graeme Cruickshank: It is very interesting because the community that we support most is not aware of or concerned by regulation but it does not know what it does not know yet. In fact, most of it is seeking help for navigating through those regulations because anything that involves a human consuming it—a food or a medicine—should clearly be treated seriously. We should not be looking to make life easy for ourselves. Nobody was asking for things to be made easier. The support that the community was asking for has DSIT hosting sandboxes—I think you mentioned those already, Baroness Young—but the people I speak with are slightly on hold. They do not quite know how to react yet. They think they should be scared but they are not sure; they think there are things that they are not aware of that and should be bringing to the table but they are not sure. So we are in a slight hold

The Chair: Is that the regulators you are talking about?

Graeme Cruickshank: No, sorry—these are the SMEs. Some of my colleagues who are with me today are actively trying to host conversations with the FSA and the MHRA for new biopharma materials because they are looking for a neutral party to help support that. The catapult's position is neutral in that sense and supportive.

Baroness Young of Old Scone: Perhaps I could clarify the point I was making. The FSA may not be the only body in town. If we are looking at impacts on ecosystems as opposed to on human health and safety, why is Natural England not part of the sandbox? Professor Talbot may have the answer.

Professor Nick Talbot: I see no reason why it should not be. Indeed, I can think of many advantages of it being part of all of those conversations. The only point I would make is that the same should be true of any new plant variety entered into agriculture in terms of its effect on ecosystems. There is no particular special case based on the technology that was used to create the new variety; it is about the outcomes rather than the technology that was used to create the variety. One needs only to look in fields at the massive monocultures and the crash in biodiversity across the UK to realise that agriculture has had an impact on biodiversity.

There is no reason to think that the technologies that generate the next generation of agricultural crops would have any other special consideration, but the environmental impact of any new agricultural product should be part of all of those discussions and part of the overall regulatory framework.

Q88 **Lord Strasburger:** The committee is particularly interested in the ability of companies to scale up, translate and commercialise the UK's science base in the UK. What are the challenges that they face in achieving this?

Graeme Cruickshank: The challenges are many and big, to be honest. You would expect me to say funding and finance, but I will hold that back a bit. One of the biggest challenges is recognition and realisation of what scaling up actually means. Many people assume that it just means, "Do it in a bigger bucket, please, and make me a bigger quantity of materials". That is not correct but it is not a wrong place to start from. The reality of scaling up is: "Get me material of sufficient quality that I can test in a real use condition to prove to myself and my investors that this is worth taking further". That is where real cost and challenge come in. It could be operating under GMP conditions for clinical supplies or under FFSC 22000 for food safety standards for that new material to be eaten. That is where the real challenge comes in.

In terms of going to bigger buckets, I am constantly reminded by colleagues, "Remember, Graeme, the vessel that is 1 metre long by 1 metre high by 1 metre wide is 1 metre cubed. The vessel that is 2 metres long by 2 metres high by 2 metres wide is 8, not 2. You move to 3, it is 27." Suddenly, the amount of material, time and energy consumed in going through larger scales exponentially grows; therefore, the financial burden and associated risk mounts up as organisations seek to cross that valley of death. We often think of translations on a linear scale; we talk about TRL levels 1 to 9, and there are nice hops. These hops are not equal; they are not equally sized. The real pain comes in going through levels 5, 6 and 7. Only then do people take you seriously because the investment decision that you are asking for is significant. Therefore, I need to be reassured that this food does taste good, that this medicine is effective or that your biostimulant will increase my yield in that field. The real challenge for companies initially is the recognition that that is the challenge. Once they have that, there is the truth about funding: the quantum of funding required, with patience, is not readily available.

Lord Strasburger: Thank you. Professor Talbot, would you like to add anything to that?

Professor Nick Talbot: I agree completely on the need for patient capital and many of the points that have been raised previously. I would stress that, in the field of agricultural biotechnology, the timelines are even longer and the valley of death is more like a canyon. It is very long. That provides its own special challenges; indeed, the environment has been such that many companies fail on that journey, not just in the UK but in the US too. Companies that have raised substantial amounts of venture funding have not made it to the end of the valley of death to scale up to the point of deploying products. I would argue that there is a need for a greater amount of intervention in the agricultural biotech space than even in the biopharma space that was talked about in the previous session.

