



Environmental Audit Committee

Oral evidence: Environmental change and food security, HC 880

Wednesday 7 June 2023

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Members present: Philip Dunne (Chair); Duncan Baker; Sir Christopher Chope; Barry Gardiner; James Gray; Ian Levy; Clive Lewis; Caroline Lucas; Dr Matthew Offord; Cat Smith; Claudia Webbe.

Questions 185 - 258

Witnesses

I: George Monbiot, author of *Regenesi*s: Feeding the World Without Devouring the Planet; and Professor James Lowenberg-DeBoer, Elizabeth Creak Chair of Agri-Tech Economics, Harper Adams University.

II: Dr Jill Edmondson, Senior Lecturer, School of Biosciences, University of Sheffield; Judicaelle Hammond, Director of Policy and Advice, Country Land and Business Association; and Edwin Morgan, Director of Communications, Harvest London.

Written evidence from witnesses:

[George Monbiot](#)

[Professor James Lowenberg-DeBoer](#)

[Dr Jill Edmondson](#)

[The Country Land and Business Association](#)

[Harvest London](#)



Examination of witnesses

Witnesses: George Monbiot and Professor James Lowenberg-DeBoer.

Q185 **Chair:** Good afternoon, and welcome to the Environmental Audit Committee for our oral evidence session in our inquiry on climate change and food security. We are very pleased to have two groups of witnesses today—two panels. We are joined in person by George Monbiot. George, could you very briefly explain your interest in this topic?

George Monbiot: Thanks very much, Philip. I am a journalist, an author, and I wrote this book “Regenesis: Feeding the World Without Devouring the Planet”. Food and farming has been an interest of mine for 30 or 40 years now. I see it as absolutely essential to the question of whether we are going to get through this century and those that follow.

Q186 **Chair:** Thank you very much, and we are joined on screen from Indiana by Professor James Lowenberg-DeBoer, who is a Professor at Harper Adams University in Shropshire in the county that I represent. James, could you also explain your interest in the topic?

Professor Lowenberg-DeBoer: I am an agricultural economist. I have spent my career looking at the economics of new technology in agriculture. My students and I did much of the early economics work on precision agriculture in the 1990s and pursued that.

One of the important things to note about me is that, in addition to being professionally interested in the economic precision agriculture, I am also a farmer in the United States. I earn a considerable part of my income from agriculture every year, so I am concerned about it both professionally and personally.

Q187 **Chair:** We share that in common—not the academic aspect, but I should declare that I am also a farmer here in Shropshire and Herefordshire, where we grow livestock as well as cereals. I am a member of the CLA and the NFU, to get that on the record as well.

George, I will start with you. We have obviously seen the consequence of conflict on food security over the last 12 months, with Putin’s invasion of Ukraine, but we also saw the impact of climate change with various fresh food products not being available in supermarkets in the UK this winter. You have written extensively on this topic, as you have said in your opening introduction. Could you give us your reflection on the key challenges affecting our ability to secure the food that we need to continue to survive in the UK and for decades ahead?

George Monbiot: As I am sure you are all aware, we are becoming more and more cognisant of the huge threats now posed to the global food system by environmental change but also by geopolitical shifts. But I would separate these out from an even greater threat to the global food system, which is the global food system.



HOUSE OF COMMONS

It is a system that is losing its resilience in a very similar way to how the global financial system was losing its resilience in the approach to 2008, and for very similar reasons: extreme corporate concentration, similar strategies being pursued by the same corporations, synchronisation and the loss of what system theories call modularity—in other words, a compartmentalisation of the system; everything flows into one as trade goes around the world.

For all these reasons, as any systems theorist would point out, we are seeing a global food system that is already losing its resilience, and now it has to cope with ever more extreme environmental shocks, sometimes coupled with geopolitical shocks.

A classic example of this was after Russia invaded Ukraine. The Indian Government stepped forward and said, “Don’t worry about the wheat shortfall. We are going to have a record harvest this year. We are going to become a super exporter.” A month later they came forward again and said, “About that wheat harvest—there has been a huge heatwave, the grain has shrivelled on the plants and we are going to impose an export ban instead.” We saw then an environmental crisis coming together with a geopolitical crisis. However, it might not take a major push to shove this very fragile system past its tipping point, and the prospect of that is almost unthinkable.

Had the financial system gone down, we know it would have created global misery on a huge scale, but if the food system goes down we are talking about an even more serious set of implications. While governments were able to bail out the global financial system at the eleventh hour by producing future money, you cannot bail out the food system by producing future food.

Q188 Chair: Thank you. You have raised lots of interesting issues there. I am conscious that we have quite a lot to get through quite quickly, so I will come back to some of it later. James, do you share George’s concerns about resilience of the system, or do you have a different perspective on how food producers have been coping with increased demand through increased population over decades?

Professor Lowenberg-DeBoer: I agree completely with George’s concern, even though I might suggest some additional solutions that he has not focused on. I will emphasise two things here. One of them is that the resilience of any system—in particular the food system—requires diversity. If you depend on one or two or three sources of food, those can be easily disrupted, and history gives us ample examples of what happens. If you depend too much on imports, disruption of imports by war or natural disaster causes a problem. If you depend only on corporate farms, there are other issues that happen. Therefore, having a diverse food system with different kinds of producers, different kinds of farms with different specialties, different sizes in different parts of the country and in different parts of the world, it creates resilience.



HOUSE OF COMMONS

Secondly, I want to emphasise the role of farmer livelihoods. If farmers cannot support their families by producing food, the whole food system is undermined. I remind the Committee that in many ways food security is a public good. Food itself is private—if you eat it, I cannot eat it—but food security in the sense that the whole society is going to have enough food is a social creation.

In particular, I have that experience. From early in my career, I lived in the Sahel region of west Africa in the 1980s and 1990s, when it was very, very food insecure. Even though my family and I were food secure, we lived in a society where many people were incredibly worried about where their next meal was coming from. That creates a tension, and it creates distortions that are felt by everyone, not just by them.

Q189 **Chair:** Thank you. We had the example of the pandemic just before the conflagration in eastern Europe, where a lot of agriculture was disrupted around the world. George, how would you characterise that experience in acting as an advance warning of resilience? Did we see resilience breaking down in many economies?

George Monbiot: Actually, the food system survived better than I would have anticipated. There were disruptions and we did see sharp fluctuations in global food prices. We also saw more people going hungry, but it was pretty well in trend. It did not have the enormous impact that we might have expected. The thing that tips the system over the brink is impossible to predict. It can be the butterfly's wing. It can be a relatively small fluctuation, like the subprime crisis in the US that tipped the financial system. It might be a very big disruption, but it almost certainly will not be the thing that we think it is going to be.

The really worrying trend here is that since 2015 the rate of global chronic hunger has been rising. For the first five years of that rise, global food prices were historically low. Any economist will tell you that is impossible; if food prices are low fewer people will be hungry. What we were seeing there was that a system that has lost its resilience starts transmitting shocks, instead of damping them down. A resilient, robust, complex system, using negative feedback loops, will damp down shocks. In a system losing its resilience, those negative feedback loops will turn to positive ones. It will amplify shocks.

Those shocks did not fall on us, the rich nations, because we were front of the queue. We had hard currencies and strong buying power. They hit the poor nations, and we saw local food price spikes even when the global price was low. However, we should be just as worried about this situation as the poorer nations are, because this is what system theories call flickering. When you start seeing these apparently inexplicable fluctuations happening, that suggests you are close to a tipping point.

I have been reading the transcripts of previous hearings on this subject by the Committee and—if I may be allowed a note of mild criticism—I will say that there has been too much focus on our national situation. In



some cases, there has been a confusion between food security and food nationalism. I know that Henry Dimbleby went to some lengths to say that there are lots of different kinds of food security, and one is a U-boat food security where it is food nationalism. However, the thing that threatens us far more than any other factor is the global system going down.

Reading scientific papers now, going back 10 or 12 years, about the threats to the global system, you get the impression that there has been no pickup of this at all—not in politics, not in the media—anywhere in the world. It is as if the scientists are behind a sheet of plate glass. You can see their hands banging the glass, you can see their lips moving but you cannot hear what they are saying. It is a truly terrifying situation. I read over 5,000 papers when I was researching this book. The most frightening of all were the ones that related to the systemic fragility of the global food system, and no one is attending to that. We urgently need to.

Q190 **Chair:** One of the reasons we have been focused on the UK is that that is where the UK Government are able to exert some influence. Internationally, we can exert influence through aid. We can exert influence through science and technological endeavour that we encourage here. Gene editing, for example, is one way of making crops more robust internationally. Do you think we are doing enough to try to export technological advance?

George Monbiot: It is not just about that; it really isn't. This isn't just about producing more food. We produce a great deal of food. The average—

Chair: Grow resistant varieties.

George Monbiot: Yes. We certainly need all of that. We need a great deal of innovation right across the board, but this is about something else. This is about the system itself, and the system operates on principles that are completely different from those that the Committee has been discussing so far. They are the principles that affect all complex systems, and there has been no recognition of this. A role that the UK could have would be to start the international conversation that urgently needs to be had.

Q191 **Chair:** James, you wanted to come in on that.

Professor Lowenberg-DeBoer: Yes. Back to the effect of the pandemic. As far as I can see, there was not a lot of impact of the pandemic on production, except perhaps in fruit and vegetable production where labour was an issue. Where we saw the big impact and the big disruptions was in the supply chain, which could not adapt quickly enough. We had dairy producers in the UK, the US and elsewhere dumping milk, not because there wasn't a demand for milk but because the processes were set up to serve certain markets, in restaurants and



HOUSE OF COMMONS

catering establishments, not individual consumers, and so it took them some time.

Rigidities in the supply chain—I think this reinforces what George has been saying about the fragility of the system—cost cutting and tight margins encourage processors and retailers to focus on one or two key markets and key products, without the flexibility to switch between them easily as it needs.

Q192 Chair: Do you have some suggestions on what the UK can do, George, to improve resilience in the way that you have been describing internationally?

George Monbiot: Yes. There are six components of systemic resilience. One is diversity, and James has spoken about the urgent need to start diversifying our food systems. There are a lot of interesting ways we can go. I am fascinated by the potential of perennial grain crops, for example, which is now beginning to be realised. I am also fascinated by the potential of precision fermentation, which can create an entirely different food system, because another of those elements is a backup system.

Then there is modularity, which I have mentioned: to what extent is systemic failure contagious? If you can have firewalls within your system, as they tried to introduce to the banking system after 2008, you can prevent that contagion from spreading. You need circuit breakers, which is effective regulation—that again speaks to what James is talking about—and the regulation that can again prevent contagious collapse from happening. You need asynchronicity. You need to desynchronise the food system.

