



## Science and Technology Committee

### Uncorrected oral evidence: Nature-based solutions for climate change

Tuesday 7 September 2021

11 am

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Members present: Lord Patel (The Chair); Baroness Blackwood of North Oxford; Viscount Hanworth; Lord Holmes of Richmond; Lord Kakkar; Lord Krebs; Baroness Rock; Lord Sarfraz; Baroness Sheehan; Baroness Walmsley.

Evidence Session No. 2

Virtual Proceeding

Questions 9 - 21

#### Witnesses

Professor Chris Collins, Professor of Environmental Chemistry, University of Reading; Dr Lynn Dicks, University Lecturer in Animal Ecology, University of Cambridge; Dr Lisa Norton, Agroecology researcher, UK Centre for Ecology and Hydrology.

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## Examination of witnesses

Professor Chris Collins, Dr Lynn Dicks and Dr Lisa Norton.

Q9 **The Chair:** Good morning to Professor Collins, Dr Dicks and Dr Norton. Thank you for joining us today. We are very grateful to you for helping with this inquiry. We have had one session this morning, and you may have heard some of it. We are looking forward to hearing from you.

Let me kick off and very briefly ask—you do not need to go into detail—how you would define a nature-based solution in the agricultural or grasslands context, starting with Professor Collins.

**Professor Chris Collins:** Thank you. There are two definitions we have come across. The first is from the International Union for Conservation of Nature. It is a bit of a mouthful, but I will give it to you: “actions to protect, sustainably manage and restore natural and modified ecosystems in ways that address societal challenges effectively and adaptively, to provide both human well-being and biodiversity benefits. They are underpinned by benefits that flow from healthy ecosystems and target major challenges like climate change, disaster risk reduction, food and water security, health and are critical to economic development”.

I think the one we preferred was from the EU, which is: “Solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience”, although we were a little concerned, particularly Lynn, about the words “inspired ... by”. We felt it could be a bit harder. A couple of examples are hedgerows and buffer strips, which I know Lynn and Lisa will speak to in more detail. Things we think that are out of scope are practices such as minimum tillage. We see those as management practices, not nature-based solutions.

**The Chair:** Thank you very much. Dr Dicks, do you have anything to add?

**Dr Lynn Dicks:** Yes, I have been involved in quite a few discussions about the definition of nature-based solutions and one of the sticking points is: what exactly do we mean by nature here? Does it have to be things that are completely natural—native species only, for example? For me, that is important. If you put the word “inspired” by nature in there, then you can have things such as, for example, a city tree, which is a framework with some moss on it, and call that a nature-based solution. I think that is out of scope. For me, it is nature as in natural—things that would naturally occur there and native species only.

**The Chair:** Thank you very much. Dr Norton.

**Dr Lisa Norton:** I wanted to add something on the “solutions” part of “nature-based solutions”, thinking about who the solutions are for. Very often we might think of them as solutions for society, but more often than not it is farmers or land managers who are adopting them. Whether they work as solutions, whether they get adopted in the first place and

how they are maintained, particularly on agricultural land, depends on what farmers will get out of them as much as what wider society will.

Therefore, I think a nature-based solution on agricultural land has to be of value to the farmer, so it could be about what they are paid, but it is better if it also fits in with their goals for the land, and they are likely to be at least partly production oriented. For example, if for grasslands we say that improving species richness is a nature-based solution, it may have a cost to the farmer, but if it also improves the nutritional quality of the forage and leads to healthier animals and potentially improves soil quality, leading to greater long-term productivity, you are much more likely to get farmers to buy into it as a solution for them and for society.

**The Chair:** Thank you very much, all three of you.

Q10 **Baroness Rock:** To declare my interests on the register, I am a director of a tenant farming enterprise, Wrackelford Farms Ltd.