I reflect on the fact that I spent a year working in a biotechnology start-up in the US. During that time, most of our R&D was funded by either state or federal funding through grants. There was much more state intervention—something that surprised me enormously at the time, but I realised that most of our work was grant-funded. The investors were investing in capital and in infrastructure but much of the actual science was being funded through government funding. It is about having that type of funding, longer timelines and a greater appreciation both for how long field trials take and for how long variety registration and so on will take after that. The deregulation process for genetically modified crops is a long process. There are a number of things here: certainly greater intervention to enable companies to have access to that type of funding; and all that can be done to simplify the regulatory regime as much as possible. We have started on that journey with the legislation that has been passed through the Houses, but there is still some way to go to provide that simple regulatory regime that is necessary for agricultural biotechnology to flourish.

Lord Strasburger: Can I ask you about academics? What are the major challenges for academics in translating ideas from academia into practical applications? What can the Government do to bridge that valley of death that you spoke of?

Professor Nick Talbot: That is a very good question. At the Sainsbury Laboratory, we spent a lot of our history doing IP licensing work. We predominantly worked with large companies; we filed patents, then that IP was licensed to large companies. We have had very product collaborative relations with many of the major agricultural biotechnology companies, particularly in the US but also across Europe.

We recognised the fact that we were not doing very much of our own innovation, so we set up our own scheme, called TSL Ventures, where we have our own seed investment so that we can provide pre-seed and seed funding and our own budget to file IP. We can generate our own companies in-house and take them to a much more advanced stage before we talk to investors and go to series A funding. That process has been borne out of a frustration around how to carry out that type of translational work because we realised that most of the activities that had taken place—I reflect on my time working in universities, too—that spin-outs were often premature based on virtually no, or very thin, IP. We have taken that approach to try to address some of those problems.

Graeme Cruickshank: Supporting that academic translation across the valley of death is exactly the space where the catapults are expected to play, leveraging whichever source of funding we can—whether it is part of BBSRC grants, Innovate UK funding or supporting people to source private equity—but it usually results in difficult conversations because we tend to be speaking different languages with slightly different expectations.

I mentioned the mindset shift before. Transferring across the valley of death means that the exam question is no longer "Is this possible?" but "Is this viable?" In fact, technoeconomic analysis and industrial realities must be brought to bear. We tend to find that some early interactions can be painful on both sides, for example where a colleague provides an incredible reaction with high-nutrient media and interesting reagents that cost more than the product being produced. That is an uncomfortable position for people to be in until we realise, "No, there's a way forward to change this. This is how we can produce something that's economically viable."

That does not happen in one conversation, though. What needs to happen are multiple interactions with the academics, building trust over time through a portfolio of projects—to grow patience and trust, again—that allows us to learn each other's languages and needs. I am proud of the Researchers in Residence programme at CPI; we have a significant cohort of early-stage researchers who come and embed with us for a period of time. We are learning bleeding-edge science from them and they are learning some of the things that people with hair my colour picked up over the years. That is part of our job: not letting those previous failures—which, to be clear, were the things we learned from—go to waste. Having that passed down to other generations is very important to us.

The opportunity to collaborate with academics is constrained today. I understand that the public purse is constrained—of course it is. However, we are doubly constrained in the innovate space—innovate (IUK) being the piece that is in the middle-facing industry—because as RTOs, a cap exists collectively between catapults and academics. It means that, even when we find the academics to support and we can support them, the amount of grant available for us to collaborate collectively on that part is constrained to somewhere between 30% and 50%; it depends on the call. Even when we (as the nation) are spending money, we are limiting our ability to support these academics to take things through to the next level.

Q89 **The Chair:** Why is it constrained?