The system is on a knife edge a lot of the time. 55% of global grain trade goes through a number of pinch points: the Turkish straits, the Strait of Malacca, Bab-el-Mandeb, the Strait of Hormuz, the Suez Canal, the Panama Canal. We have been amazingly lucky so far. The Ever Given got stuck across the Suez Canal in 2021. The Russian invasion of Ukraine was in 2022. If those two things had coincided, the food chain could have snapped for hundreds of millions of people. The shelves could have cleared.

Everything is on a very, very narrow safety margin at the moment, so we need to desynchronise that. A huge programme is required to turn this back into a resilient system. There is not a single policy that will do it, but I would be very happy to have further discussions with anyone who is interested in doing this because a different mindset is required—a whole new way of thinking about what systemic resilience looks like.

Q193 Chair: Also, it is difficult for us to influence the global food situation—the challenges of drought along the Nile impacting a country that has a population approaching twice the size of the UK.



George Monbiot: Of course, this is true, but by starting to talk about it—as far as I know, this is the first hearing in any legislature around the world that is discussing this issue.

Q194 **Chair:** I think you have just given us a headline. That is very good to hear. James, I think you want to come back, and then we are going to move on.

Professor Lowenberg-DeBoer: It is important to mention here that technology gives us some new tools, and George has mentioned some of those new opportunities. Work at Harper Adams and elsewhere, particularly in the UK, has shown the potential for agricultural robotics, AI and agritech in general, to better integrate natural systems and food production systems. In the past, with mechanisation, that favoured large roughly rectangular fields and eliminating other kinds of hedgerows and in-field trees and so on.

With autonomous machinery, with AI, with agritech, we can do a much better job of integrating different kinds of crops and plants into the same planting systems, producing resilience but also allowing room for biodiversity and all the benefits that that brings with it.

In this regard, the UK has some advantages. We are ahead in many ways on the research in this area. We are also ahead in what we can say is the regulatory sphere. British Standards is about to come out with a code of practice for autonomous crop equipment, which would provide a framework for the use of this technology.

In some places in the world—in the US state of California and in the EU—there have been very rigid rules about how autonomous equipment might be used by farmers, which in many cases make it economically infeasible. The rules that are coming out from British Standards, and a code of practice, which was produced by a stakeholder group, will facilitate that by providing guidance on how farmers might accept that risk. Britain is playing a real role here in creating an environment where this kind of technology can be effectively used.

Q195 **Chair:** I visited the robotic plant within Harper Adams's facilities. Part of the environmental land management scheme support for sustainable farming incentives is to encourage take-up of contemporary modern technology, including robotics. Do you think that that is a good example of how food security can be used as part of the new subsidy or support mechanisms for agriculture—public money for public good?

Professor Lowenberg-DeBoer: It is a good start. Farmers need to start experimenting with this technology. What always happens with new technology is that farmers discover ways to use it that were not evident to the original creators. They are much more familiar with day-to-day reality problems, and so the new programmes help move in that direction.



If you asked me what the constraints are to moving that technology into greater widespread use, there are maybe two things. One of them is better business models. How can the agriculture sector take advantage of these new capabilities? If labour is no longer the key binding constraint for most farmers, are there things that we can do, like mix cropping, strip cropping and individual plant management that we could not do in the past? Then how does that get to farmers?

This is an area where Britain has not been a shining example. The transfer of technology from science to farming in Britain has been less than many of its neighbouring countries with similar agricultural circumstances—France, Germany, Denmark—and certainly much less than in the US or in New Zealand. There is really a need for a better pathway for science to reach agriculture and for agriculture to provide its feedback.

Q196 **Barry Gardiner:** I would like to focus on the role of land use in food sustainability. Globally, we are projected to have to feed 2 billion more people within the next 30 years and, of course, the more land we use for our own purposes the less is available—certainly, the more we use for food the less is available for the other purposes that we benefit from. Whether that is biodiversity or emissions sequestration, recreation or horticulture, all those other things, as well as other species, will be crowded out. How do we square that circle?

George Monbiot: I am glad you asked me this. Thank you, Barry. Land use is the crucial environmental metric that is perennially neglected. We only really talk about land when it comes to urban sprawl. Urban sprawl is an important issue. It is bad for cities and bad for the countryside, but the entire urban area of the planet—all the homes, all the businesses, all the infrastructure—is 1% of the land surface. Farming occupies 38% of the land surface. Of that, 12% is crops, and roughly half that land is used to provide crops for animals; 26% is grazing for livestock. This is a tremendously profligate land use.

It is mirrored in the UK, where 51% of the land is used for grazing or grass for livestock. It produces a very small proportion of our food, but it has a humongous ecological opportunity cost and carbon opportunity cost, because every hectare, as you say, that we use for our own purposes is a hectare that cannot be used for other purposes. The great majority of the world's wildlife species depend on wild ecosystems for their survival. Earth systems themselves depend on wild ecosystems for their survival.

It is already the case that the biomass of mammals on earth consists of just 4% wild mammals, 36% humans and 60% livestock, and yet livestock populations are growing by 2.4% a year. This is the bit we cannot afford. We could feed everyone extremely well on plants. We could feed everyone extremely well incidentally on single-celled organisms, which is where precision fermentation comes in, but there is



HOUSE OF COMMONS

just no good way of feeding everyone well on livestock products because there is not enough planet on which to do it.

We have seen this great push by celebrity chefs and food writers saying, "Eat pasture-fed meat". We could eat pasture-fed meat if we had several planets and no space for wild ecosystems on any of them. The global demand for pasture-fed meat is now driving the destruction of the Amazon.

It seems to me that the only way we are going to get through this century is through a major rewilding of both land and sea to stop the sixth great extinction in its tracks and to draw down large amounts of carbon dioxide from the atmosphere. That can only happen if we basically stop eating animal products. That is the thing that is preventing that transition from taking place. The land issue is primarily an animal farming issue, but the land issue is also potentially the most important of all environmental issues and the most neglected, and it is high time we focus laser-like on that issue.

Q197 Barry Gardiner: Thanks very much. Professor Lowenberg-DeBoer, you talked earlier in your response to the Chair about technological innovations and the application of science. To what extent could that increase the efficiency of the way we use land, globally but also in the UK?

Professor Lowenberg-DeBoer: There is very substantial potential, and my own work has focused much more on crop production than on livestock production. In the crop production area, there is a major potential to use technology, data and analysis to intensify agriculture and production on the land that we already use.

Let's take the example of mixed cropping. In the US there is good evidence that maize and soybean production can be increased somewhere around 15% to 20% by growing them in strips instead of in large field monocultures. In the past this was not possible because it required too much work. If you have autonomous equipment, if you have robotics, this all of a sudden changes and becomes a possibility. That is just an example. We need much more work in Europe and the UK on how that can happen with European farming systems.

Q198 Barry Gardiner: Sorry to interrupt you, Professor, but are there not going to be very strong pushbacks from industry and from farming communities, where huge amounts of capital have been invested in machinery precisely to strip whole plains, to go towards a system such as you are talking about where that would not be appropriate, and where that equipment in effect would become redundant?

Professor Lowenberg-DeBoer: You are talking about a transition issue, and I think there will be at least two pathways for the adoption of autonomous equipment worldwide. There will be one pathway in North America, Australia, Brazil, Argentina—places where there are large



basically rectangular fields—and we will see a lot of co-robotics. We are seeing this happen already. We are seeing the introduction, for instance, of smart grain carts in which there is still a human operator in the combine harvester but there is a smart grain cart that syncs itself and facilitates unloading.

I think what will happen in much of Europe and in Asia is autonomous equipment. There, conventional machines have been used and, as we know, the size of tractors in the UK has been growing over time. Sometimes it surprises me how large equipment is used in relatively small fields, but that is what is available. There is an opportunity there for something that comes in and fits the northern European, Asian situation much better. Yes, there are transition issues and there is resistance—there always is, in new technology, from the old technology—but there are places where this will happen more quickly and more slowly.

Q199 Barry Gardiner: You believe that it is possible to meet the biodiversity challenges that we face and the net zero challenges that we face without removing some land from food production, even with the increased global population that is predicated?

Professor Lowenberg-DeBoer: I think there are good reasons to think about changes in land use. If we think about livestock production in the UK, with changes in the subsidy situation, many beef and sheep farms are unprofitable. There are reasons to think about whether they should change the way that they do business. There are changes in consumer preferences—in some parts of the world there is less demand for red meat than there was in the past. There are other issues around environmental carrying capacity for intensive livestock and the willingness of society to tolerate that, and animal welfare issues. There are a lot of reasons to rethink the use of land. There may be some areas that are better off with other kinds of land use, in nature, woodlands or perennial trees, or if perennial grain crops are developed, that would be wonderful.

There is a reason to think about changes in land use, but there are also many opportunities within the current land use to better integrate natural systems. Instead of focusing on large fields with only a single monocrop, do we now have fields that have several different crops in them and perhaps natural areas that serve as host areas for predatory insects and so on? With technology, we can better integrate nature and crop production.

Q200 Barry Gardiner: George, you spoke about the bottlenecks in the system. There are other bottlenecks in the system, though, and they are the companies that export grain around the world. You are talking about four major companies that control 90% of grain movements around the world. They also represent a bottleneck in the system in food security and food supply. If you look at the profit margins they have been making— I am sure you have done, and that you have seen the evidence that was



HOUSE OF COMMONS

presented in Dariush Sokolov's papers on that—you will see that they have been making post-pandemic profits that are over 2,000 times higher than their pre-pandemic profits. The way in which the system is conjoined is not just bottlenecks geographically, but also financially. What does the Government have to do about that?

George Monbiot: This is a very good point because this introduces extreme systemic risk. They have become too big to fail and we all know where that leads. Their synchronisation of strategies—and they have also been integrating with the financial system and IT systems to enhance what systems theories called the network density of the system. The more dense the system becomes, the more fragile that system becomes. We urgently need, in this sector and in all others, to reintroduce strong anti-trust laws and to weaken intellectual property rights. Those things have to go together, because what has been driving the mergers and acquisitions has been the demand to acquire more intellectual property rights to control the food system horizontally and vertically from farm to fork. This all adds to the danger that we face—not just systemic danger. This is possibly the greatest existential threat we face and unfortunately no one is talking about the potential collapse of this system, which has been weakened by these corporate strategies. It is also, of course, for the reasons that you pointed out, driving food inflation.

Governments have to govern. Governments have to step in and be interventionist. Even those governments committed to free market theory surely can see that in a situation of monopoly like this, you cannot have anything approaching a free market. We need this in every sector, but we need it more urgently in the food sector than in any others. We need to start breaking up the large corporations and we need to limit the scope of what they can own.

Q201 **Barry Gardiner:** Thank you. I want to move now to locally and nationally; I know you wanted to remain globally. The Government is developing its own land use framework. What principles would you like to see enshrined in that framework to make sure that we do get our land used effectively, efficiently and sustainably?

