HOUSE OF COMMONS

Science and Technology Committee

Oral evidence: Unlocking the Potential of Agricultural Science and Technology, HC 415

Wednesday 13 July 2022

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Watch the meeting

Members present: Carol Monaghan (Chair); Katherine Fletcher; Rebecca Long Bailey; Graham Stringer; Tracey Crouch.

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Witnesses

I: Professor Alistair Griffiths, Director of Science and Collections, Royal Horticultural Society; and Professor Malcolm Hawkesford, Head of the Designing Future Wheat Institute Strategic Programme, Rothamsted Research.

II: Dr David Flanders, Chief Executive Officer, Agrimetrics; and Dr Ruth Bastow, Innovation Director, Crop Health and Protection (CHAP).

III: Professor Louise Fresco, Former President of the Executive Board, Wageningen University; and Ismahane Elouafi, Chief Scientist, Food Agricultural Organisation (FAO).

Examination of witnesses

Witnesses: Professor Griffiths and Professor Hawkesford.

In the absence of the Chair, Carol Monaghan took the Chair.

Q1 **Chair:** This is a one-off session on unlocking the potential of agricultural science and technology. Welcome this morning to our two witnesses: Professor Alistair Griffiths and Professor Malcolm Hawkesford.

If any members of the Committee have relevant interests they would like to declare, I ask that they do that now. If not, perhaps I may start with Professor Malcolm Hawkesford, head of the Designing Future Wheat Institute Strategic Programme at Rothamsted Research. What are the major challenges that currently face UK agriculture and food production?

Professor Hawkesford: The first one, which has always been the case, is producing enough quality food for UK markets and beyond. That has always been the case, but currently farming production—I speak mostly with experience in the wheat sector—has particular issues with regard to pressure to have a low environmental footprint. This brings all sorts of additional complications. It can probably be summarised by having efficient farming. Efficiency has always been important for profitability and it is even more important now to have this low environmental footprint.

Why is there a need for that, apart from public opinion? It is because of certain impacts in contributing to climate change, for which farming is well known. Those climate change issues directly impact production, for example currently with a lot of extreme weather conditions, but also long-term changing conditions, so the kinds of varieties grown and the agronomy used need to adapt to these changes. There are lots of other specific issues, not small ones, that come alongside that—perhaps increased problems with diseases and their control and limitations with regard to inputs, particularly chemical inputs for the control of such diseases.

Q2 **Chair:** Are the issues you have just been describing becoming more acute?

Professor Hawkesford: People are acutely aware of them. Some of the issues certainly are. It is definitely the case with some of the controls of pesticide use and with the increasing awareness of the importance of the right fertiliser inputs. Previously, we were not quite so aware of some of the detrimental effects that farming could have. Now we are much more aware of them, so there is increased pressure to adopt methodologies for farming, which include inputs but also the management of soils, for example. That is also a key issue. They have always been there and farmers have always been aware of them, but now there is increasing pressure on them to adapt their methodologies.

It is all about being efficient, as they have always wanted to be. I am a big promoter of the farming community. They have always wanted to look after their land. They have always needed to be profitable because they are businesses and they need to live. A lot of the pressures now upon them are about being efficient and, therefore, profitable, but the one overriding issue which we cannot do much about or which is extremely difficult to do, thinking about it, is climate change. That is definitely an increasing problem. We have a classic example at the moment with these very hot conditions.

Q3 **Chair:** Some of my colleagues will ask about this in a bit more detail. If I may turn to Professor Griffiths, who is director of science and collections at the Royal Horticultural Society, is horticulture in the UK facing the same sorts of challenges as agriculture, or are there some different issues that you would like to make us aware of?

Professor Griffiths: There are significant challenges. One is looking at the potential of cultivated plants and landscapes in the UK and the ornamental and horticultural landscape industry, which is often the Cinderella of agriculture but has a major potential, particularly within cities, to help more people in those cities in dealing with climate and biodiversity crises.

The fundamental challenge is that, even in the 2021 UK plant science research strategy, there was little mention of the horticultural industry or horticultural and cultivated plants, yet we use more cultivated plants in our daily lives than we use food or medicinal plants. Food agriculturalist organisations talk about 50,000 different types of plants. There are 32,500 medicinal plants. In this country alone, through the RHS plant finder we have 88,000 different types of cultivated plants.

The challenges we face are similar. There are big challenges in how we accelerate the transition, which we have to, to P3 with new growing media technologies. How do we deal with water, which will be critically essential in cooling our cities on days like today? How do we make sure we have more water-use efficient plants? There is the pest and disease increase elements. To take ash dieback, for example, there is an estimated cost of £15 billion in not developing good UK plant scientists. We have good ones, but we need to invest and build on all of these things.

The industry has worked with DEFRA on an ornamental horticultural roundtable growth strategy. What it is really about is the right plant in the right place with the right purpose, and how they all interact. It is critical to get fundamental investment in understanding that we need to look at more than just species and the natural and farming environment, which are critically important. We also need to look at this no man's land which is our cultivated landscapes.

There are 30 million domestic gardens. There are 700,000 hectares of domestic gardens, of which 25.9% are within cities. What role can we

play to optimise these cultivated plant genetic resources and landscapes to maximise the health and environmental benefits? We need landscapes to adapt to climate change. We need to know how to grow them so they can perform to their best capabilities. We also need to have good biosecurity in plant health so they can maximise those benefits. While doing that, we need to minimise resource use and waste to maximise those genetic resources.

The industry is valued by Oxford Economics at £28.8 billion to the UK economy. We believe in investment in the horticultural and landscape industry and delivery of many of the 25-year environmental plan issues, including mental health. Covid-19 shows you that seeing is believing in terms of domestic gardens. Thank you, Government, for keeping open garden centres during lockdown, because you averted quite a number of mental health challenges. There is overwhelming evidence about mental health and our cultivated landscapes, our habitat. We could grow with this strategy. If you look at the unlocking green growth strategy, it is £13.2 billion by 2030 to put the green back into green infrastructure, but we have the same challenges of pests, diseases, nutrition, water, labour and a whole bunch of other things that need support.

Q4 **Chair:** Professor Griffiths, do you think there is enough public and Government understanding of the importance of horticulture?

Professor Griffiths: I do not think there is enough Government understanding. I have been talking about this for eight years. I am pleased to be invited here to talk about this missing link and the opportunity for growth, but also a win-win situation in helping to get to net zero. The general public are seeing these elements more and more: plants for flood mitigation; plants for noise reduction; plants for cooling; and plants for water-use efficiency.

A good example of that where the public have seen what we can do is linked to biodiversity. Cultivated biodiversity is not even recognised in Government measures of biodiversity in this country, but plants for pollinators, underpinned by research, have been adopted by the public. They are buying plants with the plant pollinator logo and putting them in their gardens. We are getting economic growth and helping to contribute to biodiversity.

A study in Leicestershire showed that in one domestic garden there were 2,600 different species of organisms within that garden, and a quarter of ladybirds, bees and butterflies resided within that single garden. We need more to be done in how to unlock the UK's gardening capital of the world and shine globally. Nowhere else in the world understands the cultivar. "Ornamental" is a bad word and does not help; it should be "environmental horticulture".

These challenges face us, particularly the recent loss of the AHDB levy fund for research and development. There is a loss of almost £2 million R&D for horticulture. That investment is critically needed so that we can

do what is needed right now for the climate and biodiversity crisis. We need to follow the road map, which is fabulous. There are many great things in that road map and it is a great piece of work, but we also need to look at how we do applied research on the ground to understand how these plants will adapt to climate change, and how we can use them to optimise the plant genetic resources—the 400,000 domesticated and cultivated plants in this country—to provide those health and environmental benefits.

Chair: Thank you, Professor Griffiths. I have to say that probably 25% of the living organisms in my garden at the moment are midges. I will now turn to my colleagues.

Graham Stringer: You have made me forget what I was going to say.

Chair: Apologies.

Q5 **Graham Stringer:** Professor Hawkesford, most things in this area are a balance and a trade-off; you improve one thing and do not improve the other. As a priority, should we still be producing biofuels?

Professor Hawkesford: That is a tricky one. Food production is the primary role of agriculture, but in certain areas, perhaps areas of lower productivity, why not produce biofuels? It all comes down to appropriate land use. One argument is that we might want to reduce the amount of land we use for agriculture so that we can have more diverse uses for the countryside. Then we might be focused on increasing yields on the land we do use for food production, and any land that is then put aside for biofuels will impact on such a strategy. We can produce biofuels or food. You cannot produce both to the maximum. It is a tricky one to answer, and I apologise.

Q6 **Graham Stringer:** That was partly why I asked you. It is useful to know, because land use for biofuels is a matter of some debate at the present time.

Professor Hawkesford: It depends on the profitability of the biofuels and the demand within the UK for supplies of such fuels.

Q7 **Graham Stringer:** That is probably a regulatory issue as well, is it not?

Professor Hawkesford: Indeed.

Q8 **Graham Stringer:** In terms of other trade-offs and balances, can you talk us through how you make choices between crop yields and the reduction in pesticides?

Professor Hawkesford: Pesticides specifically, or inputs generally?

Q9 **Graham Stringer:** You can certainly widen it, but, if you prefer, chemicals on the land.

Professor Hawkesford: All farmers want yield; that is what they get paid for. A lot of plant and crop science research is focused on inputs and

efficiency, be it fertiliser inputs, water-use efficiency, which my colleague has already mentioned, or the use of agrichemicals to control pests.

A better solution to the use of inputs such as chemicals is to have varieties which can cope with lower inputs, including agrichemicals. There is a huge amount of research looking for resistant varieties both within the academic sector and the plant-breeding industry. By far the best solution is to have the appropriate varieties, and that is where the major focus of research certainly lies. Having said that, at the moment in some cases there are no alternatives to using some pesticides.

Q10 **Graham Stringer:** At the present time are we maximising the nutrients in the UK ecosystem and avoiding as much as we can chemical inputs? Where are we in that debate?

Professor Hawkesford: The UK is in a fantastic position, and UK farming is really good about this. There are some instances where it can still be improved. There is a lot of work going on at the level of agricultural research to improve both management and the kinds of varieties we use, but we are pretty good in terms of fertiliser use efficiency within the UK system compared with many areas of the world. Globally, it is a completely different issue in terms of how well fertilisers are used. Of course, a big driver is the cost of all agrichemicals and fertilisers, which currently has really rocketed.

Q11 **Graham Stringer:** Professor Griffiths, you mentioned in your opening remarks ash dieback. I took from your comments that you do not think the Government have the right policies on ash dieback. What do you think those policies should be?

Professor Griffiths: It is not about the policies that are in place around that; it is about how we may tackle the plant health side of things in relation to those industries and the opportunities for saving around those aspects. There are a number of areas in relation to plant health. There is already some very good work with both industry and Government, in particular the plant healthy assurance scheme created by both industry and Government.