Graeme Cruickshank: Because of a funding requirement, or a law, that says, "In this call, the amount of funds available for RTOs—academics, catapults, and research and technology organisations collectively—is capped at 30% of the entire allocation of money". It is a thing that is written into the process and which I would love to see addressed. It might be something that is relatively straightforward to reconsider.

Lord Strasburger: Is there anything more that the Government should be doing to help bridge this?

Graeme Cruickshank: Revisiting some of the unintended consequences of those funding pots is one thing. I also think that the Government do have the opportunity to invest in significant infrastructure in dedicated new spaces. I am not advocating for more generalist infrastructure because what we find is that, as you scale up, your generalist kit is less useful and your specific kit is more necessary. I know for a fact that we recently provided some evidence to support the case that GMP facilities for microbiome and phage manufacturing does not exist and that that is a major gap. I heard earlier contributors mention the antimicrobial resistance challenge. We know for a fact that one of the silver bullets we would like to use is in the phage area but, today, that area of science is not easy to handle because of concerns around cross-contamination. Without dedicated facilities, we will be leaving that major opportunity on the table.

Q90 **Baroness Willis of Summertown:** I want to move on from that but stay in the same vein in terms of facilities; by that, I mean the relationship between facilities for an SME and the facilities that are available to the university, including whether you think there are often barriers. First, I note that you are in a science park, which has presumably come out of UEA but is also philanthropically

funded, or there is different money. Not every university has that ability yet, when people get a research grant, the grant is often dedicated to that particular piece of kit, which would be very useful but cannot be used by someone who is trying to spin out. Is that a tension that is more widely seen?

Professor Nick Talbot: It is. It is very much a tension in the way that university finances work, too. In my previous role, I was a deputy vice-chancellor at a university so I was very aware of this. On access to research facilities, sometimes perverse barriers are created by university faculties. Sometimes they do not allow access unless it is under full cost recovery from academics—even in their own institution, let alone outside—yet some of the most successful activities that I have been involved with have been through allowing a company to have access to facilities. The removal of those barriers is important—we certainly tried to do a lot of that in the university I was in previously—but there is more that the Government could do to try to look at that. Across the Norwich Research Park, we have taken a view to try to remove as many of those barriers as we could.

Interestingly, one of the things that happened in the Covid pandemic was that, suddenly, all those barriers were removed. It showed that, yes, it could be done. All the facilities were being used; all of the testing for Norwich was being done at the Earlham Institute, the Quadram Institute and so on. It was good to see how that could happen. Another great success in Norwich was the John Innes Centre opening its facilities to a spin-in company, Tropic Biosciences, enabling it to grow without any initial capital initially and to use its facilities; they still have a close relationship. Trying to remove those structural barriers, where possible, would be a good thing to do.

Obviously, there are Charity Commission rules on what charities are and are not allowed to do in terms of having commercial activities within them but that area could be looked at because, very often, the commercial activity is consistent with the mission of the charity. There are things that could be done to look at that. We currently have a large-scale investment going into the John Innes Centre in the Sainsbury Laboratory; we are building more headroom in to allow a research hotel model where companies can come and use facilities. But the tension there is in the way Research Council rules operate in terms of full cost recovery, so we are having to navigate that territory. The more that can be done to clear and remove the obstacles, the better it would be.

Baroness Willis of Summertown: Dr Cruickshank, do you have a view on this?

Graeme Cruickshank: Anything that reduces friction is a useful thing. Unfortunately, friction is usually created by funding areas being prescribed too tightly, in terms of for whom and for what. The opportunity to have slightly more liquid funding, in order to allow for more discretion in what that funding is used for, would be a step change in the UK's innovation potential. Our job is to help academics scale up and, importantly, to engage with them early enough in their Research Council-funded endeavours to be guiding at a small enough scale such that, when they want to go to a larger scale—which is expensive—we are debugged more. I sometimes feel that we are too siloed. An academic will say, "I am done because my grant is now finished. Therefore, this is the thing I want you to scale up". I then have a difficult conversation. I say, "Well, that might be you done but it may not meet the technoeconomic requirements you need for this to be executable in the market. We may need to take a step back before we take two steps forward". They say, "Gosh, where will that funding come from?"