George Monbiot: As Henry Dimbleby pointed out to you, 20% of farm land in Britain produces just 3% of our food. Within that, there are areas that produce almost nothing. There is one sheep per hectare, one sheep per two hectares, and in some cases, one sheep per 10, which unfortunately is enough to prevent any trees from growing, because the sheep preferentially nibble up the tree seedlings as they are highly nutritious. We are producing almost no food and almost no nature across vast areas of land. There are more trees per hectare in some inner London boroughs than there are in our uplands, including our national parks.

It is a scandalous situation, and that is entirely an artefact of grazing. It is not the tree line. The altitudinal tree line in most of Britain would be at about 4,000 or 5,000 feet. It is entirely through grazing. We have to have



a much more rational use of land. To say in areas that are so patently unproductive, the ones I am talking about, that land is far better used for rewilding—it is far better used to produce nature. In doing so, you can draw down large amounts of carbon. According to the Government's Climate Change Committee, switching from pasture to woodland in the UK means the sequestration of an extra 25 tonnes per hectare of carbon just below ground, let alone the carbon above ground in the form of the trees. We are one of the most nature depleted nations on earth and the only way we will reverse that is to set aside large areas of land and sea for nature to do its thing, rather than being constantly knocked back by our highly unproductive production systems.

This vision contrasts starkly with that of the National Farmers Union, which is trying to get to net zero by means that are not just unfeasible but actually disproven, including, I think, that 49% of its net zero commitment will come from BECCS—bioenergy with carbon capture and storage—which we know will not fly. If you want to sequester carbon—in some circumstances, particularly anaerobic soils actually store carbon—the best way to do it is to stop farming in certain areas. That is by far and away the most effective way of drawing down carbon. It is also the most effective way of restoring ecosystems. It is proven. It is a proven technology, rewilding, unlike the technologies on which the NFU and others rely.

Q202 Cat Smith: Half of the world's global population suffers from severe water shortage at least one month a year. Water is a huge part of the conversation we need to have here. My opening question is: how much of a threat is water insecurity and water pollution globally to food security?

George Monbiot: Thank you. I am so glad you asked that. James quite rightly talked about the need to close the yield gap and to raise yields where they can be raised, but the problem is that that often requires irrigation and we are already maxed out: 70% of the water we withdraw is withdrawn for agriculture, many rivers are now ceasing to reach the sea, lakes are shrinking, groundwater supplies are dwindling and saline water is being drawn into aquifers because of the depletion of fresh water. Anyone can see that we are beyond the limits of water use already, and yet a paper looking into what water use would be required to meet this requirement of closing the yield gap found that we would need to increase global water use by 146%, which we just cannot do. That water does not exist. Without attending to the water issue, everything else is a pipe dream. We are relying on something that is not there.

We have a very dangerous situation indeed now with some of the most important irrigated areas having no prospect of being able to continue. The Indus Valley, the largest irrigated area on earth, is divided primarily between two nuclear powers, with a third having a small part of it. Some of the most unstable regions on earth are there. It is hard to see how things are going to end well as water supplies diminish, because glaciers



are retreating. Soon we will see, instead of the extra flow you get from the melting, diminished flow because the resource is not there any more. As demand for water for agriculture, homes and industry in the Indus Valley increases, the prospect for water wars there is as real as the prospect of oil wars in the Middle East, and this is a phenomenally dangerous situation.

As we know, even in the UK now we are seeing many farmers suffering from severe water stress. We know that the drier parts of the world are likely to become drier while the wetter parts become wetter. We know that there is an escalating cycle of soil moisture loss because as the ground dries out, it produces less evaporation, so you get less moisture in the air, and then it dries out more and on you go. You can very quickly see mass aridification. One estimate suggests an extra 1° of global heating would dry out 32% of the planet's land surface.

Q203 Cat Smith: Can I draw on the UK example of the River Wye catchment? What are the consequences of the changes there for food security in the UK?

George Monbiot: The River Wye shows us that no freshwater ecosystem can survive intensive livestock farming. We are seeing one of the most protected rivers in Britain, one of the most celebrated rivers in Britain, effectively being turned into a sewer. That is a result of the chicken farms in the catchment, primarily. 70% of the phosphorus coming into the catchment comes from agriculture, and it is primarily this intense concentration of chicken farms. Just as no terrestrial ecosystem can survive extensive livestock farming, no aquatic ecosystem can survive intensive livestock farming because of the throughput of nutrients.

We talk a lot about how we need to become more self-reliant in chicken and pork in this country. All you are measuring there is a throughput of Brazilian and US soy and maize. It is as far as you can get from being self-reliant. You are just bringing in one product to turn into another. Those nutrients have to have somewhere to go. You are putting a large amount of nutrients through highly concentrated populations of animals. There could be many tens of thousands of chickens in a single factory, as I call them—a single giant steel shed—and the dung they produce has to go somewhere. It is a high-volume, low-value product and it will not go very far. It will be spread in the catchment and even if you do not dump it straight into the river, the effect is more or less the same.

The Wye is effectively dead now. The ecosystem there is anchored by ranunculus beds—water crowfoot—which has a similar role to mangroves in a tropical sea. The water crowfoot is where the fish breed, the invertebrates breed and everything shelters. It has been eliminated from almost the entire main stem of the river by the microcellular algae whose blooms are stimulated by the nitrogen phosphorus going into the water.

Q204 Cat Smith: Do you think that there is any way of mitigating against the nutrient pollution from this large number of poultry farms, or do you



think it will just come down to a reduction in the number of poultry farms in the catchment?

George Monbiot: I think that the only sure way is to drastically reduce the number of farms. Once planning permission has been given for those farms, the rest is a tragedy foretold because those nutrients will seep into the water. There has been talk about creating fertiliser plants, pelletisation plants and anaerobic digestion plants. So far it is all talk. It has not materialised. The economics are probably against it, so it might never materialise. Even those plants can create enormous problems. Anaerobic digestion is a huge water pollution problem, both through leakage—I witnessed what happened in a tributary of the Wye, the River Llynfi, which was completely wiped out twice, we believe from leakage from an anaerobic digestion plant—but also through spreading the digestate on fields. This is an even more concentrated source of nutrients, which has caused innumerable cases of diffuse pollution around the country.

Q205 **Cat Smith:** Thank you. Professor, a quick final question. How much potential is there for precision irrigation and agriculture techniques to increase water efficiency and prevent agricultural water pollution, would you say?

Professor Lowenberg-DeBoer: I was going to add that there is a great potential for technology to improve use of water. George is correct that much of the world's available water sources for irrigation are running out or drying up. Irrigation is threatened. Most of the world's irrigation is furrow or flood irrigation, which is inefficient and hard to manage. There are systems out there that can do a much better job, both sprinkler systems and drip irrigation systems. They require some investment, but one of the key issues there is understanding how to manage this. If you talk to centre pivot manufacturers in the US and elsewhere, they have systems that can manage water effectively. They can put a drop of water exactly where you want it. The question is, where do you want it? Farmers, irrigation management and companies are struggling to come up with the algorithms that will optimise that system. That could make the use of agriculture irrigation water much more effective and could reduce some of the pressure that George is talking about.

In the UK, while irrigation is mostly an issue with horticulture, fruit and vegetable producers, and there are some producers that are running short of water, the travelling gun systems that are typically used are only slightly better than furrow and flood irrigation systems at precision application. There are possible systems that could be used in the UK to improve the precision of irrigation, but to the best of my knowledge, they are not being widely used.

Q206 **Duncan Baker:** The water scarcity comments that you made at the beginning were quite scary. The east of England is, I think, the area of the country that is worst depleted with its scarcity of water, and yet it is the area that grows the most food. If you take the water resource



management plans that the water companies are putting together, why is it that some parts of the country have huge surpluses in megalitres of water—Yorkshire Water, for instance—yet in my patch, which covers a huge area, Anglian Water is seriously depleted? We cannot grow or run factories. 10% of the soft fruit market is grown in East Anglia. They simply do not have enough water to grow food. What is it about these water resource management plans? How important are they? Have we been incredibly lax in looking at new technologies, for instance, such as desalination plants—recognising the environmental issues that they have created? A lot of that can now start to be rectified. We are simply running out of water. How will we deal with that?

George Monbiot: These are very good questions. On desalinisation first, it is expensive. It is a good way of producing drinking water in some places that are short of it, but if you want to use it to produce irrigation water, food could become a lot more expensive. Maybe in future there will be much cheaper ways of doing it, with small modular reactors, for instance. I do not know.

One thing I urge—I think that this has happened in East Anglia and elsewhere in the world—is to pay attention to the irrigation efficiency paradox, which is a bit like the Jevons paradox in energy. The more efficient you become, the more you end up using. That is because, like with your berry crops in East Anglia, you say, “Great, now water has become cheaper, it has become a smaller component of our overall costs, so we can grow more crops that require irrigation”. You expand your irrigated area. We have seen a classic example of this in the Guadiaro Basin in Spain, where they invested €600 million in reducing water use and ended up creating more water use. It was a total catastrophe, and it is because they did not put controls on how the surplus water would be used. If you are to improve your irrigation efficiency, you also need to bring in regulations that say that this must not lead to an increase in water use, otherwise you create more of a problem than you started with.

Q207 **Duncan Baker:** It is not just about agriculture. It is about the economic damage. If you cannot run factories or build houses for people because you simply cannot get enough water to it, which is what is happening in the east, that is incredibly damaging for the country.

George Monbiot: I know it is a major issue in north Norfolk, where you represent. In fact, I have just come down from there this morning and seen it with my own eyes.

Q208 **Caroline Lucas:** My first question is to Professor Lowenberg-DeBoer. You will have heard the calls for a reduction in livestock farming to rewild more land. Could you clarify your view on that specifically and whether you think there are any unintended consequences from reducing livestock farming?

Professor Lowenberg-DeBoer: I think that there are many reasons to rethink livestock farming, but if we think about land use planning, one of



the key criteria should be multifunctionality. Great Britain is a relatively densely populated island with intensive use. Every hectare needs to be used in multiple different ways. Thinking about the implications of rewilding or changing the livestock sector, there are issues around rural communities, the economic and cultural life of those communities. There are issues around farmer livelihoods. There are ecological issues, because if you remove grazing you change the ecology, and there are certain birds and insects and so on that are disadvantaged and others that will come in. You have a different ecology without grazing. Would a different kind of grazing, a better controlled grazing be a better issue? It is about thinking through the implications.

Q209 **Caroline Lucas:** Do you think the answer to your question is yes? You are raising a lot of questions. I am trying to pin you down on to what you think.

Professor Lowenberg-DeBoer: I think that it would be extreme to exclude livestock production totally. I think that, yes, there are good reasons to rethink in certain areas. Almost every farm has some areas, as George has pointed out, that would be better off in woodlands or grasslands or some other natural system, but that needs to be done with a sensitivity to the local and regional livelihoods.

Q210 **Caroline Lucas:** George, you are about to destroy the livelihoods of loads of farmers and completely change the local ecology. What is your defence?