As to the key element, in New Zealand—I know the Government are working on this—every New Zealander is a biosecurity person. They look after their sites, which is probably why—I cannot prove it—Covid-19 worked quite effectively there, because they had an understanding of disease and issues. We need to look not only at improved monitoring and surveillance of plant pests, but at further improvement of our supply chains—not removing genetic resources into this country that we will need for resilience against pests and climate change, but looking at how we can better bring them into the country through that.

We also need to reduce risks that we know of already. Where there are challenges, we need to look abroad but also in the UK to undertake research on existing pests and diseases, and also to do horizon scanning

for the top 10 that we think may be coming in. For example, rose rosette virus in the US is a significant issue. It is our national flower and it earns quite a lot of money.

We have to look at that, but, most of all, we have to work on that. The Government are beginning to work on that, but we need to advance this element of engagement and link that to how we look at behavioural change, providing information and knowledge for practitioners on the ground—foresters and horticulturalists—about effective control and management strategies of existing problems.

Q12 **Graham Stringer:** Do the Government have their priorities correct in what plant science supports? Would you in any sense recommend a change of focus in terms of which particular approaches and technologies are supported?

Professor Griffiths: In that the planet and human resilience is utterly dependent on plant diversity and will be more critically needed going forward, we need to invest significantly more in plant sciences, full stop, across the board. It is a small amount compared with other areas of research. We also need to go back a little bit.

If you look at Wageningen, Cornell in America, the Academy of Sciences and so on, we need to continue what the road map is saying, because it is very good, but we also need to take stock and understand what genetic diversity we have in this country, which is basic applied research, but applied-oriented science, strategically applied, specifically applied and experimental development research. The Government paper that talks about the types of research that have happened does not match the offer in the research strategy.

I will give you an example of the reason why we need to understand what these plants are. One shrub that we have looked at—we have looked at its morphology—can capture 10 times more particulate pollution than another shrub, and that is due to its features and the basic fundamentals of botany. We need to understand what we have with those genetic resources so that we can then understand them and test them in the field linked to climate change. We can then marry that up. For many of the good research projects, first they have gathered all the cultivars and all the species—not species. We need to think about the cultivar more, bring them together and then look at the new technologies out there, because that will speed up things. We need to act within five or 10 years, so we need to learn and do. While doing that, we need to do the other long-term strategic work that may take 10 to 20 years.

Q13 **Katherine Fletcher:** Gentlemen, I do not know whether the following two points are formal declarations of interest. One is that I was honoured to be an undergraduate at Rothamsted for a very short period asking stupid questions. Secondly, the horticultural growers in my patch will not forgive me if I do not put the marvellousness of west Lancashire on the map for that kind of stuff.

We have just had quite an interesting overview of where we are. I want to turn to solutions. In doing so, I may just pick up a couple of the points you raise. Both of you have been talking about developing different cultivar or species lines for specific purposes: reduced water consumption in agricultural settings, or reduced water consumption in a garden setting that will allow for a city to manage itself.

The Genetic Technology (Precision Breeding) Bill is going through Parliament at the moment. I have served on the Committee. I believe it has just gone off to the Lords. For the purposes of the tape and general public, that is using scientific techniques to look within species for positive traits and consolidate them. Professor Hawkesford, what do you think gene editing can offer for some of the issues we have just been talking about, as well as the opportunities?

Professor Hawkesford: As for improving any of those key traits, those are incredibly complex, and they are built up of multiple complex traits. Genome editing, or even GM technology, usually focuses on single genes. All of these processes probably involve hundreds of genes. The trick is to have enough knowledge to know exactly where one should be focusing. That is the basic goal of some quite good plant science research in the UK, but it is incredibly difficult to pin down. Scientists have been working in this area for, dare I say, 50 years or more. More recently, it has been possible to identify some key targets. Once you have identified a key target you can start using these technologies. Genome-editing technology is also in its infancy relatively.

Q14 **Katherine Fletcher:** CRISPR.

Professor Hawkesford: CRISPR is one approach you can use within genome editing. There are several ways in which you can do this editing. It is very precise editing. It is very clean technology and does not leave anything that you would not want, so you end up with a plant, crop or whatever, which is pretty much indistinguishable from the original, because all you have done is literally to make a few precise edits. That is completely different from all other forms of gene modification and a lot of plant breeding technologies. This is definitely the way forward, but the trick is to find out exactly what to do that will really work. I fear that we still have a long way to go for a lot of these big traits: water-use efficiency, input use and climate resilience.

Q15 **Katherine Fletcher:** Fertilisers and pesticides.

Professor Hawkesford: Yes. In some cases there are specific examples where there are claims and good evidence, but they are fairly restricted because of the complexity of the system, not the technology, and knowing exactly what to change.

Q16 **Chair:** Katherine, for clarification, could you explain what CRISPR is, for anybody, including myself, who does not know what it is?

Professor Hawkesford: There are various ways to do genome editing. It is basically about taking DNA, cutting it and changing individual bases

within the DNA. The CRISPR/Cas technology is one way you can do this. There are several different ways in which you can do it, but it is about introducing enzymes to cut the DNA, edit the DNA and then repair it. CRISPR is just one method of several.

Chair: I am sorry, Katherine.

Q17 **Katherine Fletcher:** I apologise. I am quite regularly pulled up on that. If I paraphrase what you are saying, gene editing has a role to play, for example, in generating a wheat that barely requires fertiliser in most UK conditions, but that nirvana requires an enormous amount of research input to make sure you are editing correctly. Is it in the junk DNA, as I was taught, or is it actually in the expressed? We have great hopes to help mitigate. Before I come to Professor Griffiths with the same question, what can we do to accelerate that understanding? It is almost like having a spanner, which is the gene-editing technique, but you have to understand where the nuts should go on the car. Is that fair?

Professor Hawkesford: Yes.

Q18 **Katherine Fletcher:** What can we do to make sure we understand the car better so we can use the spanner properly?

Professor Hawkesford: This comes back to the question of how we fund science and the science that we should be funding. We fund basic plant science to a reasonable extent in this country. Having said that, there are lots and lots of proposals of international quality that go to the Research Council but do not get funded because there is not sufficient funding. We are quite good at that basic science and some of the translational science when it comes to interacting with industry.

The big gap in the middle is the area to which you refer. In my opinion, we should have a bit more focus on that to understand how all these nuts and bolts come together rather than just looking at the individual nuts and bolts. The way to do that—I speak from personal experience here—is to have big teams within the UK, not big teams focused on one site but virtual big teams. We have such a team for wheat research in the UK at the moment, which is immensely productive, to bring together diversity of expertise and knowledge. That is definitely the way to go forward.

Q19 **Katherine Fletcher:** We will return to that because it is very interesting and ties into some of the research we heard about DARPA and orienting science around missions. Before I get over-excited, Professor Griffiths, what is your view on gene editing and that big, very technical spanner?

Professor Griffiths: It goes back to what I said previously. A paper has been published this week about the demise of botany and botanical people who look at whole-plant systems, and also the ecological elements of interaction. I do not think we know fully what we have, or perhaps we do not have people within the institutes that are doing some of this fundamental translational research who have a full understanding of the genetic diversity that is already apparent. For example, there are 60

different varieties of heritage purple tomatoes in this country; there are 26,000 different types of daffodils, one of which, Carlton, is the producer of galantamine. I do not think we have that expertise and knowledge.

I am not saying we should not be supporting that kind of research. If we want to accelerate this, we have to increase both sides of research so we can work together in understanding that car a little better to match what we think these character traits are like. Are they arachnoid hairs, stellate hairs or lepidote hairs that will capture more pollution, or different types of hair shapes, or is it the physiology that will link to that? That plant-based system and ecological-based approach will be critical. A bit like green energy, we probably know that electric cars are not the solution, but in the meantime we need to use the green plant stuff in the best way we possibly can and learn as we are going.

Q20 **Katherine Fletcher:** I think I am following you, but I just want to make sure. What you are saying is that, while we have an exciting technology in gene editing which will allow us to do stuff, and there is straight research into how a plant consumes water, becomes insect resistant and grows with minimal inputs that can have benefits, there is already enormous unresearched diversity within the UK that nature has presented us, and cataloguing and understanding that better might give shortcuts to breeding programmes and benefit programmes that could deliver in the intervening period. Is that fair?

Professor Griffiths: That is absolutely right.

Q21 **Katherine Fletcher:** We have not checked whether we have any Model Ts in the cupboard basically.

Professor Griffiths: Yes.

Q22 **Katherine Fletcher:** Professor Hawkesford?

Professor Hawkesford: That is one of the key approaches that we have in the wheat-breeding programme looking at diversity. We currently work with a germplasm collection of what are called landraces, which are wheats grown more than 100 years ago, of which there are almost 1,000 different types. If you start to look at the diversity among all of these natural wheats, you can find all sorts of characters. If you bring together different traits, again to refer to a paper published just this past week, there are prospects of potentially doubling yields just by bringing together natural diversity in the right combination.

Q23 **Katherine Fletcher:** A bit of precision breeding might help to speed that along.

Professor Hawkesford: Indeed.

Q24 **Katherine Fletcher:** I want to turn to the slightly more controversial topic of genetically modified and GM. Before I do that, what role do we have with technology to align with this? When we were in the Chair's home town of Glasgow we saw some very exciting stuff in the space

satellite industry. They were talking excitedly about launching clusters of small sets of satellites that can tell you, within a range of 30 cm, how damp the soil is, how much humic acid is in it, and allowing that information to be given directly to farmers. So, even with no improvements in plant stock and breeding lines, they were selling an exciting future.

Professor Hawkesford, is there technology there that can also accelerate us while we are on this pure science journey?

Professor Hawkesford: Yes, 100%. Improving agronomy is just as important as improving the genetic basis of the crops that we grow. Both have massive roles to play and the increasing use of such technology is definitely coming to farmers. Farmers have GPS; they know exactly where they are, and all of this additional information, however it is generated—from satellites or elsewhere—is definitely a way forward to improving the efficiency of farming.

Q25 **Katherine Fletcher:** Professor Griffiths, do you agree with that?

Professor Griffiths: I think there is some really interesting technology on phenotyping, which means basically going over a plant and measuring all the different characteristics that may be there. That will be possible. There are still some challenges with phenotyping. You cannot necessarily get everything, but literally there is technology out there; there are drones that will fly over a plant and measure certain parameters that will help us better understand those systems.

The other really interesting technology is twinning whereby we can do digital twins of real-life situations, say cultivated landscapes in cities, and put in the parameters—it is early days—and understand how they might behave according to different climate predictions with different types of plants. It is fascinating stuff that could be adopted and needs to be developed further.

Q26 **Katherine Fletcher:** If we have a series of mission-oriented actions, be they reducing inputs in the land, leaving more land for nature or using the land we do use in a more efficient and effective way, this kind of technology will provide information that allows us to start to address those challenges more quickly. Where is the UK on that?