Baroness Willis of Summertown: Looking at what the Government could do, are they releasing some of the legislation that tightly involves all of this? I am thinking of your earlier comment about different funding models and only 30% being allowed. It is absolutely classic overlegislating, to the point that it ties down. Where would the removal of those sorts of legislative processes sit? Do you have any thoughts on that?

Professor Nick Talbot: It would sit in research institutes. Some of this is to allow the Research Council or, ultimately, UKRI to delegate more freedom to the institutes and give them some flexible funding. There is no funding stream directly analogous to QR in universities, which would enable one to have rather more freedom in how it is spent. Whatever can be done to release them from that more prescriptive funding is a good thing. Similarly, some of that is about trying to persuade universities to have less rigid financial models, which impede innovation.

Graeme Cruickshank: Innovation in itself is horizontal, not vertical. Engineering Biology is particularly horizontal and is very much a team game. Later, I would like to touch on this question: are we talking to Defra, DESNZ or DSIT? Who is holding the reins? The answer is everybody and nobody at the same time. The opportunity exists for much more cohesive chevroning together in this space, recognising that it is for the greater good collectively and not just your job or mine.

Baroness Willis of Summertown: That very much sits within the

facilities, as well as the funding of the work.

Graeme Cruickshank: Yes.

Q91 **Lord Berkeley:** Following on from the last discussion, we have heard from a lot of small companies and SMEs about the difficulty in getting access to infrastructure for the next stage of their expansion, whether it is a field, a laboratory or buildings. That needs investment. The question everybody is asking is: where is that going to come from? You have given us a very interesting outline of how long-term many of these things are, for very good reasons, but we have to find the investment. They have to convince the investors that this will take five years, 10 years or whatever the hell it does take. What do you think the Government can do about it? It is a silly question but, clearly, help is needed.

Graeme Cruickshank: Absolutely. Short of waving a magic wand and finding a magic money tree, which I do not think we can do, we may have to recognise that our funds could be invested more intentionally. What I mean by that is that organisations hop from grant to grant or fund to fund. It may take six to 12 months to go through the process. It just about has the money to survive, it is just about to start the work and then there is a dearth of calls that are available and it risks dying at that stage.

However, if we were to think about some of our funds being slightly longer-term—not necessarily more; just slightly longer-term—it would provide surety to those entities that they can pay their bills over a period of time, but with a gated approach. It is conditional funding, where funding for five years is conditional on x, y and z being achieved. It is not just, "Take all this money".

I cannot remember who mentioned earlier that we do not like picking winners but, unfortunately, we will have to. We will have to decide which entities, programmes or projects we have a higher degree of confidence in and provide them with a degree of longer-term surety of funding that allows them to retain their staff, retain their innovation programmes, keep going and wait for the next spring to come around, when we will be able to test their agri-tech product in a real field condition, for instance.

Lord Berkeley: That is all fine, assuming that you can persuade the officials and politicians that it is safe to do that and that you are not going to run away with the money and go off to Timbuktu, as Baroness Willis was suggesting. There must be a happy mean here somewhere. What is it? Is it education of civil servants? Is it more politicians like Lord Willetts or not? What needs doing to make this easier?

Professor Nick Talbot: I certainly agree with Dr Cruickshank's assessment that we need longer-term funding. Giving out the same amount of money in longer-term grants of five to eight years would be better than what is done currently, which is funding one to three years. Do a fund and filter model, where you fund but then stage gate against performance milestones. However, peer review and short-term funding are so deeply culturally embedded—not just in politics but in science, too—that it is quite difficult to move from one stage to another. The Wellcome Trust is doing this with much of its discovery science; it is moving to a longer-term funding stream to try to overcome some of those issues.

On what else needs to change, there probably needs to be a greater understanding in the Treasury of the long-term nature of innovation in this space. The US, as has been mentioned this morning, funds and intervenes a lot more and a lot further down the innovation pipeline than we do in the UK. That probably needs to be better understood. Of course, it is also about venture funds and innovation banking systems. In the private sector, there needs to be a greater understanding of that, perhaps.