George Monbiot: There will be transitions, and we have to ensure that they are just transitions. In fact, farming is in a much better place to have a just transition than virtually any other industry because we are spending £3.4 billion a year in the UK on farm subsidies. We can simply pay people to do something differently. If you compare that to any other industry, such as my own, journalism, which is about to go down in flames thanks to AI—will no one think of the journalists? No, no one will. No one is proposing a just transition there. There is no easy way out. A lot of people will just be thrown out of work. With farming, you can say instead of paying people to stay in livestock farming, which is effectively what we are doing, with area payments and some aspects of ELMs, we can pay them to get out of it but do something else on the same land. If you pay farmers the same amount of money for rewilding, because rewilding is cheaper than chasing sheep over rain-sodden hills, which is actually very expensive and loss-making, farmers will end up with more money in their pockets than they do at the moment.

Q211 **Caroline Lucas:** Thank you. You have encouraged the Committee to think more globally. I wondered if there is anything more you might say around the dependency of the UK's meat and dairy sector on imported feed and the impact that is having on biodiversity and climate.

George Monbiot: Feed imports are creating devastating effects on the other side of the world, for instance the Cerrado ecosystem in Brazil



HOUSE OF COMMONS

where an area the size of Spain has been destroyed since the 1960s, as well as large chunks of the southern Amazon and Gran Chaco and other crucial ecosystems to grow the soy, which is primarily used to feed livestock, particularly pigs and chickens but also supplementary feed for cattle, sheep and other livestock. This not only wrecks terrestrial ecosystems, but also causes quite analogous symptoms to those being felt by our rivers over here because it creates a massive flush of nutrients.

We are seeing the great tributaries of the Amazon, such as the Tapajós, the Xingu and the Tocantins, now channelling vast amounts of fertiliser and soil nutrients from these ploughed-up soils into the Amazon and out into the Atlantic. Now, for six months every year, we see one of the most spectacular unnatural phenomena on earth, which is the formation of a continuous band of sargassum weed, fertilised by these nutrients, stretching all the way down the Gulf of Mexico, around much of the coast of South America and right the way across the Atlantic to the shores of west Africa. It is all fertilised by this enormous flush of nutrients being generated by the demands of our livestock. The teleconnections of this disastrous trade are just as important or even more important to focus on than the immediate impacts that we see in the UK.

Q212 **Caroline Lucas:** As a quick aside, at our last hearing you might have noticed that Dairy UK claimed that the dairy industry is making a positive contribution towards global cooling, so we are all fine because it is reducing methane emissions. I wondered if you might make a quick comment on that.

George Monbiot: This is such a phenomenal misreading of the science that it can only be deliberate. When GWPE was converted to GWP* through the recalculations of methane's global heating impact at Oxford University, it showed that the long-term impact of methane in the atmosphere was smaller but also that the short-term impact of methane in the atmosphere is comparatively greater. We know in trying to prevent climate breakdown we have to act as fast as possible. The sources of greenhouse gases that can most quickly be removed are the ones that we should concentrate on first. The biggest source of anthropogenic methane on earth is the livestock industry, particularly ruminant animals such as cattle and sheep. We urgently need to reduce the methane source from those ruminant animals. That would make a significant impact on the future trajectory of global heating.

Q213 **Caroline Lucas:** You are an advocate, as we know, for reducing meat and dairy consumption by promoting alternative proteins. I wondered if you could say which of those proteins you see as holding the greatest advantage.

George Monbiot: I think that the most exciting technology for me is precision fermentation, which is a refined form of brewing. For 12,000 years we have been refining the cultivation of multicellular organisms of plants and animals. It is an inefficient way of producing food that



smashes up an awful lot of planet. We can produce protein and fat far more efficiently with much less land use, much less water use and much less fertiliser use by growing microbes in vats. I know it does not sound very appealing, but the implications are extraordinary and the potential dietary transformation can be as well. I was the first person on earth outside the laboratory to eat a pancake made entirely from bacteria. A small flip for man. It tasted just like a pancake. It was delicious. There is an enormous potential range of far better substitutes for animal products that you can produce with microbes than you can produce with plants. Plants are actually a very poor means of producing substitutes for animal products. Microbes have far greater potential with far lower environmental cost.

Q214 **Caroline Lucas:** I will put that last question to Professor Lowenberg-DeBoer, if there is time. What is your response to precision fermentation as a way forward?

Professor Lowenberg-DeBoer: In short, I think that precision fermentation will find a place in the market like many other food alternatives, but to me it sounds like more process. One of the things we are advised by nutritionists is to eat less processed food and to eat things that are closer to nature. Is it a possibility? Is it a part of the portfolio? Absolutely. I would hesitate to come to depend on that greatly.

Q215 **Caroline Lucas:** Thank you. Can I quickly put that back to you?

George Monbiot: Yes. I think it can lead to far less processing because you can basically tell bacteria to produce whatever you want them to. If you want long-chain Omega-3s, you have long-chain Omega-3s. I visited a laboratory in Amsterdam recently, which has discovered a bacterium that smells and tastes exactly of sausages. If you multiply those, you can make sausages with far less processing than you require to make sausages out of pigs because you are growing the raw materials straight there in the vat. Plant-based substitutes for animal products require a lot of processing. Microbial ones potentially much less.

Barry Gardiner: Are they Lincolnshire or Cumberland sausages? That is really important.

Q216 **Clive Lewis:** Professor Lowenberg-DeBoer, how can Government facilitate a more rapid innovation in agriculture to meet things like food security, net zero and the challenges of depleting biodiversity?

Professor Lowenberg-DeBoer: The conclusion of the Awareness of Science group that met with Lord Curry much of last year indicates that the key element is reducing the fragmentation in the process of transferring science and technology from laboratories and research to farms. The UK is unusual among its other industrialised country competitors in having almost no public sector extension or farm advisory service. While those services have diminished over time in many parts of the world, they still play a very crucial role in the US and other places in facilitating the overall system. The UK does not have that.



There are many organisations, non-profits, for-profit organisations, businesses that are involved in technology transfer. Farmers are very wary because everybody is trying to sell them something. Somewhere there needs to be a third party evaluator and a facilitator that helps that to occur. Reducing the fragmentation is a key element in making UK farming more productive and helping it be more competitive in the world.

Q217 Clive Lewis: What role do you see things such as digital technology and precision agriculture play? What kind of role could that play? Is there a role for that in enhancing sustainability and the efficiency of farming?

Professor Lowenberg-DeBoer: Absolutely. Precision agriculture, broadly digital agriculture, has potential in reducing many of the problems that we have talked about today—in reducing water pollution by applying fertilisers in the right amount at the right time in the right quantities in the right place, rather than just broadcasting them. Similarly with pesticide. There is a great possibility of using this technology, but that technology will only be used if it is part of profitable farming systems. Up until this point, there have been a few things that have been widely adopted. Autosteer, for instance, is being adopted in Britain and everywhere in the world where there are mechanised systems because the benefits are easy to see and evaluate.

Other technologies have faced much more resistance, in part because there are technical issues. Sometimes they don't work quite as well as promised, but also because there are economic issues in how much they cost versus the benefit of how much farmers are recognised for the public good aspects of what they do. There is a great potential for the technology, but getting it into the hands of farmers in the right form is key.

Q218 Clive Lewis: Thank you, Professor Lowenberg-DeBoer. George, you have been talking about germ sausages, not German sausages, and bacteria-made pancakes. I think I have had a few of them myself in my time. What other alternative agricultural techniques are there that you are aware of and there is clear evidence can help us capture carbon, enhance biodiversity and restore soil health?

George Monbiot: If I may, I would like to go back to something I mentioned briefly, which is the potential of perennial grain crops. Almost all our grain crops on earth today are annual crops. Large areas covered by annual crops are rare in nature. They generally happen in the aftermath of a disaster, such as a volcanic eruption, a major fire or a landslide, and the annuals can quickly colonise before they get shaded out again by the perennials. To grow our annual crops, we had to create a disaster every year and we had to clear the land, either by ploughing it or spraying it and starting all over with a lot of nutrients, a lot of pesticides and often a lot of water to get those seedlings going. We pamper them until they reach maturity and then we start the whole process again.



If you can grow perennial grain crops instead, which can stay in the soil for several years at a time, you can massively reduce nearly all of the inputs and impacts of arable farming. There is a group called The Land Institute in Salina, Kansas, which has been, with other organisations, scanning thousands of potential candidates with some great successes so far. In fact, in conjunction with the University of Yunnan in China, they have produced a short grain rice variety with the romantic name of PR23, which was a simple cross between annual short grain rice and a wild relative. That is now being grown across several thousand hectares of land in China. The farmers are desperate for the seed because they have a major labour shortage there with so many young people having moved to the cities. You need far less labour to grow it. You also need far cheaper inputs. You need less fertiliser, less pesticide and less water. The roots get well-established, so they can feed themselves to a large extent on water and nutrients. It deals with the huge soil erosion crisis they have in Yunnan with terraces collapsing and the rest of it because you are not ploughing so often, and the roots can help bind the soil. You have much bigger, more robust plants with much deeper roots.

The Land Institute has found that some of its cultivars are far more resilient to environmental shocks as well. For example, it was growing perennial sunflowers beside a control crop of annual sunflowers. It got hit by a major drought. The annuals were completely wiped out and the perennials sailed through it because they had deeper roots and tougher above-ground structure.

Q219 **Clive Lewis:** Can I ask, was precision genetic technology used to splice those two together, or was it done through more natural—

George Monbiot: They are doing it without genetic modification at the moment so that they can sell it into the European Union if they so wish. It is all what is called conventional breeding, although conventional breeding has now become extremely complicated and technical. They could, in theory, speed it up with genetic modification. The shocking thing, to my eye, is that this is basically left to an NGO. This tremendous world-changing technology is being run out of a small farmhouse in Salina, Kansas. This is something that governments should be getting behind. There could be great potential for perennial crops in Britain, but if crops are not being specifically developed for the British context, that potential might be stifled. I would love to see an intense research programme on this sponsored by governments.

Q220 **Clive Lewis:** On a more general note, you are clearly identified as someone who has been at the forefront of warning us about the climate crisis. You are seen as an environmentalist. You seem to be someone who embraces cutting edge technologies, as opposed to perhaps sometimes more natural methods. I know you have made an analogy between climate protestors siding with fossil fuel companies in some of the ways that some of the people in NGOs and others look at that new technology. Do you want to talk us a little through that? You do not fit



into a box when it comes to that.

George Monbiot: No. I think there is a regrettable neophobia in parts of the environmental movement. I know people who will not have a microwave oven in the house, but they do have a wood burning stove. The one will not kill them, the other one might very well do so. The microwave oven is nasty because it is new and the wood burning stove is fine because it is old. We have a similar thing with our fetishisation particularly of pastoralism, of grass-fed meat, which a lot of environmentalists will get behind, even though it is the most damaging of all food products because of its enormous land demand and the huge ecological and carbon opportunity costs it introduced by the conversion of wild ecosystems into pasture or the failure to convert pasture back into wild ecosystems.