Professor Hawkesford: I think we are among the leaders, but there are plenty of other countries in Europe and further afield—Australia, the US and China—which have big activities in remote sensing and agriculture, and also in the area of phenotyping, which my colleague mentioned. We are good in the UK, but we are a relatively small country. I come back to the point I made previously about needing to assemble big teams to be competitive internationally.

Q27 **Katherine Fletcher:** In that context—we cannot be five-star at everything—where would you want to see us focus the science and technology of agriculture in the future?

Professor Hawkesford: In my opinion, we need to look at different options; we should not have a single focus. The one option is genetic improvement and breeding, where there is a big industry push, and a big academic link to that, but also the whole science of technology around improving agronomy and using technology tools. Both of these areas are critical for UK farming. We have industry support and innovation in both of those areas and plenty of academic experts.

Q28 **Katherine Fletcher:** Professor Griffiths, would you add anything? What do we need to do?

Professor Griffiths: It is all about understanding and realising that we have a wealth of knowledge and information on cultivated plant genetic diversity, particularly ornamentals, many of which are in our daily lives in cities. What we need to do is ramp up and create climate-smart cities and landscapes that will deal with and tolerate climate changes. I am afraid that the way to do that goes back to two basics and the adoption of technologies by knowing what we actually have and how those different character traits and different things can benefit us so that we can go into breeding, plant selection, growing and testing.

Q29 **Katherine Fletcher:** In your earlier comments you were talking about improving our ability to get genetics into this country. Were you talking effectively about sanitary and phytosanitary checks?

Professor Griffiths: There is concern in some instances that we get to a point where we do not enable genetic resources from around the world to come into the UK. I believe there are two fundamental reasons why that should not happen and also to make sure that when it does come in it comes in very safely.

The two fundamental reasons are these. If we are looking at 4° to 5° increases in temperature and extremes of flooding and drought by 2030, we need more diversity. As with people, we need more plant genetic diversity so we have more tools in the box that we can call on. The other one is that the majority of plant resistance will often come from these collections. Ash dieback and elm came from overseas; it came from genetic resource institutes that had many cultivars. We need those things to come in. We have to look at making sure that is as easy as possible to bring in while making sure that we are plant healthy in the country.

Q30 **Katherine Fletcher:** The counter to that would be the introduction of alien invasives. Genetic modification was talked about and dropped. It is something on which I have done some work. Is there a role for genetic modification in terms of different species being combined, as opposed to gene editing, to play in the solution to moving forward?

Professor Hawkesford: As to the technology of genetic modification to produce a final product, we are to an extent looking at that in the past, because genome editing can do so much more and leave a much cleaner final product. However, there are some things which are quite difficult to imagine doing through just using genome editing, which is just editing

some of the DNA in that plant. You could transfer things within the same species or modify how things are working within a species, but there are still some things where it might be better to bring in a trait from, say, a tomato into a cucumber or something like that. There could be different reasons for wanting to do that transfer between species, but the basic technology of GM is an older one and has been superseded. I think that genome editing will also continue to evolve and give us much better tools.

Q31 **Tracey Crouch:** Professor Griffiths, you mentioned in response to Katherine a second ago the use of technology to enable our better understanding of what we have around us and why and what it means. I assume that, like me, you are obsessed with the New York City tree map. Do you think that something like that should happen here, especially in urban areas? Would that be a really good use of investment?

Professor Griffiths: Mapping our trees and understanding the benefits of that has been clearly demonstrated through some of the i-Tree work that has happened in relation to the UK, valuing the economics of carbon sequestration, pollution capture and all the leisure activities that they provide. What is important is that you need long-term sustainability for a map like that. Again, it is about working with a consortium of different groups with perhaps different audiences on where those trees are and making sure you have long-term stability of that. You will also get a good understanding of what trees are doing well plant health-wise.

I also know there is Treezilla—another app—that has a focus on plant health. Our forest research looks at those things. It is helpful to have that. The RHS also has My Garden. There are 126,000 people on there and 80,000 different types of plant in their gardens are already on that mapping system. It is about understanding what we have.

As to where some of the challenges lie, particularly in relation to net zero, trees have been grossly underestimated, as have landscapes, for their potential carbon sequestration and storage, because the underground part of it has not been measured, particularly in urban systems, and also their optimal growth.

Q32 **Tracey Crouch:** My brief talks about the bushy, hairy-leafed cotoneaster, which the RHS is looking at in terms of its ability to trap harmful airborne particles. I spent a significant amount of my time supporting a school on a main road in my constituency to get an ivy screen. It sounds like the cotoneaster is more effective than an ivy screen, but it also might be more expensive. Through the scientific research that you are doing, do you see that in the future plants like cotoneaster could, if the price comes down, be more effective in protecting particularly young, vulnerable lungs from harmful particles?

Professor Griffiths: We currently have a two-year research project with the 1851 Royal Commission which is looking at exactly pollution capture. We have also looked at all the ivies. Believe it or not, there are 1,600

different types of ivy in this country, so we can look at which ones have which hairs and we can then generate it. Ivy is a multiple-service provider. It cools; it provides green for wellbeing; it provides food for birds; and it captures particulate pollution. I believe multiple-service provision will be very critical. We also need to look again at water-use effectiveness. There are a lot of plants out there already in those 400,000 that can be repurposed and used, but we just need to understand which ones are better than others, and what those traits are.

Q33 **Graham Stringer:** If I may follow up Katherine's question, at the present time gene editing is covered by the same legislation as genetic modification. The Government say they want to go step by step and move to genetic editing because they will change the genome only in a way that it would change in nature; there would not be cross-species change. When I listened to the evidence given to the Genetic Technology (Precision Breeding) Bill, we seemed to be being told that that is not the case. The plants are not that pure and there is already exchange between different species and plants, so the legislative basis on which the Government are proceeding is not a scientific one. Would that be your opinion?

Professor Hawkesford: I think we are going forward in a very cautious way and that is probably quite important for public acceptance, which is fairly critical. There are always different caveats one can make and all sorts of things do happen in nature in terms of transfers of genes, but the whole concept and technology of genome editing is really a clean way of doing what we want to do and would be achieved via lots of different ways of traditional breeding methods, but in a precise and rapid way without going as far as doing GM technology, where you have a lot of other parts of the machinery—for example, antibiotic resistance, etc.—carried forward. It is definitely a clean way of doing it. You could say that we could go further, but in terms of public acceptability, world markets and acceptability of products it is definitely a sensible and cautious way forward. I do not have anything against that as an approach.

Chair: I thank both Professor Griffiths and Professor Hawkesford for their evidence this morning.

Katherine Fletcher: Thank you, gentlemen.

Examination of witnesses

Witnesses: Dr Bastow and Dr Flanders.

Q34 **Chair:** Welcome to our session this morning. We have Dr David Flanders, chief executive officer at Agrimetrics, and Dr Ruth Bastow, innovation director at Crop Health and Protection, or CHAP. Thank you for joining us this morning.

If I may turn first to Dr Bastow, what are the key problems facing UK agriculture at the moment, and how would you prioritise them in terms of

solutions?

Dr Bastow: As we heard from Malcolm this morning, there is always a challenge in producing enough nutritious and safe food in a way that reduces your impact and environmental footprint, remembering that it needs to be economically viable as well. Farming, agriculture, is a business. That is the big picture we have heard about. Certainly, thinking about what is happening at the moment out there, farming and agriculture, like any other industrial sector, is facing inflationary input and energy prices. Fertiliser has gone up by at least 150% in the past 12 months. Those are the sorts of things we need to think about. That means we are seeing difficulties. People are thinking about how to make ends meet, deciding how much fertiliser to put on and whether they will reach the yield at the end of the day.

You have probably all heard about the labour shortages that agriculture is currently facing. They are massive. There are 50% vacancies, maybe even more at the moment. We need to think about that. You have also heard news headlines to the effect that animals are not reaching abattoirs; fruit and veg are rotting in the fields; crops are not being picked. That is another key problem for the industry.

Then there is climate change. It is massive. We have a sector that is reliant on the weather outside. There is a massive heatwave at the moment. We are thinking about what is happening. Is there enough water in the fields for crops? Equally, it was not that long ago that we were worried about flooding and soil erosion. We were also thinking about the storm damage that hit especially the forestry sector. We need to think about how we deal with that.

Linked to that is our challenge in meeting net zero. That is a really big problem for the industry. We need to think what we need to do to mitigate our emissions, but the unique thing about agriculture is the fact that we can help to be that carbon store and sequester that carbon, but then we need to think about the trade-offs we will have around that as well. You have heard from many farmers about removal of the BPS payment and the move to an uncertain future, so we need to make sure farmers have certainty.

Those are the things that I think are the challenges out there. It might sound a bit doom and gloom, but I do not think it is.

Q35 **Chair:** That is a good overview. Maybe you can say something about the immediate threat of this heatwave. Does that pose problems just now, or can we weather it, as it were?

Dr Bastow: I certainly think about those people who are trying to grow out in the field, whether they are early harvests or not. You are certainly thinking about when you want to plant your next crops. I am also thinking about those people who are able to grow the next crop and the droughts that may arise. I am sure we can weather the storm. Farming is

a resilient industry, but we need to think about this going forward. We will get more and more of this, so we need to think about how we are dealing with that.

Q36 **Chair:** Dr Flanders, what are the key barriers, if there are any, facing the rolling out of AI and data solutions in the agricultural sector?

Dr Flanders: There are many, and some of the barriers will certainly flip round to be advantages. The first is semi-historical, in that this is the Science and Technology Committee. The way I see the whole agrifood system is like an atom. It has a huge electron cloud with a tiny but very heavy nucleus. The nucleus is the farm and farming, and the whole agricultural sector is the electron cloud around that.

What has severely hampered the uptake of technology on UK and European farms is the common agricultural policy because subsidy is a disincentive to innovation. There is a massive opportunity for the UK now it is no longer beholden to the common agricultural policy. I would say that is a big potential advantage. Within that timeframe it is no coincidence that the parts of the sector that were not heavily subsidised are the most innovative: pigs, poultry and horticulture. They did not get any EU subsidy and they have grasped technology. To be frank, 40% to 50% of British farmers would not be profitable were it not for the common agricultural policy. I think the fact that the replacement of the environmental landscape management system—ELMS—by DEFRA still has not been finally sorted out is an opportunity that is ever-eroding.

An extreme example is New Zealand in the 1980s. New Zealand had an economic crisis. Its main industry is now tourism, but pre-Covid the primary industry was the food sector. Overnight, they killed subsidies for New Zealand farms. Everybody was up in arms and said the whole industry was going to go bankrupt. The stats I read indicate that 9% of famers went bankrupt. Then they have had to rely on innovation. New Zealand 30-odd years later still bats well above its size and weight through agricultural innovation because subsidy was taken away. That is the first big point.