The other point I would make about agricultural biotechnology is that we have to remember that this is ultimately about food security. There is a biosecurity and well-being argument to be made about this; that sometimes gets overlooked. There is a responsibility to do that, for which we will need to innovate quite dramatically. If we are going to move to sustainable, low-input and low-carbon agricultural practices, a massive transition needs to be made. I do not think that it will happen without a considerable amount of intervention.

Graeme Cruickshank: Can I pick up on something that Lord Willetts or Dr Dix suggested around the cohort in the Civil Service? The ability to navigate process is vital, and we would not want to undermine that skill set. However, he mentioned the success model of the Industrial Strategy Challenge Fund. Please forget the name and its history—just focus on the model, where leaders with industry experience were dropped in to manage a portfolio of projects and programmes. They were very skilled at understanding, "What difference is this work making? Can I see this getting to industry? Will this be commercialisable?" That is a slightly different mindset from the previous one: "How do I follow the process and use the funds appropriately, with good governance in-year and so on?" That is essential but layer on top people with industry experience who are able to say, "Together, these four things make a sensible approach".

The Chair: Lord Lucas—apologies, I missed you earlier.

Q92 **Lord Lucas:** To come back to an earlier subject, how do our facilities and infrastructure compare with what is available abroad, in particular Bio Base in Belgium? Should we be doing something there?

Graeme Cruickshank: Absolutely. We should be recognising what we have, celebrating what we have and encouraging people to use it more than they already do today. A plethora of organisations across Europe are able to provide scale-up fermentation facilities. Unfortunately, that is not what most of our SMEs need. They think it is what they need so they go, often incentivised by direct access to vouchers for up to €60,000 of liquid funds that are prepaid by European schemes, as I mentioned earlier—it is discretionary spend; it is, "Have whatever you want. Please come use this asset"—only to discover that they do not have end-to-end support in strain development, process development, scale-up, separation and final stabilisation or formulation.

I probably should have said that my background is in formulation science. I came from consumer goods; that is the expertise I was asked to bring to this community. How do we turn these things into something that does not just live in a flask? How do you take it out, stabilise it, touch it, put it into a product and sell it? That is where the magic happens; the UK has that. The UK should be proud of its catapult network. I have colleagues from across Europe who are jealous of our construct, yet we do not seem to celebrate it and invest in it enough. We are quite happy to throw stones at ourselves because we think that things are expensive, without realising that that is what it costs to do work at that scale.

I would love for the UK to celebrate the assets and provide more fuel to the engine; by "fuel", I mean funding for SMEs, academics or other colleagues to come and use the assets that exist. It is not just about the size of the fermenter. It is about the process design, the scale-up, the separation, the isolation and, interestingly, the industrial knowledge that says, "Here's how you make money out of that".

Professor Nick Talbot: At the Norwich Research Park, we are lucky in that we have just received a large-scale investment through the UKRI Infrastructure Fund. We raised £52 million of private money, which triggered a £320-million government investment—through the HP3 project at the John Innes Centre and the Sainsbury Laboratory—to build the next generation of infrastructure in plant and microbial sciences. That is replacing infrastructure built in 1967. The glasshouses at the world's premier

plant science institute are much older than any commercial contractor working in horticulture. It has taken a long time to generate that level of investment. Nevertheless, when these facilities are completed by 2028, they will be absolutely world-leading.

We feel that it is incumbent on us to raise a lot of other money to try to equip those facilities, which we are doing through fundraising, private money and so on. A principle of capital investment has been the "batteries not included" model, which has certainly afflicted investments in the university sector. Large-scale capital has emerged but there is nothing to equip the building and no cost to make it operational. We are already seeing that with the biofoundry investment, which started with a capital-only grant and has now been eclipsed by other investments in Asia and elsewhere. If there is a lesson to be learned, it is that one. I realise that this has to be done within a spending envelope but, sometimes, it would be better to fund a smaller number of things at a higher level with some operational costs attached than to fund a lot more capital without that.