We have to get beyond this. We have to put aside childish things and see how, just as in energy, new technologies—be it solar, wind, small modular reactors, geothermal—offer us a way out of fossil fuels, new food technologies can offer us a way out of the most damaging impacts of all, which are those introduced by the food production system. Food production is the top cause of habitat destruction, wildlife loss, species extinction, soil degradation, fresh water use, land use and one of the top causes of climate breakdown, fresh water pollution and air pollution. We urgently need to attend to it just as urgently as we need to attend to the issue of fossil fuels. Unless we develop the necessary technologies that make it easy for us to substitute the most damaging products, we make it much harder for ourselves. One of the things that I am trying to do is to dissuade environmentalists from standing in the way of some of the more promising technologies.

Q221 **Chair:** I want to finish with one other question, which is about measurement and metrics. The Government has a food data transparency partnership being established here in the UK. Do you think that this will provide some answers to the questions about the impact of natural capital? You have made some bold claims, George, about the damage of pasture-fed grass and the benefits of rewilding. How will we measure the impact on nature and food production if we take large swathes of current grassland, which cannot do anything other than raise livestock, into rewilding? It has to be measured in some way to be able to prove that it has the benefits that you describe.

George Monbiot: Yes. We certainly need better metrics right across the board. One of them is soil carbon. At the moment, our means of discerning soil carbon are extremely crude—too crude to give us reliable readings for changes from year to year. We need a great investment in soil science right across the board. Soil is more or less a black box to us, yet we produce 99% of our calories from it. I am very much in favour of better metrics.

I would strongly challenge your contention that the only thing you can do with pasture land is to raise meat in it. Rewilding is something that you



can do. Rewilding is a great benefit to humanity as well as to the natural world because of its potential to help stop the collapse of our life support systems. Nothing is more important than that. There is a danger of falling into this productivist mindset that the only thing that you can do on a piece of land is production. Actually, sometimes a far more productive use of that land, if I can adapt that term, is to stop trying to produce a small amount of food in it and instead allow nature to flourish, which then allows humanity to flourish.

Q222 **Chair:** Albeit that we currently import 50% of our food, so unless we adopt your new technologies to replace that food, which I guess is your argument, it will take some time to do that. Whether we can do that in time I think is an open question. I will ask James about this question of measurement, metrics and soil. I know Harper Adams have done a lot of work looking at the different ways of measuring soil, and I am interested in whether you agree with George that it is in its infancy at the moment.

Professor Lowenberg-DeBoer: I agree that we need a lot more work on soil science and agricultural science in general. In particular, we need cost-effective ways to measure environmental indicators using remote sensing and other kinds of technology that would give us better widespread indicators instead of just taking a sample here and there. I agree completely.

Q223 **Chair:** Okay. I would like to conclude that panel. Thank you very much to our panellists, George Monbiot and James Lowenberg-DeBoer, for joining us from Indiana. I will suspend while we get the second panel.

Examination of witnesses

Witnesses: Dr Jill Edmondson, Judicaelle Hammond and Edwin Morgan.

Q224 **Chair:** Welcome back to the Environmental Audit Committee for our second panel on food security. I am delighted to welcome Dr Jill Edmondson from the University of Sheffield, Judicaelle Hammond from the Country Land and Business Association, and Edwin Morgan from Harvest London. I think you were listening to the earlier panel, so you may have some responses to what you have heard.

Judicaelle, I will ask you about the CLA's proposition representing your members. I think there are 28,000 members, of which I am one, as I said earlier. What do you think the main priority should be in securing food supplies for the UK?

Judicaelle Hammond: The Government produced their own report in December 2021 about food security. I think that this has not been mentioned yet, but it was quite an interesting read in the sense that, as has been mentioned before, we import quite a lot of the food we eat. Food self-sufficiency, which is potentially what Henry Dimbleby called U-boat, if you look at the statistics below the global cumulative figure of food security through food produced in this country, varies tremendously by sector. Where we really have a problem is fruit and vegetables. There



HOUSE OF COMMONS

are specific issues in ensuring that we focus government efforts on those sectors where we can do better, because in this country we can grow more apples in particular and other fruit than we are growing at the moment.

There are issues with water availability, which have already been discussed. There are issues about sea level rise and flooding, which we have not yet talked about. The issues of environment, climate change and food production cannot be disaggregated. They are coterminous. We cannot have farming if the environment and the ecological system do not work.

Q225 **Chair:** How do you respond to George's challenge about the problems generated by using pasture for such a large proportion of our land mass?

Judicaelle Hammond: There is a need for diversity in the farming systems that we have, and that will include the kinds of systems that Professor Lowenberg-DeBoer was talking about—what has been called sustainable intensification. It is the highly developed use of technology and so on, still on a large scale; agroecology, which will include pasture-fed livestock rearing; and land that is going to be used either primarily or entirely for nature. I think that is one of the ways of building resilience into the system, but we are great fans of the three dimensions that Henry Dimbleby had in his food strategy, and it seems to me that we cannot have one way of looking at land use. It needs to be a rich tapestry, and that will include livestock, for reasons of having the kinds of ecology and habitats that James Lowenberg-DeBoer was talking about.

Q226 **Chair:** We are going to have some more questions specifically on land use. I would like to bring in Jill. You have done a lot of work on urban horticulture. Can you set the scene for us of how significant that could be in providing the food that we need to eat?

Dr Edmondson: Certainly. Urban horticulture is focused on thinking about how we can grow fruit and vegetables in our cities and towns. It is something that historically in the UK we have done very effectively, so think back to Dig for Victory during world war two, where we grew 18% of the fruit and vegetables we ate by value in this country. We are at a much lower level of production now, but there is still fruit and vegetable production going on in our cities and towns, so we estimate that about 3% of the fruit and vegetables we eat are grown by people at household level in things like allotments.

We have much greater potential than that within our cities and towns to increase the fruit and vegetables that we grow, and we have looked at it through exercises such as mapping the amount of land that we have in our cities and towns. For example, we have about 20,000 sq km of urban area in the UK and about half of that is green space, so that is open land that could potentially be used for growing food.



If we take Sheffield, a big city in the UK, as a case study, and if we look at the green land within Sheffield and explore what within that green land could be suitable for growing food, we see that there are large areas of land potentially available. If you start to think about that as per capita availability within a city, it is about 97 square metres of land per person within Sheffield that could be used for growing food. That is four times the amount we have per person in the UK in commercial horticultural land. Not all that land could or should be converted into food growing, but if you think about converting 10% of green space within cities to food production, it could feed about 15% of the population of Sheffield on their five-a-day diet. Then if you scale that up across the UK you can start to see how thinking about shifting our horticultural production into cities and towns can provide some resilience in supply on a national scale.

Q227 Chair: Can you give us a metric for the amount of food grown at present from urban growing? It is a prejudice that it is a very small percentage of the food we consume, but I do not have a feel for the figure. Do you?

Dr Edmondson: Yes. We can estimate it. I have run, with growers across the UK, a citizen science project collecting yields that people are able to produce, and we can look at the area of land that is currently used for growing food. The estimate that I give is probably an underestimate because people have gardens that they grow in and we cannot quantify that, but now just growing in allotments on their own probably feeds 3% of the population of a city, on average, their five-a-day diet. That is a relatively small but important contribution, but the work that we have done has demonstrated that within the green resource that we have in our cities and towns, we have much greater potential to integrate horticultural production into our cities.

That is important for several reasons; first, because that is where the population of our country lives. We are more than 80% urban now and we have problems with fruit picking and vegetable picking in our rural sector. Shifting some fruit and vegetable production into our cities and towns could solve some of those problems and create livelihoods in cities and towns. We also have huge inequality in health and deprivation in cities and towns. The research that we have done has demonstrated that if you can engage people with growing food and encourage more people to grow food as part of either a lifestyle choice or potentially integrating it as community-led businesses, people eat more fruit and vegetables. There are knock-on benefits in fruit and vegetable consumption for health inequality and exercise and diet as well.

Q228 Chair: Do you have a sense of how many people are currently engaged in this and how big the challenge is to get the rest of the population engaged?

Dr Edmondson: There are about 300,000 allotments left in the UK. We have lost 60% of allotment land in the UK since peak provision in the 1950s, and the challenge with that is we have disproportionately lost land from areas of high deprivation. There has been eight times more loss in



HOUSE OF COMMONS

areas where there is high deprivation. We know that there is a growing demand and a growing interest in food production within cities and towns. For example, allotment waiting lists have increased year on year in the UK since the turn of the century, and Covid was a good example of where you saw more people interested in that shift to growing food. There are also local social enterprises and businesses cropping up in cities and towns now.

Q229 Chair: Would it be fair to categorise what you have described as requiring a wartime equivalent effort, to give over the amount of land in the urban environment that you have talked about?

Dr Edmondson: No, I don't think it would. I think there is the potential to make a big difference, and there is a will now among many local authorities to assign land over to growing food. The area is there. There is a shift in engagement that we need among the urban population, and that shift is already starting to happen. Thinking about the skills that people need in cities and towns to grow food and reconnecting people with those skills is crucially important as part of the engagement. For example, we have run pilot research in some deprived communities in Sheffield, providing people with the kits of food that they need to grow on a small scale and see how they got on. We are monitoring that year on year. One of the key things that they felt was a barrier was the skillset that they needed to start growing. Once people start growing, often that translates into further interest. We need to capitalise on that, so turn hobby growing into community-led businesses as well as household-level growing.

Q230 Chair: Edwin, could you give us a quick snapshot of hydroponics, how it works, the main risks, and the scale and nature of hydroponics? Again, without knowing anything about it directly, we have heard that one of the consequences of the energy crisis and price rises has been the business model has been very disrupted.

Edwin Morgan: Harvest London is a vertical farming company, so technically that is described as total controlled environment agriculture. If you imagine that at one end is open fields, then polytunnels and glasshouses, it is the most controlled form of agriculture. We grow inside; the lighting, the heating, the humidity, the irrigation, all of that is completely controlled in our system. It is a hydroponic system, as you mentioned, so the plants grow in plugs of organic fibre in water.

The reason you do it this way is you can have the lights on 16 hours a day all year round, so you can grow things that typically you cannot grow, or certainly not all year round, in the UK. It is much more productive as a result. We are building a much bigger farm in south London, and, hectare for hectare, that will grow about 63 times what you could grow in a British field, taking salad as an example. It uses much less water, so about 80% less than our current farm, and it will be even higher on our next farm, with no chemical pesticides. We were hearing a lot about agricultural runoff in rivers and waterways. We do not have



HOUSE OF COMMONS

that. We use fertiliser, but it does not end up in rivers. It can be treated like any normal sewage.