Dr Norton has led me very nicely on to my question: realistically, given the huge change going through at the moment in the agricultural transition programme, how large a contribution can agricultural nature-based solutions make to reducing greenhouse gas emissions and carbon sequestration in the UK, and what practices or policies can be the major contributors to this? Maybe you could start, Dr Norton.

**Dr Lisa Norton:** Yes, thanks. First, there are obviously different greenhouse gases; we have to think about methane, carbon dioxide and nitrous oxide, and nature-based solutions may differentially affect those gases. However, because most of the UK landscape is agricultural, the potential is pretty large, but the impact depends on what parts of agricultural land you can put those solutions on and the trade-offs or, ideally, synergies between production and nature-based solutions to climate change. Personally, I would like to see solutions on the productive land instead of on the bits around its edges, but I realise there are real challenges there.

We thought about major contributors. They are in areas where drainage and subsequent grazing have led to land that naturally would be bog being replaced by degraded acid or moorland grassland. For example, a switch away from agricultural management to rewetting and bog recreation would have significant impacts on greenhouse gas emissions. You would obviously need to consider the livelihoods and the cultural significance of farming in those areas if you were going to do that. Similarly with restoration of flood-plain meadows, flooded grassland can be a source of nitrous oxide, but if you get naturally adapted communities on flood-plain meadows, they can accumulate soil carbon in sediments and can be really important for greenhouse gas mitigation.

As we have just been hearing in the forestry group, trees within systems are really important; in agricultural systems, so are increased hedgerow networks filling up the gaps. We have lost hedgerows in recent years. They are going into lines of trees and becoming non-existent. We need to fill the gaps, bring the hedges back into active management cycles,

extend the length of the hedges and include more standard trees in them. They are very important, I think, for above and below-ground carbon as well as biodiversity.

Agroforestry, which we heard a bit about in the previous session, if it is well designed and carefully implemented, can provide long-term carbon stores. There is also biological pest control and use of organic fertiliser as opposed to inorganic products, so that would reduce losses from the manufacture of those inorganic products and from their application. That is a big challenge. Remixing agricultural systems might be one nature-based solution for addressing that—having more animals in arable systems, et cetera.

**Baroness Rock:** Thank you. Dr Dicks, do you think the agricultural community is prepared and able to do some of the things that Dr Norton has just talked through?

**Dr Lynn Dicks:** Some of them, definitely. When it comes to nature-based solutions in agriculture, as Dr Norton said, there are things in the productive land and there are elements that involve taking land out of production, such as peatlands and forests. That is not part of agriculture in the sense that it is not productive. For the productive parts, it is agroforestry, and energy crops are also being considered by the Climate Change Committee in its plan for 2050. That committee includes hedgerows in agroforestry. I think they are quite separate things in some ways.

Agroforestry is not very widely practised in the UK, so that is a system change to which there will be quite a lot of barriers, which I think we will come on to talk about, because of the different system that we are proposing there. Hedgerows, on the other hand, have been around for hundreds of years, and farmers and rural communities have the skills to manage them. They have been developed from the ground up over many years, so they are part of our agricultural system. The farming community fully understands how to manage them, what their value could be and how they could be improved.

**Baroness Rock:** Thank you, Dr Dicks. On the hedgerow issue, I see it is the lowest financial support under the new SFI pilot scheme, however. Professor Collins, do you have anything to add on that?

**Professor Chris Collins:** Of the practices that Lisa touched on, one we did not mention was reflooding some of the lowland peats, which we know are particularly valuable for their carbon storage. I know there has been research around flooding those peats just over winter periods; we can then protect the peat for longer and maintain that carbon, which is critical. What has not been done is to look, as Lisa said, at monitoring the other greenhouse gases when they are being flooded. It is about that balance and what crops you grow when they are flooded.

There is perhaps some potential for growing biomass crops when they are flooded. That is something we should not forget, considering how critical those peatlands are.