The second is access to data. The farming sector, the nucleus, is deeply suspicious of data. One could argue, going back to my first point, that they are able to do that because they have been subsidised. They are very suspicious of anything to do with Government; they have had bad experiences as organisations through the RPA. To cap it, when technology first started to be sold on to farms, there was a farm management system software which, rather perniciously, took farmers' data without permission, so that has tainted it. There is a lot of data in agriculture, particularly on farms. It is siloed, no pun intended; systems do not talk to each other; there is no encouragement to share that data. I could talk more about that later. There is a lot of data out there and it is difficult to get hold of it. What drives it is information.

On infrastructure, 5G broadband is poor in rural areas. I think we have a very weak regulator. When I go to Scandinavia, on a Swedish mountain I can get five bars. That is because sensible countries ensured that 95% of their land area had mobile phone coverage. In this country, lobbying took place and it is 90% or 95% of the population. That is just appalling for rural areas. That is an example where Government can re-intervene and do something sensible. On 5G and broadband issues, it is no good having the best technology in the world if you cannot get hold of it. There are ways round that. LoRaWAN and low networks are available.

The big issue for me is skills. From my perspective, it is wonderful to talk to the Science and Technology Committee. I see that at least three members have science backgrounds with recognised A-levels, but, to be frank, you are in the minority. There are not enough STEM people in the UK or in Parliament. Thank goodness you are here showing interest. Particularly for people without a science background, it is great that you are showing an interest. Even worse, there are even fewer in the senior ranks of the civil service and in the media.

I go back to the point Katherine Fletcher made earlier. We still have our heads in a bucket. The rest of the world is in GM and has been for years. People are not foaming at the mouth after 30 years of GM. We are still living in a world where there is a lack of understanding of science and lack of education, and we have a media that do not understand science, with massively notable exceptions. I think that is a UK-endemic disease.

Q37 **Chair:** To be clear, I do not think the whole world is using GM; it is the European Union.

Dr Flanders: Apart from the European Union. That is very well picked up. South America, North America and China are, although they claim they are not. That goes for most of Asia. Nearly all the soya grown in the world is GM. Even places that do not admit to having it do really. This goes back to the earlier conversation that you had. Before I got into data I was a genomic scientist. That was my background originally.

To go back to the civil service, I have met some wonderful, good and hard-working people in DEFRA, but DEFRA is not fit for purpose. To be quite frank, one of my jobs here is to spike interest in my democratic representatives. The best thing that could happen to UK agriculture is for DEFRA to be sorted out. I do not wish to sound like a lockdown visitor to Bishop Auckland, but coming from a data AI perspective the siloed nature of data on farms reflects the siloed nature of the British civil service. That has to be addressed on a big scale. It is really exemplified by DEFRA. They are wonderful, hard-working people; they are very clever. I have met them. However, it is the Balkans. They are very good at growing grass where difficult matters get kicked into. Nothing goes between the different islands, and it has lost its focus on food. It is very environmentally biased.

If you are asking for my opinion as a member of the public, I would split DEFRA. I would put food production into BEIS; I would have a secretary of state for food production within BEIS. I would just acknowledge that DEFRA is environment-based and environmental. That would help UK food security, UK farming and the UK consumer.

Q38 **Chair:** I am aware of time and I know that colleagues would like to ask some questions, but can I take you back a few paragraphs? You were talking about removing subsidy and improving innovation. I will throw something back at you. Surely, if you remove subsidy, you remove the ability to pay for innovation and bring in expensive techniques. How do you balance those two?

Dr Flanders: That is very good. If I did not say exactly that I apologise. That has been the disadvantage. There is either actual subsidy, which was the CAP and basic payments scheme, or implied subsidy, for example, US trade barriers. My point would be that ELMS is replacing the CAP, and that is a subsidy, but there is a massive opportunity to use that to drive good behaviour. I go back to my background now. I would say that AI and data provide a great way of policing and patrolling that, looking for the environmental benefits and net zero, which is not something we have had a chance to go into. I think there are great opportunities for the UK in the use of AI. We have talked about Earth observation satellite data—we do a lot of that at Agrimetrics—to provide veracity for what we are doing. I am not saying no subsidy; I am saying that inevitably there has to be subsidy, but it is about the way it is directed. Before, you were paid for just having land, which was insane.

Chair: We will have an opportunity to explore this a bit further.

Q39 **Tracey Crouch:** I rather enjoyed that left-field grenade into the discussion, so thank you for that.

Dr Bastow, can I come to you, please? How well developed is precision farming in the UK? I am particularly interested if you can provide some context as to how well it compares to other countries.

Dr Bastow: Certainly, precision farming and that precision ag approach is widespread. There is GPS technology and the ability to alter steer on machinery across the UK. That is commonplace. You will see it in a lot of places and on a lot of farms. There are things like variable rate application, which is the ability to go out there, map a field, understand it, be able to place that information within a machine, within a tractor, and then say, "This is the amount of seed I require in this part of the field and this is the amount of fertiliser I require in this part of the field." You really are making sure it is a precision approach, applying only what you need and where you need it, which means, as a grower, you are reducing your inputs, you are reducing your costs, and, most importantly, you are reducing any negative environmental impact that might come about as a result.

The same is true for the plant protection products we were talking about earlier such as pesticides and herbicides. You have variable rate application for those as well. You are able to zone up the field. If you need something in one area and not the other, you can turn nozzles on and off, and you are able to apply products in the field like that. That is where we are now, but, looking a bit to the future, and that is certainly what excites me and it is why I am in this area, thinking of—

Q40 **Tracey Crouch:** Before you do, why isn't everyone using it?

Dr Bastow: Lots of people are using it, but, again, it is technology and some of the barriers that David was talking about earlier. It is always going to be price. A new bit of kit is hugely expensive. Are you going to decide to take that on or not? Are you going to try to figure that out? What is the ROI on that? Margins are always tight in agriculture, but even more so at the moment. Coming out of Covid and thinking about what you want to do next is massive. With price inflation spikes, it is even more so. The cost can be high for small businesses especially to take on that sort of cost.

Thinking about what you might want to do for the future is what really inspires and excites me. That is why I am here. I am a farmer's daughter, but science got me into this area. For me, it is not thinking about a region of a field, but getting down to a plant or maybe even a leaf. We are working on those sorts of projects at CHAP with companies like the Small Robot Company out there in the field looking at sensors that are able to detect pests, how much pathogen and how much disease there is, so that in the future you will be able to deploy, potentially, a robot just to that leaf to be able to spray a specific chemical. Those are the sorts of things we are looking forward to.

Compared to other countries—I think that was the end of the question—we are hitting out there. Other countries are using very similar technologies and very similar approaches. As always, countries like the US are perhaps driving more of that entrepreneurial sector. We heard earlier from Malcolm that there is a valley of death in the middle. You might get a great idea and great tech, but you can't always get it out on to the market; it often goes overseas to be developed instead. The Netherlands is always held up as an example, especially for the horticultural area, and Japan as well, thinking about the robotics that have come out of the automotive industry. We need to think about those areas that might take it forward in the future.

Q41 **Tracey Crouch:** Do you think we have the right mix of agri-tech and agri-science approaches? If not, how do you think they can be recalibrated?

Dr Bastow: We already have a great science base here in the UK and I think you need to keep funding blue-skies research. You never know what is going to happen or what is round the corner and what your challenge is going to be, so you certainly need to keep that funding base. I am from

an academic background who has come more into this sector, and it is clear to me that we have a huge hole in funding what industries' problems are. We need to think about solutions for real-life problems, not develop solutions and then think, "I'll go and look for a problem. What can I apply it to?" There is certainly a gap there for that.

The agri-tech centres have a key role in this. They are really set up to understand industries' needs—big and small; it really doesn't matter—and then work with them to co-develop those solutions, thinking about what we want to do with funding in that area. At the moment, the work that has been done, and the funding from BEIS that is lining up with DEFRA in this area, are very welcome, but we need to do more of that. It is not always new, shiny technology, either. We have great stuff out there, but people do not hear about it. Maybe the technology is not fit for purpose, but the technology is out there and we need to get it adopted. That has to do with trust in the sector.

If I am growing an arable crop, I probably have 40 years of my life to get it right. I am not going to mess about with it every year. I need to know that the new tech I am putting on my farm, if I think I can afford it, will actually do something for me and will give me a return on investment. There is a gap in the middle where you have a technology and you think it works, but you need to trial it in real-life scenarios. Is it going to be rainy? Do we have drought? Does it work in the north? Does it work in the west? Does it work on your soil types? There are all these sorts of things. We definitely have a gap in the system. There are lots of systems that do that—Innovative Farmers, LEAF and so on—but we need to link them all up to get more of this technology out to the people.

Q42 **Tracey Crouch:** Finally, do you think that UK agriculture is joined up to ensure the optimal use of nutrients and water? What steps do you think we can take if it is not?

Dr Bastow: It comes back to the sustainability approach. Often, in the past, due to the green revolution, we have been an input sector. We really know high-yielding varieties that require fertiliser and inputs. That is absolutely fine. It has fed thousands of mouths and saved a lot from starvation, but we also need to think now about more circular-economy approaches such as closing those feedback loops in the system in water and in nutrients, which we heard about earlier. That is what we really need to do.

We have been working on a great, novel project, where we have been looking at extracting nutrients and minerals from groundwater. Groundwater we take for us to drink is treated so it is safe, and one of those treatments is to remove high levels of nutrients, including nutrients like nitrogen that plants need. We have been thinking about ways with an innovative SME to extract those nutrients from our water—it is about 50% of what the plant needs—so that it is safe for us to drink. It used to be a waste product, removed as a salty brine, shipped off to water treatment works and removed. We can use that for greenhouses,

glasshouses and vertical farms as a liquid or even dry it down and use it in the field.

Not only do you get the wastes from another system back into your system for a circular-economy approach, but it has a lower carbon footprint than the normal water treatment as well, so it is a win-win situation. We need more of that. We need more about looking at renewable energy in the sector. We really need to be able to close the loops in the system.

Q43 **Tracey Crouch:** Thank you. Dr Flanders?

Dr Flanders: Ruth has put it beautifully. Just to extrapolate back to my fantasy big picture image, the great opportunity for data and AI in the circular economy, which Ruth outlined so nicely, is this. Traditionally, farmers get paid for what they produce, their yield, and they pay for inputs. Precision agriculture, AI and data allow you to change that model completely where farmers get rewarded for their outputs but they pay for their inputs according to output. That was not possible a few years ago, but now it is. The major plus of that is it reduces the incentive for the agrichemical companies to encourage farmers to throw chemicals on just in case.

Precision ag means you know exactly where you need to put things. If you join that up in a circular manner, farmers can then be paid—their input suppliers, their agronomist advisers, their chemicals and so on. There is then an incentive to reduce their use to make them most efficient. This is an example where—back to my point about subsidy for ELMS—there is a major potential for the UK, through subsidy and ELMS, to turn farming on its head and say that you get rewarded for outputs as per the global economy, but you pay the input reward, and that will encourage everybody to adopt technology, including the supply companies.

Tracey Crouch: Thank you.