We grow in east London. All our customers are restaurants, a bit of retail, and are within 10 miles of the farm. So, within four hours of being harvested it goes on to a customer's plate on a pizza, for example, so it is incredibly fresh. It is not coming from Spain like most of our salad or most fresh herbs in the UK. If you went into a supermarket, it would say Morocco or Israel or Egypt or something like that. Typically, those are airfreighted fresh herbs. We are growing things such as Thai basil, which does come from Thailand, incredibly, and it travels by plane. Those are some of the benefits.

As you mention, energy is a big use. In our farm we use 100% renewable energy and we fixed for several years, so we have not been affected, but it has caused trouble for some businesses in the sector. It shows how important it is getting that energy bit right. Obviously longer term the quicker and more the Government can decarbonise the electricity grid, that will create many more opportunities for vertical farming.

Q231 **Chair:** How big is the scale of the sector in the UK?

Edwin Morgan: There are only a handful of players in the UK. It is not the biggest market for it. It is hard to say exactly, but out of the total UK fruit and vegetable supply of about 8 million tonnes per year, vertical farming might be a few thousand tonnes. At the moment it is small, considering it really did not exist at all 10 years ago and has grown in the last five years. Several new large farms have opened. It has grown very quickly.

Q232 **Cat Smith:** I have a few questions on land use, if I can start with Ms Hammond. The CLA is against the idea of a land use framework. Can you outline to the Committee why and, if the Government do go ahead with one, how would you like to see your concerns addressed?

Judicaelle Hammond: I should say first that we have been discussing the idea of a land use framework with our members for about two years. We started just before the Food, Farming and Countryside Commission published their report, which I think was the end of 2019 or beginning of 2020. I think one of the first recommendations was that a land use framework should be put in. We started with a very open mind, and we only came to the conclusion that we came to and that was reflected in the submission to this Committee after a considerable amount of feedback from members that there were already a lot of overlapping systems and regulations on how you use land that, taken individually, do not necessarily work very well—the planning system probably being chief among them, but there are others.

The local nature recovery strategies are coming up this year, and there is the environmental impact assessment system. There are a lot of things that members would rather worked well and then started working



together, rather than having an overarching extra layer where it was not clear what the scope was, what the aim of having a land use framework was and, more importantly, how it would be used once it was created. There was and still is a lot of very legitimate scepticism about whether it is a silver bullet.

Q233 Cat Smith: Mr Morgan, on the controlled environment farming and agriculture that you were talking about, you have argued in your submissions to the Committee that it is much more effective than more traditional farming methods. Would you like to see more land made available for the type of farming that you have outlined?

Edwin Morgan: I would not say it was more effective. It is good to have that diversity that was talked about earlier. For example, we are probably not going to grow lots of cereal crops or root vegetables in vertical farms, and British farming will handle that very well. What would help the industry expand are things such as: if it could have the same exemption from business rates as a normal farm if you are producing food in a vertical farm, and that kind of thing.

When it comes to the land use framework and the planning system that we were just talking about, I do not have a position per se on the land use framework. If it happens to have the flexibility so that you could have solar panels on farmland—maybe combined with grazing or other crops—combined with a vertical farm, so you had the power going directly to the farm, it would be a very interesting combination and a great way of producing more food while using the land and also potentially freeing up some land for rewilding.

Q234 Cat Smith: Dr Edmondson, you have talked about urban horticulture in your earlier answers to the Chair of the Committee. Do you see urban horticulture having a role in the Government's land use framework?

Dr Edmondson: I see urban horticulture as being one of those things that can potentially start to think about how we shift horticulture, or at least some of our horticultural production, away from the degradation associated with commercial horticultural production that we have in the UK. It is part of a suite of options that we have not fully explored at present, if we start to think not only about using some of the green spaces that we have in our cities for food production that we do not currently, but also the grey spaces that we forget about.

We write off buildings as unproductive spaces, but they have huge potential as well. For example, think about the flat roofs that we have on buildings and the waste heat generated from them that could be used for a controlled environment, and the waste water that we have in urban systems. We could start to think about how we recycle waste and recycle nutrients in our urban system into green land that could be used for more conventional growing in urban systems, and also that grey space that we do not currently think about as a productive landscape at all.



Q235 **Cat Smith:** Can I push you slightly further? What are the challenges about identifying spaces in the urban environment and what are the trade-offs?

Dr Edmondson: There are key challenges around it, particularly if you think that urban areas are incredibly dense—80% of our population live in cities and towns, and we all have requirements for green spaces. During Covid was a nice example of when we were hugely reliant on those benefits for health and wellbeing, along with other things. Horticulture, if it is integrated well, can provide important benefits to urban people, even if they are not participating in the growing. The diversity of crops grown in urban horticultural systems can provide hotspots for pollinator biodiversity, for example. They can also contribute to urban cooling.

My background is in soils, which we were talking about earlier. People grow in urban systems in a very sustainable way. They already recycle nutrients back into those systems, so they have high levels of carbon storage in them when you compare it to conventional agriculture.

When we think about how we integrate horticulture into our urban landscape, it is about valuing the multiple benefits, not just the food production potential. Part of the integration across the urban landscape is working with the communities that those green spaces are situated in, to ensure that what is done is acceptable to the people and needed and wanted in those spaces.

Q236 **Cat Smith:** I am conscious of time, and I think we are about to have a vote, but if I have time, I want to ask each member of the panel a final question on this section. What is your assessment of the contribution of the Government's environmental land management scheme? What contribution do you think it can make towards food security in England? I do not mind who goes first.

Judicaelle Hammond: It is definitely going in the right direction, and of course food security and food production is very much embedded in the schemes in the legislation and in the Agriculture Act. They will provide one of the ways in which the resilience can be built back into the system in favouring not only sustainable food production, which is what the sustainable farming incentive is doing, but also all the other types of land use that we have been talking about this afternoon for countryside stewardship and the landscape recovery scheme.

It is definitely going in the right direction. There are issues in how we deal with crisis, so again there are provisions in the Agriculture Act for that. They have not been tested. If there is at any point failure in the system—and we have seen that failure recently in the dairy sector and the pig sector during the pandemic—it is very ad hoc and it is a little bit late. If you think about the amount of time it took for government to react on those things, it is a little bit scary. That for me is a risk point.



HOUSE OF COMMONS

Edwin Morgan: Vertical farming does not receive agricultural subsidies. It is not something we spend a lot of time on but in future if a lot of the drive of government policy is to find a space for rewilding while also producing food in the UK, technology like vertical farming can help, so how could that be worked into the system?

Chair: I am afraid we have a vote, so I am going to call a halt and come back.

Sitting suspended for a Division in the House.

On resuming—

Chair: Welcome back to our second panel of the Environmental Audit Committee's inquiry into environmental change and food security. Our next set of questions is from Clive Lewis.

Q237 **Clive Lewis:** Edwin, in your submission you have argued that controlled environment agriculture has considerable scope to grow. Could you explain why the UK should look to control this particular sector? You have explained it is important, but why should it and how should it?

Edwin Morgan: I think the UK is quite a good fit for vertical farming because, as was explained earlier, we are relatively densely populated and we import a lot of our food—£10 billion worth of fruit and vegetables, in particular. We buy hundreds of millions of pounds of salad alone in the UK every year, and nearly all of that comes from Europe or slightly further afield. It is a natural fit.

Our universities have done a lot of research in this area. As was mentioned earlier, there is a good research base from engineering companies and automation companies, which can produce a lot of the technology, so I think it is a good time for all of those to come together. I think it fits with the drive towards net zero. Hopefully it has a lot of unity across the political spectrum and will give investors a lot of reassurance that that is going to be the direction, so it is something good to invest in.

As I mentioned earlier, there are clearly challenges to doing it, energy being the biggest. You asked earlier about how the Government can encourage innovation in agriculture in general. It is worth saying that Innovate UK, the research funding arm of government, is doing quite a lot of work in this area and deserves credit. For disclosure, we have a grant at the moment that is about exploiting the data from our farms to try to maximise the profitability of the method. That is data from sensors, and the climate, and using machine learning to try to grow crops with enhanced yield to make them—even, at the extreme, you can make them taste better or grow quicker or have certain qualities. Those are all the things that vertical farming can do, and that are much harder to do in a field where you are subject to the weather.

There are lots of reasons I think it is a good time. One of the slight challenges is that different parts of government are not sure what it is. It is quite a new thing, so DEFRA is a bit confused about it, to put it one



way. There is a big collaborative DEFRA-Innovate UK programme at the moment about innovation, and we have been told, "Well, technically, you are food production. It kind of fits, but DEFRA is not really thinking about that." Hopefully we can try to break down that kind of thinking.

Q238 Clive Lewis: What are the downsides? I know that there has been a big vertical farm opened in Norfolk, and I know that one of my colleagues, Duncan Baker, was speaking before about water shortages. What is their usage like? I know energy is quite high in usage, but what about water? Are there any downsides to the technology?

Edwin Morgan: Water is definitely one of the strengths. In our current farm, it is about 80% less water per kilogram of produce if you were to compare a bag of spinach you bought in the supermarket. The next one will be much more efficient than that, and there are examples where they have reduced it by 95% plus. It is very strong on water and particularly with the shortages that we have seen recently, that makes the case even more. We also import a lot of this food from water-stressed parts of the world.

Energy is the big challenge. I think consumer acceptance will be a challenge. At the moment it is quite a small thing. People do not know about it; most people have not heard of it. I think there might be a bit of, "Oh, this is factory food. I am not sure about that. I like my food to be grown in soil." It cannot be classed as organic, because organic food is grown in soil under the current definition. That might be an educational challenge over time, but I hope that people will come round to that.

Cost is still an issue. With crops such as basil, we are on parity with other suppliers. On other things the industry is still more expensive, so you rely on customers who appreciate the other sustainability benefits. It is fair to say that the big suppliers, the big retailers, the supermarkets that we are speaking to, are all increasingly interested in vertically-farmed produce because they see the sustainability and the security value as well. It means that they are not going to have shortages because there has been a drought in Spain.

Q239 Clive Lewis: Do the Government need to set any kind of targets or indicators or metrics to chivvy this along in any way, or to support the industry?

Edwin Morgan: I do not think they should set a target for X percentage grown in a vertical farm by a particular date. I think there are specific things. As I mentioned, with innovation funding it should be clear that if it is for food production, vertical farming counts. For business rates it is food production again, so why would it be any different to another farm? On environmental land management schemes and those kinds of subsidies, we are not saying that vertical farming should get basic payments as in the past, but if you could combine the vertical farm with an existing farm in a way that would free up some land for rewilding, because it is much more productive in space and the farmer is still



HOUSE OF COMMONS

growing and producing food on their overall package of land, you should encourage that through the subsidy regime.

Q240 **Clive Lewis:** Again, looking at the vertical farm in Norfolk, there is a big plug about the fact that it was done on 100% recyclable energy. Is that standard? I understand it is quite energy intensive. Is it all from renewables? Are there issues with that? Is there anything that you would like to raise around the fact that there is a lot of energy required for this? That could be problematic, because it could see an increase in emissions and carbon going out, so talk us through that.