Q11 **Lord Sarfraz:** I would like to declare an interest in an agricultural technology business that works with smallholder farmers in Asia. Dr Norton, how happy are you with the existing evidence base for carbon sequestration potential and co-benefits of various nature-based solutions?

**Dr Lisa Norton:** Can I pass this to Dr Dicks, as we decided who would lead on questions and this was the one that she was going to lead on?

**Dr Lynn Dicks:** Thank you. If it is okay, I will take that question. It is a big question and there is quite a lot of evidence. I am going to try to summarise how I see the evidence, or how I would interpret it, for agroforestry, hedgerows and field margins, using the kind of approach to strength of evidence or confidence that the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystems Services—IPBES—would use, which is based on how much evidence there is, the quality and quantity of the evidence, and the level of agreement on that evidence. I will give you my take on this evidence. It would be better to have a consensus from a group of scientists who all looked at the same evidence and then agreed among themselves what the confidence should be.

Starting with agroforestry, there is not very much evidence on agroforestry systems in temperate climates, especially in northern temperate climates like here. There is more from Europe—there are more studies on Mediterranean systems, where agroforestry is more common—and from the rest of the world, such as the tropics. We are limited to quite a small number of studies on the effects of agroforestry on carbon sequestration and storage.

Overall, there is good evidence that carbon storage is higher with agroforestry, which is mostly because of the carbon stored in the trees, but much of the evidence comes from the trees being quite young. They are not very mature in the sense that there really are only a few studies on this, mostly in silvopastoral systems, where you have grassland with trees. There is a study from Scotland and a study from lowland England showing that if you compare pasture with silvopastoral—so trees and pasture with woodland—you generally have more carbon overall in the woodland. But, from a landscape perspective, you would have to take quite a lot of grassland out of production and turn it into woodland, and then you lose the productive area of that land; it might be better to have silvopastoral because it also produces food or livestock. From that perspective, there is reasonable evidence for silvopastoral, although I would class it as established but incomplete because there are not very many studies.

The other thing I want to talk about with each of these things is the trade-off with yield. That is important because we cannot really recommend small-scale measures in agricultural production systems that

reduce overall food production because that goes counter to the general context in which we have to take land out of production at a much larger scale, for example, to restore woodland and peat. If we are going to take land out of production, we cannot reduce production in the farmland we have left. Therefore, there is a kind of constraint on all of this, which is that the things we should incentivise do not have a yield trade-off.

When it comes to agroforestry, is there a yield trade-off? We do not know. There is a small amount of evidence, but it is not in agreement, especially in silvoarable systems. I can find only one study on wheat that finds a slight yield increase and another study also in wheat that finds a decrease. We are not really sure of the effect on yield of these silvoarable systems and I do not know of any evidence on the silvopastoral systems from the yields perspective, which is important here.

Talking about hedgerows and field margins, we have a really good synthesis of evidence. There has been a gathering of evidence there up to 2016, and then some quantitative meta-analysis of all the studies for both hedgerows and field margins, both of which show that there is a carbon benefit. It is a small carbon benefit in the soil and, for the above-ground biomass, if you have hedgerows, as you can imagine, you get more carbon. Because that is based on more than 10 studies in both cases, we have well-established evidence that you get good climate carbon sequestration from hedgerows and field margins as long as they are grassy. You have to have perennial field margins, preferably in the long term. If you are annually cultivating them—for example, you might do that for rare weed or arable flower conservation—then you do not get the same carbon benefit, or you would not expect to.

From a yield perspective, it looks quite different for field margins and hedgerows. It seems that, although hedgerows have a yield cost very close to the hedgerows—a hedge height or two hedge heights away from the hedge, you have a drop of yield—further away, there is a small gain in yield, which is thought to be because the soil is less eroded when you have hedgerow on a field compared with not having it. Overall, there is a slight gain in yield from having hedgerows, so there is no yield penalty. Not only do you get the carbon sequestration at larger scale, it seems, from the synthesis that we have, you also do not have a yield penalty.