Q44 **Rebecca Long Bailey:** Dr Flanders, I have a few questions on AI and data. First, I think it will be helpful for people watching at home to understand the advantages that the use of agricultural data and AI offers to agricultural and food production sectors. Secondly, you mentioned earlier that the sector was deeply suspicious of data, and you referred particularly to an incident where farmers were upset about the fact that their data had been shared in an unauthorised manner with third parties. Can you explain what happened in that incident and what we can do to restore faith in that sharing of data?

Dr Flanders: There are several things. It was not quite that; it was even more pernicious. It was, "If you don't tick this box, we can use your data." That was the issue. That was many years ago. That caused a big row at the time, understandably, when it leaked out. GDPR issues are helping. Everybody has become more aware of data. What is helping the

people watching at home and everybody has been that the paradox of Covid is that stale, pale, old males like me, who tend to be the people who sit in front of you and run businesses, have suddenly become aware of data because they have to use Teams and Zoom to talk to people. They have suddenly had to look at their IT department. That has been very good.

The boring old people I deal with at my level in industry are suddenly aware of data, so that helps, which means that it is now at boardroom level, where it often was not before. Organisations are now appointing chief data and chief information offers, which they were not before. That self-correcting way did not help at the time. I apologise, I have forgotten what your first question was.

Q45 **Rebecca Long Bailey:** It was about the advantages that agricultural data and AI can provide.

Dr Flanders: I have given some of the ones I believe are the big picture. On a smaller scale, I will give you a nice example. I am obviously biased about what we do. Back to Katherine's point about Earth observation, Agrimetrics and many in the sector use a lot of Earth observation data—satellite data. It is the game changer, particularly because of the fact that there is a lot of free data now available through Copernicus, the European satellite system.

An example of that is that you need to know what is going on at the time. So we use a combination of Earth observation data—we have a data platform—and AI technology. We know before anybody else the main crops grown in the UK. We can also identify field boundaries and so on. I cannot name them in a public forum, but we are partnering with a large organisation many times bigger than us and we are currently looking at Ukraine. What is key is that 30% of the world's wheat exports and sunflower come from Ukraine. The world needs to know what is going on. You can see from space. We are using Earth observation technologies developed in the UK to work out what is growing and later what the yields are likely to be, which is a bit of an extrapolation further.

I have a nice similar example. I apologise because I have very good friends in DEFRA. The building block of agriculture is the field. When I came into this job six and a half years ago—we have core ground funding from the Government, Innovate UK—I realised that you could probably build a business for agriculture by just having a nice data platform with modern technology pulling all these data together. Getting data out of the Government, DEFRA, is very difficult for understandable reasons. The prime example was that the Rural Payments Agency has every farm boundary in Britain. That is the building block. With the Dutch, you get them. It allows technology to build. It helps agriculture. I spent a long time trying to get this, and I could not.

I then partnered with Airbus, which, as well as making planes, is the world's largest private supplier of Earth observation data. We developed

an algorithm together to identify UK field boundaries purely because we could not get it from RPA, which is a double use of taxpayers' money. Having developed the technology, we now jointly sell that worldwide with Airbus. It takes a bit of tuning, but it is AI use of Earth observation data. In a way, that is a silver lining from a cloud. Maybe that should not have happened in the first place, but it has a nice silver lining.

There are other examples. We do a thing called Fields of the World, which is open-access, free data. We use that technology with Earth observation technology and the data we pull together. Anybody who is watching online can go and look at Fields of the World. It is 11 of the world's major crops and 12 of the world's largest food-producing countries. You can look at a given field and see that stack of data involved in there. There is great potential for the things that start small in the UK.

Going back to my point about ELMS, something I have not touched on but has been touched on a bit by Ruth is robotics. The labour shortages caused by Brexit in the farming sector are driving robotics, which the UK is leading in. Using AI, data, information technology and sensors, you can pick strawberries by machine. That is the future. I think that is a great potential for the UK and worldwide. We have been pushed into it, but there is great potential. Back to your point, it starts small in the UK, but there is great potential to expand it.

Q46 **Rebecca Long Bailey:** You mentioned the issue of skills earlier. In your view, how do we address the skills shortage in agriculture? Is it a question of pay? Is it a question of skills training?

Dr Flanders: Am I allowed to bash my head against the floor in a Committee meeting? I do not have the answer. My first monologue about STEM shortages is basically an answer to that. It is very prescient of the UK Government to fund the agri-tech initiative, which George Freeman as Minister for Life Sciences drove in 2013. At that point no one cared about agri-tech. About $13.1 billion went into agri-tech in the US. We are fourth in the world. There is all that money coming in. That is really good. The minus side is that if you are not in a purely capitalist environment it is difficult to keep people. We pay reasonably, but we are Government supported, and I cannot give people stock options.

Going back to my point about general interest in data, if you are a data scientist or a software engineer, you are in massive demand. Levelling up has occurred because of remote working. London salary levels are now the same everywhere. We hire people all over the country, which is great, but it means the salary levels have gone up. If you are a software engineer or a data scientist, you are massively in demand because we do not have enough people, but, if you also have agri-tech experience, you are a gold-plated hen's tooth. I am partly in this job to do public good. I almost think my public good is training people for the sector because they get poached by people who pay more money.

We have seen more and more young people come in, some of them driven by the fact that there is money in it. Also, food is a big issue in society, and that is good. It was less so when I was growing up, but I am old. Some of the young people we see coming into my company and others with the agri-tech sectors genuinely want to make a difference. They see that food and anything to do with it is important. It is being sucked in at a lower level. It is a combination of, "Food is important," and, "I can make reasonable money at this." I do not have an overall answer. I just beg for more STEM in UK schools somehow.

Q47 **Rebecca Long Bailey:** Dr Bastow, going back to the points you made earlier about precision farming, more broadly, can you explain to the Committee to what extent precision farming can help the UK increase crop yields while reducing environmental impact?

Dr Bastow: I touched a bit on this earlier. If you are able to apply a product such as fertiliser or a crop protection product in a precision manner, only applying it exactly where it is needed, you are reducing your inputs and you are also making sure that you have a minimal environmental impact, as you said.

Coming back to the robotics that David just talked about, if we take it a bit wider outside into that field, you are talking about picking, harvesting, and making sure you are getting it right at that point when you need it, so you are reducing waste in the system as well. So we need to think about that. Even further on, that precision agriculture will help in that, instead of having heavy, large tractors out in the field, we have light robots out on the field or swarms of them. Maybe they are run by solar renewable energy. Let's think about that. The footprint is smaller and they are not compacting the soil. There is a real concern about soil health and thinking about what we want to do about this for the future. That brown gold underneath us drives everything forward and we need to maintain it. If we do not have heavy machinery out, that is going to help as well. We need to think about those things.

Alistair also touched earlier on thinking about surveillance systems in agriculture but also outside agriculture. If we had a great surveillance system in the UK that monitored and automatically tested for pests and diseases in the air—and there are already many ways we can do that—and we had it linked up all over the UK, you could see the spread of a disease, whether for animal, plant or crop health, or understand if something comes across the border. You are not just going to test for it at our ports and airports. They do not really care about that. If we have another version of ash dieback or something else, it is going to come in. These are all the sorts of technologies through that sensor, precision, data and AI approach that we could think about and are going to help. That means you keep your plant healthier, which means it is going to yield more.

Q48 **Rebecca Long Bailey:** On those new technologies, I remember visiting a north-west science park a few years ago where they developed what I

called the moth radar. I think it had a special technical name, but it did exactly what you just suggested and mapped out potential pests that were coming towards particular areas. That technology has been in existence for some time, and yet it has not been employed within the UK. What do the Government need to do to support the deployment of that technology?

Dr Bastow: There are two things here. Get it out in the field, get it tested and make sure it is useful for the end user, and then help get that price point down. We talked earlier about why people do not adopt these technologies. It has to be at a price point that is viable to make a good return on your investment, or you are going to back it as a national service. Maybe we need a UK surveillance service that allows us to do that, and that is for our public good. We can think about that as well.

It is also about trust in the system. We heard about trust in data. Does it really do what you say it is going to do? Let us say I tell you that I have a sensor that detects potato blight in the field before you can see it with the naked eye. As a grower, I am going to say that sensor can tell you whether or not you are going to spray. Normally, I spray them whether or not I see blight because it is going to take out my crops, so I need to do it. Do you trust it? We need to have data and evidence behind this and really make sure that it is going to do what it says on the tin for the farmer and the grower.

Q49 **Rebecca Long Bailey:** Do you think the UK is fully exploiting its greenhouse and vertical farming opportunities?

Dr Bastow: The honest answer to that is no. There is always room for improvement. Greenhouse growers and companies around the UK are totally innovative. They are really driving the sector forward. They are looking at renewable energy, ground source heating and heat stores in water. They are doing the circular-economy approach left, right and centre, taking the nutrients from the plants and putting it back in for compost. They are taking some plants such as tomato plants end of life and converting them into biomaterial like a bioplastic to wrap your tomatoes in, and that is biodegradable. This is really good stuff. They are also using that precision approach to apply pesticides when you need them. There is always more we can do.

The great thing about that not growing in the field, alternative approach to the field-type growth, is that we can think about reducing our imports as well and think about where our food comes from for the future. We need to think about alternative proteins if we are thinking about our carbon footprint.

Vertical farming is another very interesting sector. Here, you are growing up, not out, so you reduce your footprint. You are controlling your temperature and your water. You are controlling every nutrient that you put into it and the lights as well. That means that you are optimising all

your inputs, reducing it as much as you can, but you are maximising your outputs. That helps with that.

You can co-locate. You can put it really near an urban centre, reducing your food miles and your waste. Back to that circular-economy approach, you can take heat from large buildings, you can take waste water, and you can take it forward like that. There are loads of innovative companies in the UK that are trying to drive that forward. Yes, we are getting there, but there is always more to do.

Rebecca Long Bailey: Thank you.

Dr Flanders: I completely agree with everything Ruth says. I would just say two things. First, you have to link that with other data, and, secondly, going back to net zero, that is not necessarily an advantage from a carbon perspective, so you have to be very careful about that. There is great hope for vertical farming, but farmers get light, water and growth medium—well, they pay for the land—basically for free, but as soon as you put things inside you have to get light, which is expensive energy. I am a great fan of vertical farming, but it needs to be taken in the whole context. It is not a panacea. Back to your first question, the UK is leading on that in many ways.

Dr Bastow: I definitely say that. The biggest problem for the vertical farming sector is energy. How do you get your energy into it? Then we start looking at renewables and you decide what your trade-off is. What do you want to grow in there for what reason? It does not mean it is going to replace our fields—absolutely not. We are always going to be needing field-based farming. Again, you think about this balanced portfolio that we need for land use in the future.

Rebecca Long Bailey: Thank you.

Q50 **Katherine Fletcher:** I want to come back on data. What struck me when listening to your opening remarks about the way data is in silos, and perhaps it is a little 20th century, is that you could probably apply that to most of Government. I do not think it is necessarily a failing of the baronetcy of DEFRA. We have heard evidence in a different setting about health data and there has been talk about creating ringfenced research environments within health data.