Edwin Morgan: You are right. It is probably the biggest single issue affecting the industry. Our farm in east London is currently 100% renewable. I am not sure about every single vertical farm in the UK. There is certainly another that I am aware of that is next to a renewable plant and it is plugged straight in, and that is very attractive for vertical farms. Again, it comes back to this issue of land use and being flexible enough in the land use framework that you can combine solar and wind with farmland and vertical farms. Having a blanket ban on solar farms, particularly on high grade agricultural land, would give you problems there. More broadly, it is the quicker you can decarbonise the electricity grid.

Q241 **Clive Lewis:** I assume if you are on the standard grid, you would face the same kind of energy price hikes and additions to your costs and overheads.

Edwin Morgan: In our particular case, because we have had a fixed deal with our renewables supplier, we have not felt that so far. Absolutely, it is something that you will be prey to, movements in energy prices, as with any other company, unless you can fix it.

Vertical farms run entirely on electricity, and we do not have the problems that glasshouses do; there have been several in the UK who have had trouble. Some of them have gone out of business growing cucumbers because they use gas for boilers to heat the glasshouses, and gas was very exposed. Also, your average farmer uses quite a lot of fuel for tractors and other vehicles, which we do not have to use because we are growing indoors.

Q242 **Clive Lewis:** This is obviously about UK food security. Is there anything about what you can contribute to that, in your opinion, as a technology, an industry, that you think you need support from the Government to achieve for UK food security? That is quite a broad question. For example, you have touched on the fact that for departmental governance you sit between BEIS and DEFRA. Are there any other factors that are hampering and holding you back from contributing to something that could give some solutions to the food security issues that this country is facing?



Edwin Morgan: I completely agree. It is geared up towards stuff that we normally have to import, so on security and also on sustainability it is much fewer emissions. Those are reasons you would want to expand it.

The simplest things are making clear it is food production and, therefore, exempt from business rates, because business rates are huge if you are in cities, as we try to be. We try to build these things in cities. You get the benefits of being near to your customers, but then you also have higher business rates and higher property prices. It is sorting out the innovation grant system that we were talking about. We are not saying that we want lots of basic payments just for producing food, but it is clear that the mixture of rates, grants and also probably slightly more controversial but longer term the organic system cannot accommodate vertical farming because it is not grown in soil. The Government can change what they say and make it organic, or maybe there is another designation that is post-organic, even. We have some advantages in that we do not use any pesticides at all. I accept that is more controversial and longer term to do.

Q243 **Clive Lewis:** After Edwin has spoken—he comes from that particular sector—is there anything you would like to contribute or add, given the questions that I have asked?

Dr Edmondson: I will add support to the idea that controlled environment horticulture and less high tech options of polytunnel growing, without necessarily the energy and the heat, can be an important part of the mix of a shift in horticultural production in the UK. It is part of the suite that we need to consider in the UK for increasing our resilience in supply. We do not produce as much as we could in the UK.

Q244 **Clive Lewis:** Are there any figures on the percentage of food supply, what it is currently contributing and what it could feasibly contribute?

Dr Edmondson: The controlled environment? We have done some mapping exercises in a city looking just at very inner-city Sheffield and not within buildings, but thinking about using flat roofs. It is a grey space option that we are not using. Those roofs present an opportunity to grow fruit and vegetables in a hydroponic way. If you say 10% of inner-city Sheffield flat roofs, and they were suitable—there are engineering challenges associated with that—using conventional hydroponic yields, you could produce 2% of the population's fruit and vegetable demand for the year. If you use 75% of that space, you could start scaling up towards 10% of Sheffield's population. Obviously, there is not the diversity of crops that you might get with food growing in soil, but there is untapped potential there that we should be exploring. As you have recognised, there are technical challenges with that and acceptance challenges as well. Would the public accept fruit and vegetables grown in that way within their food system?



Edwin Morgan: I do not see any reason why vertical farming could not grow at least the majority of the herbs and salads that we import, which is a lot. There are things where vertical farming may not be appropriate for the whole thing, but there have been cases of growing tree seedlings and accelerating the growth rapidly in a vertical farm at the beginning and then you would move it into an orchard at some point. We do not see ourselves as existing entirely alone. There would be cases where you would move it to a glasshouse or into a field and it would be part of the lifecycle.

Q245 **Chair:** We have seen that in glasshouses in Shropshire with tree seedlings. Can I pick up on this question of the comparative costs? Vertical farming can have lower emissions once you get down to zero on electricity or electricity production from renewables. We are some way away from its competitive place in the market. Assuming we hit the Government's target of 2035, will you be able to compete in producing your product compared with other conventional sources over the next 10 years? If you cannot, you will not be around.

Edwin Morgan: We are already competitive in some herbs, and we are pretty confident we will be competitive on other things soon. Ironically, the pressures on agriculture inflation are far higher than even general inflation but have slightly helped vertical farming in that our costs have not gone up so quickly, so our produce is becoming more competitive.

The other element is that it is not just about the cheapest thing that you can get at that point. Talking to supermarkets and knowing that you can get the product of the same quality all year round and you are never going to have a supply disruption is very valuable.

Q246 **Claudia Webbe:** I want to press you a bit more, Dr Edmondson, on the urban horticultural agenda. You have already talked in this session about the benefits of urban horticulture. Do you have anything else to add to those main benefits?

Dr Edmondson: Recognising the multiple benefits is really important. As I have said, there are environmental benefits in soil security and the way that soils are managed. If you compare horticulture in a city, and the way that is managed, to conventional agriculture, these soils typically store more carbon. With that comes a better ability, for example, to mitigate flooding and hold on to water. They can be refuges for biodiversity. Typically, horticultural sites within cities that are hugely diverse in the crops that they have will have a thriving pollinator community, which is very much in contrast to what you see in agricultural systems.

There is also the benefit to the people who live in and around those spaces, so people who practise food growing themselves experience better health and wellbeing in mental health, physical health and physical exercise, but also in access to fruit and vegetable crops. Eating fresh fruit and vegetables is crucial to a healthy and food secure nation. If we can



increase supply locally within communities in urban areas, we can start to increase access to those fruit and vegetable crops as well.

There are multiple benefits that come through growing fruit and vegetable in cities and towns. It is the recognition of all those benefits, on top of the fact that you can achieve a good yield in a sustainable way of those fruit and vegetable crops within a city, that is really important.

Q247 Claudia Webbe: Your study focused on the urban areas of Sheffield and Leicester, and I want to declare an interest in Leicester as the MP for Leicester East. We very much welcome your study. In the one in Sheffield, you talked about the urban gardens and how that can contribute. In Leicester you were looking at allotments and how they can contribute to urban horticulture. What role do you think urban horticulture should have in the national food strategy? I know that in Leicester you were looking at allotment sites, and we have 3,200 allotments in Leicester across 46 sites, so 1% to 2% of the total green space in Leicester. What contribution can urban horticulture make to the national food strategy?

Dr Edmondson: One of the targets of the national food strategy was to increase fruit and vegetable consumption by 30% by 2032. A key way to do that is to start increasing food growing. We have done research nationally across the UK that shows that people on average eat 6.3 portions of fruit and vegetables a day if they participate in growing food. That is 70% above the UK average, so it is an important thing to recognise. The work that we have done nationally has shown that these allotments are spaces that are hugely important in providing access to fruit and vegetable in urban horticulture within cities and towns.

I would advocate for thinking about a mixed urban horticultural landscape moving forward. We have done lots of work and mapping exercises around how we might and where we might increase provision of food growing space. Allotments are part of that mix, and we know there is a demand for more land for growing in allotments. There is potential to greatly increase fruit and vegetable production, but community gardens are an important aspect of that as well. People may not have time to manage these big areas of land that allotments present to individual households.

Part of the big issue that we need to overcome is engagement with growing. There are more people who want to grow now, but we need to engage more people. A shift in skills and knowledge is crucial to come with that availability. If we increase available land and we increase the allotment provision and increase and provide infrastructure for things such as community gardens, we need to increase the skillset as well. With that could then come potential to increase the number of community-led enterprises growing food, such as we have popping up in urban areas over the UK. Bristol is a good example. Sheffield is a good example of co-operative-led growing that feeds into a formal food system



HOUSE OF COMMONS

of provision in fruit and vegetables and an informal network that we have with that household level of growing.

Q248 **Claudia Webbe:** Does that mean you believe that there should be targets set for the proportion of fruit and vegetables that are grown in community spaces?

Dr Edmondson: Setting targets is a difficult one, because you need to reflect the needs within the community. Setting targets is challenging, but I think that we should be pushing to make land available and make it accessible to people in urban areas across the UK. When I talk about accessibility, I do not just mean accessibility of land. I mean that communities feel ownership of that land and feel able to have the skills, the knowledge and the ability to grow within that land as well, because that is part of the accessibility challenge that we have. How do we engage people and how do we motivate people to grow? How do we shift people to value jobs, for example, in the horticultural sector within urban areas? They are not jobs that exist now, so it is part of a transformation of our urban systems that we need to think about, to bring food production in. Arguably, community gardens and allotments are one way that you start to move production into those systems and create that awareness and reconnect urban people with food production.

Q249 **Claudia Webbe:** I suppose what I am indicating or signifying is that you can identify places across the UK where communities have, by themselves, engaged. In areas such as Leicester that you have looked at and studied, you have obviously discovered that practically all the allotment sites are owned by the local council, and there has not been much growth in allotment sites since the early days. To the extent to which one leaves it at that level without any shift in policy or targets, it might mean that we may not get any growth. I witness daily front and back gardens being paved over for cars. Without any intervention, that will just continue to grow. What are your thoughts about where the Government play a role?

Dr Edmondson: The Government can play a role in recognising the multiple benefits and pushing for recognition that urban horticulture can be part of our food landscape. At the moment it is not recognised that food growing within cities is part of any kind of future food production system. There is a growing recognition of the interrelatedness of health and food and public health and food production. For example, within the local policies in Sheffield, the council is committing to providing more land to growing food. Those targets could be put in place, but there need to be accompanying policies to support expansion of growing in skills, expertise and knowledge and ensuring security for that land as well. Often, some of the community-led businesses have less security in land than an allotment does, because that is protected by law. Those spaces can be lost.



There are important shifts that we need to have to ensure that if the land is provided, people can take up the opportunities to grow. That is partly providing infrastructure and partly providing skills.

Q250 Claudia Webbe: You have identified there some of the key barriers to expanding urban horticulture. Do you want to expand on that any further?

Dr Edmondson: There are a couple of issues that commonly come up when people talk about expanding food growing in cities, particularly growing in soils, not in controlled environments. That is partly associated with risk to human health, associated with contaminated land and soils, particularly with things such as heavy metals. We take a very precautionary approach to that. We think about the concentrations present in the soils, rather than thinking about the bioavailability of those metals to the crops.