Field margins deliver some really important co-benefits because they support pollinators and natural enemies, so they should deliver some pest regulation benefits. There have been a lot of studies on the effect of different grassy field margins and perennial flowery field margins on what we call ecosystem services in agriculture. There is not strong evidence that there is an increase in yield. There is usually an increase in yield, but it does not go very far into the field, if it is there at all.

From a yield perspective, the evidence is that it is simply unresolved. We have very good evidence, but it is not in agreement. If you wanted to get it into agreement, you would have to be able to define which particular elements of the context lead to there being a yield effect in having a field margin or not. It is partly, I think, to do with the fact that there are not

enough long-term studies, so if the effect takes four, five or 10 years to build up, you do not see it in a three-year study. That may be the reason why we cannot see the yield benefits of field margins. Hedgerows have good carbon storage with no yield penalty; field margins have good carbon storage in the soil but there is a yield penalty. So there is a decision to be made there.

How would we improve this evidence base? Something that has come up repeatedly is that we need long-term studies—10 years or more ideally, but at least five-year-long studies—to get empirical data on the scale so that we can see the effects.

The soil carbon benefits of these different nature-based solutions seem to look different if you only look in the upper profile compared with looking in the full profile of the soil. On agroforestry, for example, there is one study showing good carbon building up in the soil in the upper layers, but another study shows that, if you look across the whole first metre and a half of the soil, there is no difference in total carbon storage between agroforestry and the conventional comparison system. We need studies on soil carbon storage that look at the full soil profile.

We need much more quantitative synthesis on the effects of agroforestry. I have what is called a systematic map, a set of about 46 studies on agroforestry—we have only just identified the studies but not synthesised them. I can see there is quite a lot of evidence there and it has not been brought together yet, and larger-scale ones—

**The Chair:** Thank you.

**Lord Sarfraz:** Can I ask for a moment for a follow-up?

**The Chair:** It will have to be very quick.

**Lord Sarfraz:** Thank you for that answer.

**The Chair:** A comprehensive answer, yes.

Q12 **Lord Sarfraz:** My question is about navigating the whole landscape for measurement reporting and verification. We heard earlier about the UK Woodland Carbon Code, but there seem to be so many of these codes internationally and disagreement on how to measure and monitor, particularly at scale. Can you help us understand where the academic and scientific community is in agreeing on measuring, and technologies for measuring at scale?

**Professor Chris Collins:** Yes. I think that most of the push is towards remote sensing, because that allows us to do the scale relatively cheaply, but we do not have enough ground validation of those remote sensing data. If you are taking a picture from a satellite of a particular tree or a particular crop in a field, we do not know always that the signal we are getting from the satellite gives us a particular species or a particular carbon content in that soil. Obviously, lots of soils are covered most of the year round, so we would need to develop proxies. Then, if you are on

the ground, we do not really have the cheap technologies we need to measure things such as soil carbon.

We can do some quite good measurements at the surface, but they are plus or minus 1% of the carbon content, for example. If we are looking at carbon accumulation over time, that might take 10 years to grow. So it is quite difficult for us to measure that, and obviously you have huge heterogeneity within a field and between fields. We have 700 different soil types in the UK.

I want to pass over to Lisa, because I know she wants to add something about national monitoring, which I think is important in this context.

**Dr Lisa Norton:** Talking about long-term monitoring, it is important to track the solutions, how they are implemented and how they are affecting landscapes, in a robust way over the long timescales. I would put a plea in for government to reconsider funding the UK Countryside Survey, which UKCEH used to run alongside Defra. They latterly co-funded it along with NERC. It has been going since 1978 and provides useful contextual information about how the landscape is changing in relation to current land use and climate change. I know that a new survey is coming soon, the England ecosystem survey, because UKCH is advising on it. But I would stress the relevance of having the longer-term data, particularly when you talk about carbon and landscape change, because it really will help to understand what is going on and how that might be different from the wider countryside change.