Do you have a perspective on where Government should start or create an innovation environment and where Government should stop and free up organisations such as yours to move forward with the data? Where is the line for us?

Dr Flanders: That is a good question. I do not think there is a line. I would say it is blurred, and that would be important. I got into this through genomics. I was originally a plant scientist. That was my background. The health sector is a nice example of how, with anonymised data and pseudonymised data, Genomics England helped with Covid. It is less directly applicable to agriculture and others.

Coming into this in the last few years and dealing with the corridors of power, particularly in Whitehall, the default condition is, "No"; the second default condition is to kick it into touch; and the third default condition is to say, "This is multi-agency. We can't deal with it." When Liz Truss was the DEFRA Minister, off the cuff, she announced 8,000 datasets had been made available. At least that opened the genie bottle a little bit.

There is a thing called FAIR data. Many organisations, sectors, countries and within Government, in DEFRA, there are people lobbying for this. They are lobbying for more open data. FAIR data is data that is findable, accessible, interoperable and reusable. Obviously, you have to have commercial confidentiality, but if you have those driving principles that have been adopted worldwide for Government data—the default condition should be this is released, it is released in a manner that is fair, it is accessible, it is interoperable, and it is reusable—that will accelerate the economy in general. Obviously, certain things have to be kept confidential both in business and in government, but, generally, if that was the default I think that would open up the economy enormously.

Q51 **Katherine Fletcher:** That was going to be my next question. What can the UK learn from how others are doing it? You seem to suggest in your remarks that the data only gets value if it has a scale outside the UK. I grow a plant in Mozambique and grow a plant in Manchester, and there are probably two different sets of environmental conditions. What is everybody else doing that we should be looking at?

Dr Flanders: I would not quite say that. It is value in the UK and even greater value, potentially, beyond our borders.

Before I answer that question, I will say that Agrimetrics does a lot of work worldwide. I will give you two examples. The European Space Agency funds a large project led by the Satellite Applications Catapult—also funded by Innovate UK—called ForestMind. We are involved in pulling data together. It pulls Earth observation data together. It pulls what is called ground truth data together—what is happening on the ground—and it is in South America. Sainsburys is involved. It is to show to the UK consumer and others that your soyabean or your beef or your coffee has not come from land that was recently a rainforest. That is a nice global example.

In terms of money, from a capitalist position, there are massive amounts of money flowing into ag-tech, and it is starting to come to the UK. Last year, the UK was fourth in the world in terms of investment in ag-tech. On your point about genomics and related healthcare, the UK has always been really good at that in terms of biotech, Cambridge and the golden triangle, with the money flowing into biotech. It is now starting to come into ag-tech. In the UK, it was £1 billion, so we are fourth in the world after the US, China and India, which is not bad. That is happening, but I think the translational research chasm that the agri-tech centres helped to address, which Ruth eloquently described, is still the funding chasm. It

is well known in biotech. There is still that funding chasm. The UK is very good.

Q52 **Katherine Fletcher:** Is that translational research gap what is preventing us having a list of the applications that the agricultural tech can do? Do we have a knowledge gap, or can you see what the applications of agricultural data and AI are and we just need to leap over that hole?

Dr Bastow: I guess it is both. There are knowledge gaps that we need to address and we need to get that better out there. It is not just one chasm. You are not just jumping one gap here. Actually, you need to figure out whether it is going to work very simply early on. Can you test that initial idea? You need to fail fast and we need to be able to test. For example, if I want a biological alternative as a bio-pesticide out in the field, I ask, "Does it kill the beetle I want it to kill? Yes? No? Right, no; let's get rid of it. Yes, it does what I want; fantastic. Can you scale it up? Can you spray it on a plant? Is it going to stick to your leaf?" Then you need to be able to test those things, and that is the second bit.

There are lots of things here we just do not support, do not fund or do not do in a co-ordinated manner. Once you have that, as I said earlier, you want to go and test it in the field and in as many scenarios as you want. We know our problem. There are not enough tools in the toolbox for plant protection products, but, if you want a pipeline of alternatives to synthetic chemistry coming through in the long term, you need to fund that all the way along the line. It is a rate of attrition, so we need to send more in at the start than we are going to get out at the end, and we need to remember that.

Q53 **Katherine Fletcher:** It is the classic funnel. Are other countries doing stuff that we need to shamelessly copy?

Dr Flanders: Either of us can answer that. We will both give the same answer. We will probably speak as twins. I am very pleased to see you have Louise Fresco as the next witness. Worldwide, Wageningen University—I cannot pronounce it; apologies to Dutch viewers—is held up as a prime example of what you should be doing. Ruth and I visited there earlier this year, and they have a massive campus. The middle is a university, one side is industry, and the next side is a research institute. The buildings interact. You cannot tell who is where. That is because the Dutch have a triple helix model where the Government, academia and business work together.

I think it is the world's second or third biggest exporter of produce. Look at the size of it. It has a very similar climate to East Anglia, particularly. That is because it is joined up, it does things effectively, and it takes science, makes it into technology and then turns it into business very effectively. I am delighted that your next witness will be Louise because you will get some really interesting insights in the way the UK could be vastly improved by joining things up.

Q54 **Katherine Fletcher:** Anywhere else?

Dr Bastow: Certainly, the US always has that entrepreneurial spirit, but I would also say areas like Canada, which strategically picks what it wants to do. It is looking at utilising plan products for plant proteins. It strategically thinks about what it wants to do across the country, what it will grow where, and how it wants to invest in R&D. It is a pipeline—how you are going to process it, who will take it on, think about your markets. That is the approach you get in the Netherlands to take that all the way through so it is all linked up. Those are the sorts of countries we would look at.

Katherine Fletcher: Thank you.

Chair: Thanks very much. That concludes our second panel. Thank you both very much for joining us today.

Examination of witnesses

Witnesses: Professor Fresco and Ismahane Elouafi.

Q55 **Chair:** We now welcome our third panel who are appearing virtually. Good morning, and thank you for joining us. We have Professor Louise Fresco, former president of the executive board of Wageningen University & Research, and Ismahane Elouafi, the chief scientist at the Food and Agriculture Organisation of the United Nations. Thank you both very much for joining us.

Turning to our panellists, I will ask what the key regional and global challenges are facing agriculture and food production at the moment. I will start with Professor Fresco.

Professor Fresco: Thank you very much, and thank you also for the opportunity to share a few thoughts with you. I think Ismahane and I are probably very much on the same wavelength. I have listened with great interest to the previous speakers, so I think there is a great deal of coalescence of ideas here.

As for the challenges, the bottom line is that between now and 2050 we need at least 50% more food, but that food needs to be produced sustainably, it needs to be nutritious, it needs to be safe, which is a dimension that is often forgotten, and it needs to be affordable. Affordability is really very important when we think about the income levels of most of the world's population. We have a tendency in Europe and in the OECD countries in general to forget about affordability as a key factor in food production.

One of the reasons why the green revolution, with all its problems, was also a success is that it made food much more affordable. When markets opened up after the fall of the Berlin wall and the entry of China into the WTO, food prices have gone down very steadily. In fact, they have gone down steadily ever since the second world war, and it is that affordability that we should not lose sight of.

When it comes to the regional picture, there is a lot to be said, and we will touch on that also in the next questions. Basically, the equation is that by the end of this century you will have 4 billion people in Africa, and most of them will be on less than a few dollars a day. That is our biggest problem. Most of those people, although they are still partly in rural areas, will be in urban areas. Providing gainful employment in agriculture in rural areas and in food production in the entire food chain is going to be a key issue. For me, the issue is not just about agriculture, but it is also very much about food and the whole package that comes after harvesting.

You will have 5 billion people, more or less, in Asia and the Pacific and so on, and you will have about 1 billion between the Americas and Europe. Also, Australia is included in the 5 billion. It gives you a sense of the proportion. As Europe, we become smaller and smaller markets, and the two big markets are Asia and Africa. As it looks now, at least if we extrapolate, Asia will have a steady growth of income and a steady growth of the middle classes, but it is the middle classes who do not exist in Africa. African yields, to give you an idea, are only a fraction of what they are in Asia.

There is one telling statistic that I would like to quote to you without overdoing it. When you look at China's yields, they are about 40% above those of India, and India's are 40% above those in Africa. When I talk about irrigated agriculture, only 2% to 3% of sub-Saharan Africa is irrigated, whereas they have an enormous mass of water both in lakes and freshwater rivers like the Congo river and a few other big ones. The technology has not even arrived in Africa. That should be our main concern.

For the UK and Europe, our concern is to find a balance between nature conservation, maintaining biodiversity and getting agriculture truly climate-smart, which is more than just sustainability, meaning also carbon fixation in the soil. That is where a lot of work still needs to be done. The key, urgent issue today for me is food production in Africa.

Q56 **Chair:** Thank you. Could I turn now to Ismahane Elouafi? Could you add your comments to that, but also tell us what impact things like the conflict in Ukraine are having on world food supply and production, and what impact Covid-19 had on global food production?

Ismahane Elouafi: Thank you very much. I am very glad that Louise spoke before me because we are along the same lines. Thank you very much for the opportunity to address you.

What we have to say loud and clear is that we are at a very critical juncture. We are falling behind our efforts to end hunger, food insecurity and all forms of malnutrition by 2030. Louise gave out some numbers. We just published a survey last week in which we said that, right now, 828 million people are affected by hunger. Those are the statistics from 2021. If we look at pre-Covid and pre-conflict, that is 150 million more

since 2019. It is really a huge number to get our head around. We have 150 million more people who are hungry today because of Covid and because of the war as well.

The other point that I am glad Louise brought up is affordability. Right now, we have about 3.1 billion people—those are the numbers from 2020—who cannot afford a healthy diet. That impact is shown, unfortunately, mostly on our children, on the future generation.

If we look at stunting and wasting, right now—and this is the estimate from 2020—we have 45 million children under the age of five who are suffering from wasting, which is the deadliest form of malnutrition. If you are wasted as a child, you are 12 times more likely to die in the next few years. We have 149 million children under five who are stunted, which means that they will never develop to their full potential. We also have a rising number of overweight children in certain countries.

We have always said for the last few years that it cannot get worse, but we are showing that it can get worse. We are at a point where we are finally talking about solutions and we are talking about transforming our agri-food system. Right now, this is the point where we have to do it.

Going back to your question on Ukraine, it is very clear that the ongoing conflict in Ukraine is having an immediate impact within Ukraine and also a rippling effect across the global food system given the critical role of Ukraine and Russia in the agri-food system. I have a few numbers for you on the impacts of the war and Covid on agri-food systems.