Lord Lucas: I was built in 1951 and I do not want to be replaced yet, thank you.

Q93 **Lord Berkeley:** I am fascinated by the fact that it will take five years to build this new facility. Is it important to tell people that you can shove a building up in six months but what goes in it or around it takes a hell of a lot longer, is much riskier and is more expensive? Is that a fair comment? People do not understand that.

Graeme Cruickshank: That is an absolutely fair comment. It is easy to put steel in the ground and put a roof on it; that is quite straightforward. Having the appropriate infrastructure inside that makes the building operate is harder, as is deciding what assets need to go in there. By the way, by the time you get there, your needs will have changed. Therefore, retaining flexibility on your assets is essential. However, finding the people, developing them, training them and having them fully competent is a real challenge. Retaining that competency is a real challenge.

It is a bit of a British problem. We quite like building things so that we can cut a ribbon—I am sorry if that is offensive—and we do not like recognising that, for a £10-million asset, 10% maintenance each year is £1 million or if we say, "We're good at this; let's just make it £500,000", that is £500,000 a year in maintenancecosts just to maintain the asset. That is the "batteries not included" model that Professor Talbot was touching on. We sometimes forget

that these assets are useful only when they are maintained, when people work in them and when we do not just sit and look at them.

Q94 **Lord Drayson:** I would like to focus on the role of the larger industrial players—that is, the companies turning over hundreds of millions of pounds. To what extent are they interested in adopting these technologies, which have potential to disrupt them? Given the challenges that we heard about earlier around the commercial model of some of these processes, what prevents a relationship flourishing between a large, established player and one of these new, innovative, potentially disruptive companies?

Professor Nick Talbot: We have collaborations with many large companies: Bayer Crop Sciences, Corteva and American companies, as well as Rijk Zwaan and Limagrain in Europe. We have extensive collaborations with larger companies.

Genetic technologies associated with agricultural biotechnology focus very much on the US market but increasingly on Brazil, the whole of South America and south Asia. It is outside of Europe, predominantly. We have found that it has been much easier dealing with US companies in that regard than with many closer to home. That is largely because of the regulatory regime in the US, in particular the recent changes in the regulatory regime in the US that have enabled much more rapid USDA approval and FDA approval for products.

I would say that there is a willingness for them to invest. Bayer Crop Sciences was funding around 25 people in the Sainsbury Laboratory; it was a large-scale, £25-million investment over five years or so. It has funded at a large scale where it sees a commercial imperative; that was in delivering resistance genes for important, challenging crop diseases.

Graeme Cruickshank: The larger organisations that I work with see it not as necessary but as absolutely imperative. It is not a debate. They will have to change their business model and find bio-derived routes to many things. It is easy for the pharma guys to see biotherapeutics of the future. The GSKs and Fujis of this world are already investing heavily. The chemical manufacturers—the Crodas and INEOSs of this world—understand that it is necessary and will make developments.

We are seeing collaboration where possible. Something that I am personally involved in and proud of at the moment is an Innovate UK project called Flue2Chem, which is designed to join lots of specialisms together. It is capturing CO_2 emissions from a stack at a paper plant—it could be a steel plant or cement works—and

reacting it with green hydrogen. There are biocatalytic—that is, engineering biology—and chemocatalytic steps in there, which get you back to hydrocarbons. Could we go back to an oil-based economy but not take it from under the North Sea? That would be interesting.

The large end-users in that programme are taking those hydrocarbons and turning them into surfactants, which go into the detergent that you wash your clothes with. Now, the reason why that is important is because my mum does not understand any of those steps but she does understand the box of detergent on the table in front of her. Sometimes, making our science simple and understandable is necessary.

What is the barrier to them engaging more? Too many small, bitty programmes which are too much trouble. It is more trouble than it is worth for these large corporates to engage in small CR&D programmes or even what we think of as multi-million-pound programmes. At their scale, it is more of an irritation because of the paperwork requirements and the distraction from their base business. They are doing it but not through our mechanisms.