**The Chair:** Thank you very much indeed. Before I go on to the next question with Baroness Sheehan, could I please request that we keep the answers brief? What will help most is for you to have an opportunity to make important points that we get on the record and therefore in our report. Baroness Sheehan, please.

Q13 **Baroness Sheehan:** Thank you, Lord Chair, and thank you to all our specialist panellists for coming to help us today. It has been thoroughly interesting. I have a quick declaration of interest before I start. I am taking part in a countryside stewardship scheme.

The questions I want to move on to now are about the barriers and the concerns that currently prevent farmers, land managers and other key stakeholders from adopting nature-based solutions. We touched on some of those in the previous session, but if we can look at them now from the agricultural perspective that would be really useful. I hesitate to say who should start, but if you tell me who should lead on this I would be grateful.

**Dr Lisa Norton:** I will lead on this one if that is okay. Thank you. The key barrier is money, as you would expect. Any activity that is likely to reduce productivity or require costs to be set up will require that money. If you need to sacrifice land for flood meadows, for bog rewetting or to retain a high-quality grassland rather than grazing it too intensively, you are going to need money. Tree planting, management for agroforestry or hedgerow management all cost, so that is really important.



There are other barriers such as the availability of suitable seeds. If you want to plant a productive, species-rich grassland, it is quite difficult to get hold of suitable seed for where you are that will work well for your species. Similarly for trees: if you need to plant trees in your hedgerow, getting the right young trees of the right species suitable for your area can be difficult.

The other barriers are lack of evidence for farmers that things can work and be economically viable for them. They need to know that before they commit. Also, there are farmers' habits, peer pressure, the information that is specifically relevant to them, whether they have time, the expertise and the skills. If you are saying put stock back on arable land, who is going to manage the livestock? Arable farmers have often lost the ability to do that. They might not have the right farm infrastructure, fences and buildings, et cetera. I think there has been a loss of expertise from farmers about their own land. They are used to sitting in the tractor above it and putting inputs on it. They are not so used to walking over it and understanding how it changes naturally, and I think that is an issue.

As to addressing the barriers, there is obviously funding, but things like peer networks are important; they give farmers a lot of confidence in how to do things, and farmers are already thinking about these things. I would say that social and ecological solutions need to be given the same profile as technological solutions. They are important for people to take new things up and understand what they are doing, so the whole environment in which these solutions are implemented is key.

**Baroness Sheehan:** Excellent. Before I move on, could I ask you to say a little about the culture change that you think might be needed and where you think the difficulties lie in addressing that?

**Dr Lisa Norton:** There are a lot of farmers out there who recognise the role of nature in their farming and there is real impetus going on with organisations such as the Pasture-Fed Livestock Association—I particularly have been working with them—and with the innovative farmer groups that the Soil Association has been involved with developing. There is a large minority of farmers who are already changing cultures. Things like YouTube videos show how easy it is to do something, how well the cows and the pastures are doing, or how well their agroforestry is growing and how the chickens are adapting to it. It will be a slow, steady trickle rather than a massive change, because there is a lot of resistance still in the farming community with older generations not passing on to their youngsters yet.

I once heard somebody say that if you could introduce compulsory retirement for farmers at 60 it would be the biggest change, and I think they were probably right, but it is a difficult, slow, steady change, I think.

**Baroness Sheehan:** Excellent. Dr Dicks, you have your hand up.

**Dr Lynn Dicks:** I completely agree with what Dr Norton just said, especially on the vocal and quite large minority of farmers who are

driving changes now in farming systems. But, for me, the problem with a lot of farming in the UK is that there is what I call a double lock in a system that relies on synthetic fertilisers and synthetic crop protection—pesticides and fungicides—and it is quite hard to get out of that. There is a transition period that requires a risk and there is a huge lack of knowledge about the alternatives in things like biological control and using the natural ecosystems services to better regulate your pest outbreaks, for example. The key here is partly in who provides advice, where it comes from, and agricultural education, to think more ecologically and from a more system perspective about the environment you are managing. I think we are quite a long way from that for most farmers at the moment.