We are seeing that the war has disrupted the supply chain and has affected the price of grains, fertiliser and energy. After listening to the first panel, you can understand how those three are very connected and very important. Both Ukraine and Russia are important players on the global market. Their share of the market is quite big. If we look at data from the last three years, those two countries account for 30% of the global wheat export, 20% of the maize export and 78% of the sunflower oil export. Many countries depend on the Russian Federation and Ukraine for at least 30% of their wheat import needs. If we look at the numbers in 2021, Russia ranked as the top exporter of nitrogen fertiliser, the second leading supplier of potassium and the third largest exporter of phosphorus fertiliser. If you look at the importing countries, 25 countries rely on Russia with an import dependency of 30% or more for nitrogen, phosphorus and potash.

Against that background, the escalation of conflict engaging such important global agricultural commodity market players at a time of a volatile international food and import crisis raises significant concern over the conflict's potential negative impact on food security, both domestically and internationally, especially for low-income, food import-dependent countries and vulnerable population groups across the globe, many of them in Africa.

The current situation of high world food prices, high energy and fertiliser prices and high transportation costs represents a huge challenge particularly for low-income countries, most of which are importing countries. These countries are already in a very difficult situation for a variety of reasons. One of the major ones is definitely Covid-19 and the economic impacts that we have due to many restrictions that were needed during the Covid-19 pandemic. They already have problems with the balance of payments and depreciation of their currencies.

Several countries are in a protracted crisis due to conflict, climate-related problems and the economic downturn. Right now, we need to take advantage of the importance of the agri-food system to really transform them to help both in terms of food security and in reducing malnutrition and protecting the planet.

Chair: Thank you. That is a very comprehensive picture of the current situation from both of you. Thank you for those statistics as well. Some of them are really concerning.

I want to turn now to my colleague, Rebecca Long Bailey, for some questions.

Q57 **Rebecca Long Bailey:** Thank you, Chair. This is a question to both of you, and thanks for speaking to us today. To what extent is agriculture and food production balancing increased yields with a reduced environmental impact, starting with Professor Fresco?

Professor Fresco: Thank you very much for the question. I do not think this is a matter of trade-offs in the sense that you can accept some environmental damage if the yields go up. That is the thinking of the past, in a way. We really need to strive for what I would call optimal resource efficiency. Yes, you do need resources like fertiliser and inputs of plant disease control. That can also be done partly by better breeding and so on. You need to have water. All those inputs need to be there, but the question is that you have them there at the right moment and in such a way that the plants can use it, to put it simply for non-agriculturalists. You do not want to fertilise the soil; you want to fertilise the plant roots, and no more than that, and you do not want any effluents to go anywhere. The thinking really must be to optimise any inputs you use.

Let me make a very strong case here for increasing yields per unit of land, per unit of water and per unit of labour. The most important way in which we can protect the world's land surface, and with it its biodiversity, is by concentrating agriculture on the smallest possible area that we can muster. If yields had not increased since the 1960s, we would have needed probably two and a half times more land than we are using today. If India did not have its grain revolution, with all the problems that also came with it, it would have needed an area as large as the United States to feed its growing population.

As we know, the world population will still increase quite dramatically, although it will level off, starting with the middle and higher-income countries. We need to concentrate on the best possible land and not go for marginal agriculture. Marginal lands are better left to the environment, biodiversity or carbon storage forests. In my view, it is not a matter of balancing it, but of education and the technology that goes with it to really optimise whatever input we have.

Q58 **Rebecca Long Bailey:** Thank you, Professor Fresco. Ms Elouafi, the same question to you.

Ismahane Elouafi: You have heard a lot about the green revolution, and we all agree as scientists that the green revolution was very much needed in the '60s and the '70s, but right now our understanding of the issues is completely different. We need to rethink our agri-food system and we need to take into consideration what you call the true cost of food. The true cost of food includes the social cost and the environmental cost, and this is where we need to rethink how production is done worldwide.

Louise mentioned Africa in the beginning with less than 7%—5% to 6%—irrigated land, for example. The potential of producing much more in Africa in terms of quantity is amazing. Right now, if you look at any field of any staple crop, you get about one tonne per hectare in many parts of Africa—it is a huge continent, so there are differences—whereas you get about 12 tonnes in Europe. There is a potential of multiplying by 12 by providing Africa with the right technology.

In certain parts of the world, many ecosystems have been pushed to produce things that they were not meant to do. That is where we need to increase production—there is no doubt about it—because of the growing population, but we need to do it in a much smarter way. We need to put sustainability as a must have and we need to do it in those countries that need it the most, and those are mostly least income countries.

My idea, which we have been discussing in the FAO, is to produce local species in those African countries such as fonio, millet, sorghum and manioc, you name it, and you push policy to create a market for it whereby you do blending policies. Kenya has a blending policy of maize with millet. The reason behind it is not only to create a market for millet because it is more nutritious but so that people eat more nutritious food—we know that millet has much more nutrition and many more amino acids and nutrients than maize—and to reduce pressure on the price of maize.

If we can provide technology to the African countries to produce the local species that they have been breeding in their national systems at a small scale, we can help them create a market for it through policies, either public procurement, WFP procurement or the national ones, or the blending policies. It is very important right now, if we want to do it right, to provide that know-how to the south so that the south does not

produce the same way they have been doing in the last few years, which was very heavy on inputs and very heavy on the water footprint.

Q59 **Rebecca Long Bailey:** I have a very broad question. As you know, the UK and other countries across the world are going through a cost-of-living crisis and food prices are skyrocketing. You mentioned earlier the issue of the war between Ukraine and Russia and the fact that they produce a large proportion of the world's grain and fertiliser supply.

What can policymakers, particularly in the UK, do to ensure that we have some level of food security here so that we can bring prices down for consumers? Is there anything that can be done to support precision farming in the UK? Should we promote the rolling out of more wheat growing on farms? What measures can you possibly think of that we could ask Government to look at now, starting with Ms Elouafi?

Ismahane Elouafi: Those technologies that allow you to produce more and more smartly definitely have to be supported. We do not want to push countries to think about food sovereignty because that is a very dangerous path to walk. We need to open up the market. The market has to stay open within Europe and beyond Europe. We need to diversify our agri-food systems. I always go back to members. In Kent, we have about 400,000 plant species, and right now our market is concentrated on only 125.

Diversification is part of the solution going forward. We have to look into other species that we have neglected over time. Normally, they are meant to be in that ecosystem because they have survived in it for millions of years. They are more adapted to climate change. They are more nutritious because we have not pushed for more productivity. There is a negative relationship between quantity and quality. That is what we have done in certain species.

Precision agriculture and high-tech technology to produce more with less have to be pushed, combined with an open market and a regulated market globally to make sure that we are not creating more inequalities again. Sharing the know-how with the south is very important. If we share the knowledge with the south, they can produce more, hopefully, in a sustainable way because we will provide that knowledge, and that will release a little bit of pressure on the global market and reduce the inequalities, which is one of the areas that we should really tackle very quickly before we get more conflicts sparking in many parts of the world.

Q60 **Rebecca Long Bailey:** Professor Fresco, the same question to you.

Professor Fresco: To be honest, I think the UK is rather well-off compared to some countries where they depend for 50% of their imports on Ukraine, Russia and Belarus. The great thing about food is that it is produced in two different hemispheres of the world, so it is only a matter of time before countries like Argentina and Brazil step up their production. There is no reason to think but that absolute shortages would permanently drive up prices. It is important to do that because we see a

volatility of the market that is an anticipation of problems and not necessarily a shortage problem apart from those countries that are very vulnerable and, as we argue, so dependent. That is not true for the UK.

In terms of international policy, the most important thing is for all countries to keep the borders open to keep international trade flowing, as Ismahane also said. Of course, a policy needs to be science and technology-based. There is a tendency to think that one can do without fertiliser or one can do without various other modern technologies. That would be a great error. You want to use those technologies wisely. A world without fertiliser would mean vastly reduced productivity. That should not be underestimated. It is interesting, however, that the urban upper classes who are often far removed from agriculture think that the things that they have benefited so much from in terms of their own food expenditure can now be abolished, such as fertiliser. I am perhaps making a little bit of an obnoxious comment here, but I am always worried when I read certain UK papers that suggest that we can do everything without fertiliser.

Technology needs to be put in place, but that is not a matter of a year or two. Similarly, Ismahane's suggestion that we can use new varieties that have not been bred yet for any improvement is a matter of time. That cannot happen tomorrow.

From a policy perspective, probably the best thing to do for the low-income classes is to give them support either through food stamps or economic support in other ways rather than restricting UK exports. For the middle classes, if you look at the figures for the UK, you will see that from the 1960s onwards, so over the last 50 years, the average middle and upper-class households have spent much less on food. It used to be up to half of the household income, and it is now about 15%. I am not exactly sure of all the figures here, but it is more or less in that order of magnitude.

To be a little provocative, it is not a bad idea if the upper and middle classes understand the value of food again. It is not necessarily a bad thing in itself. What is a bad thing is the social nervousness it brings and the volatility in the markets. We can perhaps move on to the specifics of the technology in your further questions because there is a lot more to be said there.

Rebecca Long Bailey: Thank you both.

Q61 **Tracey Crouch:** That is exactly what we are about to do. Ms Elouafi, could you explain to the Committee what role genetic modification and gene editing is playing in global and regional agriculture, and what its potential for solving agriculture and food production problems might be?

Ismahane Elouafi: Thank you very much for the question. Indeed, it is nice to move to a technical discussion. Let us put it in perspective. We agree that the global demand for food and agricultural products by 2050

means that we need more production. The FAO projects that agricultural output may need to expand from between 40% to 53% by 2050 compared to the baseline that we had in 2012. At the same time, plant production is seriously tempered by biotech and agri-tech constraints, including the diminishing area of arable land, water scarcity, decreasing biodiversity, increasing occurrence of plant pests and diseases, and extreme weather events. The challenges are growing and we need to produce more.

Food productivity and resource use efficiency are very important. They are indispensable steps towards meeting both food production and environmental goals. That is where science can help us to identify context-specific intervention that enables the optimisation of production efficiency. We need, as we said earlier, to emphasise efficiency and produce more with less.

Sustainable crop production intensification requires an integrated approach of plant conservation, breeding, seed systems and varieties of seeds for increasing production while coping with environmental change. I always say there is always the best crop for the environment. Look at the natural resources and what the ecosystem is like, and try to push it that way. That is where science and technology, including agricultural biotechnologies, are very important, and they can help us to produce more with less in terms of quantity and quality.

At the FAO, we adopt the same broad definition of biotechnology. When we talk about biotechnology, we are using the convention on biological diversity, and we look at both the low-tech and the high-tech. We never had issues with the low-tech—for example, tissue culture and how we are multiplying different species, particularly trees—whereas we have had lots of issues with high-tech, particularly genetic modification. There is a wide range of uses and possibilities—crops adapted to abiotic and biotic stress, monitoring of genetic diversity and biodiversity, phytoremediation and improved soil health. When we think about the high-tech, the applications are huge all over the world. It is very important for us to understand that we can use those technologies to increase productivity.