Lord Drayson: That is helpful, thank you. Does the UK have any sovereign large industrial players? All of the companies that you have mentioned, outside of healthcare, are not UK companies. Is that correct?

Graeme Cruickshank: We absolutely struggle for sovereign companies. We have footprints from many companies but decision-making power typically resides outside the UK. INEOS would be the exception to the rule. Even there, I think that INEOS has a global footprint or global expansion potential, but that would be the largest centre of mass in the UK. We have strong design capability in the UK. By that, I mean companies such as Unilever, Procter & Gamble and Reckitt, which create products for all over the world from the UK but do not necessarily manufacture here.

Lord Drayson: Our inquiry is trying to understand the potential of engineering biology to move the dial, so to speak, on the UK economy and the challenges that it currently has. To what extent would it be possible to take actions that would encourage these companies to invest and build capacity and economic growth in the UK—as opposed to small R&D investments by Bayer in a few research scientists—in order to build a big factory employing lots of people and exporting to the rest of the world? Is that practical?

Graeme Cruickshank: What needs to be true is lots of cheap, green electrons. What I mean by that is ready access to significant

quantities of affordable, green electricity; that is what underpins all chemical and biochemical processes. If we have that as the base component of the UK, the UK becomes a very attractive place to invest. We have skills, we have people, we have networks, we have land and we have facilities. That is what changes the game economically.

Q95 **Lord Lucas:** Are we also limited by access to carbon?

Graeme Cruickshank: Interestingly, carbon management is something that the world, in particular the UK, needs to do better. There are three primary sources: biomass, which has tensions around competition with food versus using that land and carbon for chemical applications; carbon captured from the air via CO_2; and carbon that is already with us in the form of plastic or packaging. Today, that is sitting as a waste stream, but to me, as someone who came from the chemical industry, nothing is waste. It is simply a feedstock going from one reactor to another. Those three strands of carbon will all be necessary for us to create a more circular economy for the future. Energy and carbon—with those two things, we can recreate our manufacturing industries of the past.

Q96 **Lord Drayson:** I want to focus a bit more on what you have said about the opportunity to get these non UK-based large players to invest and scale up here in the UK. Do you see actions that could be taken as part of an industrial strategy in order to intervene effectively such that, when these large companies see an SME, rather than buying it and taking it to America to develop it, they grow it here?

Professor Nick Talbot: I would like to see that as one of the long-term aims of a science park, such as the Norwich Research Park. To me, that is a signature of success. If we get that to work over the next 20 years, we will be doing something right. That is certainly something that I would personally like to see happen.

Lord Drayson: What would it take to make that happen?

Professor Nick Talbot: Some of it is about energy costs but a lot of it is about the skills base—not just the academic skills base but the technical skills base and so on. We need to do more to make sure that there is a skilled workforce in locations that are not just Cambridge. We need to have stickiness around some of these larger centres. Then there is the diversity of skill sets. You need business directors—that is, people with legal experience who are associated with those industries—and a hinterland of other skills, which we struggle to find. I know that we are dealing with small-scale start-ups but attracting a major player to re-site or grow an

existing SME locally will depend on the scientific magnet and all of the skill sets around that.

We are close to that with certain companies that are scaling up quite dramatically on the park. They feel quite a strong sense that it would be much harder for them to do their science elsewhere. We just need to make that argument again and again and make sure that there is sufficient pull to enable them to be there. Ultimately, it will come down to things such as energy costs, availability of infrastructure and incentives for them to be there, because that is what other countries will be doing.

Graeme Cruickshank: CPI has some proven success models, just not necessarily in the engineering biology space. Pragmatic is one of the unicorn examples of providing support services to something that has grown over time. That was a 15-year journey. People seem to think that it happened in six months. As we have mentioned already, this was a long, patient journey. We have the ability to anchor people in the UK but we do not have many examples in engineering biology yet. However, I think you were asking about industrial strategy and its role here.

Lord Drayson: Exactly. What do you think the Government should and could do that would make a difference?