**Baroness Sheehan:** Thank you. Professor Collins, do you have anything to add to that? Could you address the issue of the prevalence of tenant farmers in the UK and whether you think their lack of control over the land that they work is a particular part of the problem that needs to be addressed?

**Professor Chris Collins:** Yes. Just picking up on what Lisa and Lynn have both said, the key thing is education for the farmers. We used to have a fantastic advisory service, which had demonstration farms, visited farmers and gave them practice. A lot of farmers cannot afford consultants, and if we are really going to change behaviour, we are going to have to offer that sort of advice. We need to think about a national advisory service in some capacity. I know Defra has been thinking along those lines, but I do not know where the money is coming from for that, so that, I would say, is critical.

It is also about making sure that any subsidies that come via ELMS, et cetera, are for the long term. If farmers are going to plan, they need to plan for the long term. Those subsidies need to be bound in for more than five years, I would say, in a particular practice for that change to occur.

Coming to tenant farmers, I have forgotten the statistics, but I think it is said that nearly 80% of some farms in Northern Ireland are tenanted. I come from the soils perspective. There is little encouragement if you are looking after a farm for less than a year to look after the soil when you know the benefits accrue over many years. If you use a crop such as potatoes or carrots that is particularly damaging to the soil, you are not going to restore after you have finished, so there needs to be a whole thing around how that tenancy works. I know the Crown Estate is trying to develop contracts with tenant farms such that they leave the soil in the state they found it, so I think it is things like that. I do not necessarily blame the tenant farmers because, as we keep coming back to, they have to earn a living, but maybe we need to start to provide the advice in the way they need it so that they can progress.

Q14 **Baroness Sheehan:** Can we move on to money? Dr Norton, you mentioned that as your primary concern right at the outset. How can carbon sequestration in the UK be made more attractive to private

finance on the voluntary carbon market? That is one important issue that we have not quite addressed yet, but also there are the policy and regulatory barriers. We have touched on education, et cetera, but what is the role of government in having a comprehensive framework to encourage farmers to take up land use changes?

**The Chair:** You need to be brief in your answer, because we will have opportunities to explore this in greater detail in future sessions.

**Dr Lisa Norton:** On private finance, this is a bit of a worrying angle, because we do not yet have the detail on carbon sequestration for some of the practices to make sure that investment via private finance is realistically changing practice and realistically resulting in sequestered carbon. I know of Nestlé work with producers in Cumbria, where they are supporting hedgerow planting, and that seems to me to be a fairly sound way of supporting farmers. It is kind of like an agri-environment scheme, but by Nestlé, which buys the milk from those dairy producers. That seems to work, but there is a slightly worrying move into farmers taking money from private investors for carbon sequestration with a worrying lack of administration and security around what they are actually going to do with that money and whether it will result in the benefits that we hope it will.

**Baroness Sheehan:** I guess we need robust data on how much each intervention is giving. I do not know whether anyone wants to follow on from that. Quantifying how much carbon is sequestered is something that will be necessary, and I think we are quite a way off that.

**The Chair:** Thank you very much. Okay, no answers. I will move on to the next question from Baroness Walmsley. Thank you, Baroness Sheehan.

Q15 **Baroness Walmsley:** I declare my interest as a former chair and current supporter of Botanic Gardens Conservation International, some of whose reports are relevant to the current inquiry, and I am a current, small-scale active beekeeper.

My question is this. The Climate Change Committee has suggested as much as 22% of agricultural land may need to be used for carbon sequestration in some form or other in order to hit net zero. Do you view this as realistic, and, if so, what would land managers need from the Government, such as policy, regulations and investment, to make this a reality? Perhaps an example might be future agri-environment schemes.