Genetic gains, however, particularly the improvements that are realised from the adoption of improved crop varieties, while critically important for sustainable crop production systems, translate to maximum impact on farmers' fields only when they are delivered to farmers as an integral part. Using only the breeding without using the whole package would not mean much. We should keep in mind that we need to provide to the farmers, particularly when I am talking about the south, the whole package. We need to use technology to improve fertiliser use efficiency, and we can use technologies like gene editing for that. As well as producing smartly, we need to use the gene editing technologies and other biotechnologies to really increase and speed up the breeding of animals, crops and micro-organisms.

Given the crisis around fertilisation, I agree with Louise that we cannot suddenly move towards non-chemical-based fertilisers. We see the crisis in Sri Lanka. They took a decision about two years ago and you can see how the whole economy is collapsing. We need to diversify fertilisation, and we can do so with new technologies, including biotech-based technologies, as well as with other methodologies like inter-cropping with legumes, inter-cropping with crops and mixing species together. We need to think broader, but we also need to bring in the potential of different ways of producing fertiliser, including bio-fertilisers.

If we want to get to net zero in the agri-food system, we will require innovative solutions. We need to think about climate-smart agriculture. We need to think about agroforestry, precision farming, drip irrigation, desalination, AI, but we also need to have space for new technologies to do that. If we prevent new technologies from coming to fruition, we are really losing an opportunity to use technology and innovation to increase productivity wisely and sustainably.

Q62 **Tracey Crouch:** We heard from previous witnesses about a silo mentality in some of these decision-making processes, and you just mentioned in response a joined-up and more integrated approach that is needed. Do you consider that lack of joined-up thinking and approach as one of the greatest barriers to making progress in this area?

Ismahane Elouafi: Absolutely. It is very much needed. It starts from education. Maybe Louise can talk to it better from her academic background. The way we are educating our kids has been very much creative silos, not getting people to talk holistically. I think we have really missed that boat on the education side as well as the implementation side.

In my time with the federal Government in Canada, I remember we realised that we were spending way too much money to prepare our safety engineers and our food safety employees. We brought in vets, for example, but they still needed at least six months' training to understand how to do inspections. It was even more difficult with food safety. We ended up going to universities and creating a curriculum to make sure that we got employees who already knew how to do it. Mixing education and redesigning it to get people to understand holistically how things work together and not only from certain lenses is very important.

We need to rethink the system, and that is where we are saying re-engineering the agri-food system about the way we think and the way we bring together the different actors gets them to see the lenses from the other side.

As we are doing the re-engineering, we should look at the return on investment. Unfortunately, the farmer has the lowest return on investment. The supermarket has the highest return on investment. Why, for God's sake, should the supermarket get more money for putting things on the shelves, whereas the farmer has been producing it is for at

least six to nine months and gets much less return on investment? We should keep all these things in mind as we are re-engineering and re-transforming our agri-food systems.

Q63 **Tracey Crouch:** Professor Fresco, do you have some thoughts on that? You were teed up nicely by Ms Elouafi.

Professor Fresco: Yes, I do. We are a little bit like Tweedledee and Tweedledum. There are lots of things. I want to say something about genetics, but let me first come to your question about the silos. The problem with the silos starts in Governments because we still have very separate Government Departments. You have agriculture and rural development. Infrastructure is often very different.

It has been a major surprise to me throughout my entire career that not one country in the world has an integrated food and agriculture policy that cuts across Departments, and even in its own Parliament—and I guess you are not an exception—there are no integrated Committees to look at the whole. Science and technology are separate from agriculture, for example. That is a real drawback. It leads to recruiting people with a certain type of expertise and not to more horizontal mobility, which is a very important issue.

Wageningen University, where I taught but I stepped down exactly a week ago, has been very integrated. People have a far more integrated background. There is a beautiful old English saying, which is that you need to be a master of one and a jack of all trades, or the reverse. I think you need both. You need to have the discipline but you also need to have the broad perspective, and I wish that also on Government employees.

The private sector sometimes is more able at moving horizontally. Then again, even at primary schools we do not teach food and agriculture and climate in an integrated way. It is not on the curriculum at all, which is amazing if you think of the importance of that to children's health. I spent the last few years writing a couple of children's books because science is one thing but in the end you have to start where it all starts.

If I may, Chair, I will continue a little bit on gene editing and GMOs briefly. You could spend hours on this. The issue is somehow less acute now than it was 20 years ago. We have more than 25 years of full-scale experience in the field of genetically modified crops. There is no evidence of anything there being untoward or riskier than with any non-GM crops, but, of course, as you know, proof of absence is not proof of the contrary, so we always need to be vigilant. But there is no reason to think that the ecosystem around such a field has been affected in any negative way.

The GMO crops have for the largest part been applied to animal feed because that was more palatable, literally, to the average consumer in the west. We now see a shift towards gene editing, mainly CRISPR/Cas-type of methods, that is in a way precision agriculture on a genetic level where you can tweak a gene rather than taking it from another species.

To give you a very simple example, if you take an ordinary tomato, that tomato has a number of genes that code for all kinds of antioxidants, which we humans like but the tomato itself does not need. Those genes have been dormant ever since the millennia of history of domestication of the tomato. We can wake up those genes without adding a new gene. Just by waking them up, you get a more nutritious tomato. That is gene editing. Gene editing does not necessarily lead to a genetically modified crop. That makes it far more acceptable to the public at large. Unfortunately, this distinction needs to be explained and it is not clear to everybody.

I see a great future in gene editing, mainly to reduce the reliance on chemicals for crop protection, but also in areas that we have not mentioned like animal breeding and what we call the biome both in the soil and in humans and animals. Microbial genetics, in which the UK already has quite a lot of expertise, and the role that microbes, bacteria or yeasts can play in improving food quality and nutrition, and helping people to have better digestibility, will be exciting and important areas to look at in the future.

All in all, although the EU does not want to continue pronouncing on gene editing, I expect that in the next five years—let's be optimistic—there will be a change of attitude. You see that most developing countries, including India, already have a few horticultural crops that are resistant to certain pests and diseases, the most famous case being brinjal, or eggplant. We will see a very rapid advance particularly in those high-value horticultural crops that are so important from a nutritional point of view. I hope the investments in genetic engineering, if you want to use that word, will be broader than that. Reducing food waste and increasing the shelf life of crops will be very important applications.

Tracey Crouch: Thank you.

Ismahane Elouafi: May I jump in?

Chair: Before you do, we are running quite tight for time now, so could you be brief in your responses?

Ismahane Elouafi: I forgot to mention that we are commissioning a paper on gene editing, and the idea is along the lines of what Louise mentioned. The potential is huge. There are some discrepancies between countries in terms of regulation and legislation. To help clear up the scene—it is not really for the FAO to be for or against—we commissioned an issue paper on gene editing technologies in the agri-food system. The paper shows what we know, what we do not know, the risks, the potential applications, the ethical issues and the policy.

The paper will be published in October. We have about 12 renowned scientists—the lead author is from Wageningen University—to clarify the issues to help countries, particularly in the south, to take the right decision. Unfortunately, they do not have the potential to analyse the

whole situation, so we are trying to speak up in a way that is very scientific and showcase what we know, what we do not know, the potential of this technology if the regulation worldwide is more harmonious and how it can help with food security and nutrition.

Q64 **Chair:** That is really useful. Would you be able to share that paper with the Committee once it is published?

Ismahane Elouafi: Sure.

Chair: Thank you. Finally, I turn to my colleague Graham Stringer.

Q65 **Graham Stringer:** I have two questions that, given we are pressed for time, I will try to roll into one. You mentioned the catastrophe in Sri Lanka. What lessons can we learn from that catastrophe about what not to do? What can the United Kingdom learn from the Netherlands on how to do things better than we do at the present time?

Professor Fresco: Sri Lanka is a case of good intentions, bad policy and a total lack of scientific understanding, basically switching to a no-input agriculture with disastrous consequences. You should, of course, not do that. The interesting discussion in the UK, as far as I follow it, is that there is a lot of pressure to go to low-input agriculture. The answer is not to have a blanket policy as they had in Sri Lanka but to look very carefully at what kind of level of input is suitable for a particular region and ecosystem.

There are obviously some very good soils where you should optimise your input use, and then there are all kinds of other areas where you want to reduce productivity and have agriculture in a land-sharing situation where nature conservation also has a role and therefore fertiliser and other inputs would not be used.

The key issue here is tailor-made solutions and not a blanket policy. Going down to the intricacies of where you can do what and monitor that—my colleagues on the other panel have been saying something about how well we can monitor these days—is the real future and something for which the UK can be ready.

In general, I would think that the proof of the pudding for genetics will be that we can help biological agriculture to do away with some of the chemicals they use. The emergence in 10 or 20 years' time of these different approaches rather than being just biological or conventional will help us to get the best tailor-made solution.

Right now, what can you learn from the Netherlands? If you follow our newspapers, you will see that we are in a bit of an agriculture crisis right now. There are a couple of things that are useful.

We adopted a policy on circular agriculture a couple of years ago. Circular is a difficult concept because it depends on how big you make the circle. When is a circle really closed? You always lose your energy. Making sure

that there are as few effluents as possible and you can reuse some of the waste is very important. Using human food waste means, by definition, that you need to have a system where animals, especially monogastrics like pigs and poultry, can play a role because they can use the nearly 30%—or 20% in your case—that consumers and supermarkets throw away. Circularity is certainly a concept to be adapted, but there is no blueprint approach.

Very detailed spatial planning is important. Of course, the Netherlands is much smaller than the UK. You have a lot of areas where you have conflicting zones because of infrastructure development, urban sprawl and so on. The questions of where you do what and how you do it best are important.

Last but not least, it is the issue of how you deal with the private sector. It was already mentioned that we have a triple helix system, which means that we really try to have the best understanding between science, Government and the private sector. In fact, we are now talking about the triple diamond in a way because we also want to include the NGOs and all kinds of societal organisations. To have that as a continuing dialogue is very important.

In the end, the reality is that most of the investments that will be needed for agriculture and food are coming from the private sector, not from the Government. That is even true for some of the science as well. To do that in a transparent manner and have very clear ways in which you communicate with the private sector but also explain to the public that you need to have this private sector collaboration will be really important.

I see at Wageningen University—and you have this in some of the UK universities as well—that you only have to cross the lawn to meet people from the private sector and the NGOs on our campus. That has been very useful. I believe very much in public-private partnerships, and that means that you need to regulate that in a legally palatable way.

Right now, Dutch agriculture and, I guess also, UK agriculture needs clarity on three things: what can a farmer still do with all the constraints, what kind of money can he or she count on, and what are the opportunities for the next generation? If we do not solve that, our real concern should be that we will have no farmers left. While I applaud the use of robotics, I still think the human skill, certainly in field crops, will be needed for a long time to come.

Graham Stringer: Thank you.

Chair: Thank you very much, Graham. Thank you to both our witnesses appearing virtually today, Ismahane Elouafi and Professor Louise Fresco. That concludes today's session.