We have done work nationally looking across the UK at soils in urban areas and found that although in many cases, even in allotments, things such as lead guideline values are exceeded where people are growing fruit and vegetables, there is very little bioavailability of it and there is very little transferred into the crops. The risks to human health associated with soils that exceed guideline values in the contaminated land exposure assessment model are not as great as that precautionary approach takes.

The key thing with that also is that we need to recognise the physical benefits to people of participating in growing food. The benefits often far outweigh the risks. If we start to take a less precautionary approach, we may free up more land and reduce perceptions of risk, which is one of the challenges. We were talking earlier about potential challenges of people wanting to buy produce from a controlled environment to horticulture. There is also a perceived risk associated with buying fruit and vegetables that are grown in a city where people perceive there is soil contamination. That is an important part of it.

Q251 Claudia Webbe: Of the toxicity that you described, you are indicating that it clearly shows that the benefits outweigh what your findings have shown?

Dr Edmondson: Yes. There will be cases where there are extreme levels of contamination, and in those crops there is a potential risk. But in general, the data that we have at a UK scale suggests that those risks are not as great as the benefits of food security and people's access and exercise associated with growing food.

Q252 Chair: Can I ask Judicaille a question about allotment availability? Is there evidence that your members are willing to consider allotments adjacent to population centres as a practical use of their land?

Judicaille Hammond: Anecdotally, absolutely. I do not have statistics about that. We might have more information about that towards the



HOUSE OF COMMONS

latter end of this year, because we are looking at the provision of various amenities for the community at the moment. We are doing a survey around that.

Chair: Could I suggest you include a question to that effect, if that has not already been finished? I think it would be very useful.

Q253 **Dr Matthew Offord:** The Country Land and Business Association emphasised particularly the importance of water security and food security. Considering that we do not have food security, Judicaelle, would you like to elaborate upon the lack of water security and its impact upon food security? Also, could you touch on the Government's plan for water, and certainly their ideas about securing water supplies for farmers?

Judicaelle Hammond: Certainly. There are a number of issues that are raised in the submission to this Committee, some of which could turn into very useful recommendations as far as we are concerned. One of those is the fact that water for farm production is currently not included as an essential use during droughts in the Water Resources Act 1991. I think it would make a big difference if it was, because then we would get some priority to availability.

Another is increased support for on-farm storage reservoirs. I cannot tell you how much this is something that members, particularly in the east of the country, talk about. There is a lot of talk about that. If I want to have an on-farm reservoir, what do I need? I need money, and that could be coming in part from the government grant, but even with a government grant I still need to find 60% of the funding from the bank. I need planning permission, and I also need sufficient water abstraction licences to make sure that I can fill the reservoir. There are issues about any of these three things happening and, importantly, any of these three things happening in a timely manner. At the moment, for example, for the DEFRA grant, unless you already have planning permission, there is no chance of you having the time to find a contractor to put a reservoir together and spend the money. That is an issue with bottlenecks in the planning system.

You might have planning permission and other funding, and getting the permits from the Environment Agency is an issue. One of the things that we are keen on is a working group comprising all the bits of government that are dealing with this to put together a process that can then be rolled out across the country to make this decision making as fast as possible within the constraints that DEFRA and the Treasury have on spending the money. These are two examples, and I have more.

Q254 **Dr Matthew Offord:** The experience of farmers that I have had discussions with is that the water sustainability grant is not particularly liked by the water companies. They seem to be very slow to assist in providing any kind of advice and seem quite content for it to continue as it currently is, with more reliance upon public water supplies and public companies. In addition, I put out a parliamentary question. I do not think



HOUSE OF COMMONS

the whole amount of funding has been applied for, and only one water application has been agreed for the east of England. I would have thought that would be the part of the country that would have more. That is more of an observation than anything else.

In your submission to this Committee about farming practices that could be adopted to become more self-sufficient while reducing emissions, which do you think the UK Government should prioritise? Should it be the self-sufficiency or the emissions?

Judicaelle Hammond: I am going to give you a cop-out answer. Unfortunately, these two things need to be looked at together and in parallel, because we do have a need to reduce emissions, be they from livestock or crops. There is not a great deal of time. I totally agree with George Monbiot that there is a need for pace in this, and bringing the science to the farm is something that we need the Government to help to accelerate. On the other hand, as I said in my opening remarks, there are sectors of food production where self-sufficiency is a real issue. While I can see that the ideas that are being brought by the two people on each side of me are absolutely part of the jigsaw puzzle, we still need to look at the conventional means of production as well.

Q255 **Dr Matthew Offord:** I do not think it is a cop out to say that it needs to be both, not either/or. That is more than acceptable. What kind of initiatives and incentives would you like to see the Government promote to ensure more sustainability and security, and indeed emission reduction?

Judicaelle Hammond: I will deal with the sustainability and security first. Apart from the ELM scheme, which, as I said before, is a good thing, there was a thing in the government food strategy that we thought was disappointing, which is that there is an ambition—not even a target but an ambition—on public procurement of local and high sustainability food. That would help, so make it a target and put your money where your mouth is. I know that is probably something that the Treasury does not like, but if you want to make a difference to self-sufficiency in this country, that is a big one to go for.

There are a number of technical advances in sustainability, some of which Professor Lowenberg-DeBoer talked about, but there are other things such as improvement in genetics and the kind of stuff that is being looked at now in ruminant production, feed additives and so on, which might make a difference in the short term to methane emissions. We need a difference in the short term even within the practices that are being used at the moment.

Q256 **Dr Matthew Offord:** Also in your submission, you raised ideas about farming methods, new methods, modern methods and also traditional methods, which I quite liked the sound of. What balance would you like to strike between those, or rather what balance do you think the Government should aim to strike? Where are we in current practices?



Where does that fit into this mix of new, old, modern, traditional and current?

Judicaelle Hammond: That is a really interesting question, because my land use chief adviser, who is an agronomist by background, said it is not categories; there is a spectrum. You could have traditional regenerative agriculture that is totally obsessed with data, and that is very modern. It is AI, sensors and everything else. Even in regenerative and agroecology, you need some of the very cutting edge practices. On how they all fit, I think each type of model of agriculture has a niche. Partly it is about where they are in the country and what kind of resources they have at their disposal, and you need a rich patchwork for biodiversity and for habitats purposes anyway. I don't think there is a way, or even ways, of imposing targets for how much you have in each of the three broad categories that we have already talked about. Some of it is the scale and some of it is the location; where do I want to go as a farmer?

Q257 **Dr Matthew Offord:** As a final question to bring in the other two members of the panel, on the volatility in the growing of produce that Judicaelle has described, I am sure that you would say that the whole issue of controlled environment and urban horticulture methods would assist in that. Where does that fit in with not only resource management but access to water, for example?

Edwin Morgan: Water resource conservation is a good reason to have vertical farming as part of the mix, because it uses so much less. Without going into too much detail, you can capture the water that has transpired through the plants because you are in a sealed box, essentially, and recirculate it. That is one of its real strengths. A few years ago people were pushing that as a strength of vertical farming and it was less prominent in the UK, but I think even in the last couple of years we have seen that water is much more prominent as an issue. Energy is the big thing for vertical farming but there are issues on that.

Dr Edmondson: To come in more broadly on urban horticulture, you would be growing in a city where there is water wasted from buildings and grey infrastructure every day, but there are also huge amounts of water that rush off our buildings every day when we get rain, which we get quite a lot of, and it could be more extreme. Thinking about how we recycle waste water into production but also how we manage our storm water, harvesting water from roofs and things could be an important part, and there is research being done about how we might do this. If you think about the opportunities for urban horticulture in harvesting rainwater and mitigating storm water flow, there are also additional opportunities for minimising waste, securing waste from urban systems and re-routing those back into the productive landscapes. There are big opportunities in thinking about how we use our waste and our water in a sustainable way within a city that could provide real benefit.

Dr Matthew Offord: The problem we have is that we are currently wasting our stormwater and grey water by flushing out our sewers



straight into the River Thames. That is a very good point. Thank you.

Edwin Morgan: If I can add something on the point about water systems, you should not see vertical farms as a standalone thing. The benefit is that it can be integrated with other systems. On the energy system, for example, farms could become a way of balancing load across the system— even combined with battery storage—and then using it at the time the farm needs to help with those kinds of issues. If you combine it with food manufacturing as well, literally having the farm next to or inside a manufacturing plant, you are reducing transport and the risks associated with that. There have been issues in the UK with things such as the traceability of ingredients. Again, putting that all as close as you can— logistics, distribution to urban centres, how it brings agriculture much closer to the end consumer—is one of the very interesting things that vertical farming can do.

Q258 **Chair:** I will conclude with a question to Judicaelle on what you heard in the first panel—and we touched on this a bit earlier—about the importance of soil, and re-establishing or improving soils, and the role that livestock has to play in that. Does the CLA have a view on whether livestock in the mix helps to restore the balance of fertility removed from soils in a purely monocultural arable system? If they were to be removed and go into rewilding nature, what happens to the soil in those circumstances?

Judicaelle Hammond: It would be very different. You are absolutely right that livestock can indeed help, and livestock is the basis for most of the regenerative agriculture ideas. It is a pity that George has left, but on land use changes, be it soil recovery or carbon sequestration through trees and other means, anything is possible as long as farmers and other land managers can see a viable commercial alternative. It would be a big culture change for some areas of the country to go out of livestock, and at the moment the market does not require it. I think that is the other thing that we have not really touched on. It needs to start with the diet, otherwise all we will do is to import meat from elsewhere with possibly even worse consequences.

It is a big culture change. There are risks because the funding is not in the bag now that we have left the common agricultural policy and we are at the mercy of the next spending review, basically. Commercially, this is not necessarily well and truly established in private markets. If you are a sheep farmer in Cumbria or elsewhere, you know what you are doing with sheep because chances are you are the third or fourth generation to have done it. You would be the first generation to farm for climate or biodiversity. It is still production, but it is production of something completely different. I think that we are inching in that direction with what DEFRA is doing, and fair play to it; it is listening and changing payment rates and adapting the system, but it is not quite there yet to persuade people that it is a good alternative.



HOUSE OF COMMONS

Finally, meat is still a nutritionally dense, valuable part of our diet, and we might be able to do that with meat substitutes, pulses and grains and so on. That is another thing that is potentially an opportunity, as we mention in our submission, but at the moment the vat-produced meat equivalent is not available, it would be really expensive and it is also quite energy intensive. We need to have something that is affordable and provides calories, so let's just not forget that entirely.

Chair: Thank you very much. I will conclude this panel by thanking you all for staying on later than forecast and particularly thanking Jill Edmondson, Judicaelle Hammond and Edwin Morgan for joining us this afternoon. I thank our specialists Rebecca Lees and Nick Davies for preparing our brief.