Graeme Cruickshank: This might sound slightly trite but step one is to have an overt industrial strategy that we are proud of and declare. What industry needs is the surety that there is one, slightly less so the words held in it. Forgive me if that is trite but step one is to declare that we have a strategy, nail our colours to the mast and allow people to have confidence that we are on a course that we will maintain.

Lord Drayson: Thank you very much.

Q97 **Viscount Stansgate:** My question arises out of what you have just been saying. This is a committee conducting an inquiry. It is our job to produce a report with recommendations to the Government and, incidentally, to come up with good questions to ask the Minister when they appear before us. Can you summarise the top three recommendations that you would like to make to us and would like to see as recommendations in our report?

Graeme Cruickshank: I have already said that this is a team game. Engineering Biology is a key player, but not the only player, in that team. I am going to run with that theme here, in terms of the three sets of teams that are required.

Team one is about unifying responsibilities within the different departments of Defra, DESNZ and DSIT. I am not entirely sure who to engage with, where and when. I know that work is ongoing but it will be fantastic when that multifunctional team is able to form and we know the place to go to.

In terms of the assets that exist in the UK, there will be a need for more and for replenishment but we already have an exceptional asset base, from biofoundries through to scale-up facilities, university facilities and RTO facilities. However, we do not have them easily mapped and we have a habit of confusing each other, through our names, on quite what we do. When I left industry and came to this innovation ecosystem, I sometimes thought I was looking at a plate of alphabet spaghetti because there were all these letters all over the place and I was not entirely sure what they meant. Spending some time creating a true innovation asset map, with clearer descriptions of the real capabilities that each of us has, will be helpful. CPI has started that journey with the North-East's bio cluster—BioYorkshire, York University, Fuji Film and so on—but there are many more of those. That is the second team.

The third team is about funding teams with a degree of continuity. First, larger-scale funding programmes, such as the AMSCI tool that we had previously, allow for supply chain development from academic through to SME and translation, with large-scale end-users pulling it through. Those were multi-year, larger-quanta programmes. Secondly, we have to address the cap on IUK CR&D funding that artificially limits academics and our centres working together; that would be a help. Thirdly, there is the challenge of how we provide slightly longer-term surety of funding with appropriate gates. We should not and cannot release excessive funds, but we have to retain confidence that people can continue on their journeys. That is what keeps those teams together.

Professor Nick Talbot: In our area, I would stress prioritising secondary legislation so that the precision breeding Act can be implemented and the regulations are in line with the original scientific rationale of the Act, which is that precision-bred products pose no greater risk than their conventionally bred counterparts. I would then develop a regulatory framework for food products that is based on outcomes and products rather than the technologies used to produce those crops.

The second area that I would stress is around ensuring that there are funds for early-stage translation in order to enable progression from early translational research. It is certainly the case that some ideas fail because they never get past the proof of concept funding

and are not sufficiently advanced to establish either industrial collaborations or spin-out activities. There is currently a gap between UKRI responsive mode grant funding for discovery science and Innovate UK funding; that is right at the beginning of the valley of death and is something that certainly needs attention.

Thirdly, we need to ensure that the UK remains attractive to leading scientists in the field. We need this to be a magnet for inward investment. That process has not been easy. It is now much harder to recruit leading scientists than it was five or 10 years ago. You will be aware of the reasons for that as they are well rehearsed—the visa regime and so on—but, believe me, they are serious structural impediments to our ability to hire the best talent.

We also need to ensure that the long timelines associated with crop development are understood by the venture funding industry. We need some degree of co-venturing to reduce the risk in those, with targeted, longer-term Innovate UK-type or ARIA-type funding that could sit alongside venture funding in order to enable companies to scale up in this area. Those are the areas that I would stress.

The Chair: Thank you very much. I thank both our witnesses in this second session today. It has been another very interesting session. As I said, you will get a transcript to look at very shortly after the session. I know that we have had some evidence from you already but, if you think of anything else that we might find useful and which you would like to send us, more would be appreciated. At this point, I formally conclude the session.