**Dr Lynn Dicks:** Thank you very much for the question. The Climate Change Committee's report makes the case that we need to take this land out of production. It proposes that we make that possible by increasing the yield per unit area on the farmland that we have as one thread and changing our diet so that we eat less meat so that we need less livestock production, slightly shifting some of the livestock land to crop land and reducing food waste. I have to congratulate the Climate Change Committee on putting this thinking out there, challenging us all to think about what is possible here.

You asked whether I think it is realistic, and I will focus on the increase in yield that is proposed to allow us to reduce the amount of agricultural land. That is based on the assumption that we can increase wheat yields from where they have stagnated since the mid-1990s, about 7 or 8 tonnes per hectare up to 10 tonnes per hectare, and then in their high ambition up to 20 tonnes per hectare. Nowhere in the world is achieving those kinds of yields at the moment. I do not think it is realistic to imagine that we could do that, and I do not think we should be relying on future technologies to get us there either.

One issue with the assumption that we can carry on increasing wheat yield, although we have experience of not being able to do that, is that where high yields are being achieved, in some particular examples of 16 tonnes per hectare, it relies on favourable weather as well as good crop breeding and technology, and that is not what we are seeing in the next 20 years. This year is a perfect example of a really difficult harvest created by slightly unusual weather conditions. That is the norm that we are going to be facing.

Therefore, I do not think we can rely on increasing yields, especially not through technological means, in order to take land out of production, which is slightly uncomfortable. That is why I focused my previous evidence on not wanting to incentivise things that reduce yields. We want to be at least trying to maintain and preferably increase yields, but through means that also have co-benefits for climate mitigation and biodiversity, for example.

**Baroness Walmsley:** Thank you, Dr Dicks. Dr Norton, would you like to add anything?

**Dr Lisa Norton:** I work largely on grassland and I think that what Lynn proposes is much more feasible for grassland, so it could be possible to at least maintain and increase yields on grassland if we manage it differently. Farmers have largely been set stocking grassland for a while, and there are rotational grassland techniques that I think are probably better for grass use efficiency but also better for carbon storage in soil. So there are some possibilities with grassland.

On the 22%, I totally agree with Lynn about the ambition to increase yield in wheat being unrealistic, but there are some things that we can do, and our grassland is our most extensive farmland in the UK, so that is a positive.

**Dr Lynn Dicks:** I wanted to add one thing. Even if you do increase the yields, whether that delivers taking land out of production is a separate question; it is an economic question. There is a kind of concept of passive land sparing that says that if you increase yield, you save land. Not necessarily. If you look at the past trends in yield and land use, the evidence shows that for cereal crops there might be that effect, but certainly not for all crops; you do not necessarily have that for any crops where the demand is responsive to the price, for example. In fact, you

can have the opposite: as you increase yields, you get more land going under that crop.

These are complex economic questions that are all tied up in this kind of scenario that we play out where we make land more productive, and it means that we can take land out. Because we do not have a national land use framework or strategy and no one is in charge, we are going to be relying on how individual farms and farmers behave and respond to incentives.

**Baroness Walmsley:** Indeed, and we cannot predict behaviour change, can we?

**Dr Lynn Dicks:** Not very well.

**Baroness Walmsley:** Professor Collins, do you want to add anything to that?

**Professor Chris Collins:** No. I think part of the question was about what farmers need to make that happen, so I reiterate what we said before. It is clarity of advice and long-term commitment to those challenges. Farmers work on long timelines; they do not work, necessarily, on government five-year cycles.

**Baroness Walmsley:** Right, so we want long-term policies.

**Professor Chris Collins:** Yes, absolutely.

**Baroness Walmsley:** I see. Thank you very much indeed.

**The Chair:** Thank you, Baroness Walmsley. Lord Holmes, you had an important question about land use.

Q16 **Lord Holmes of Richmond:** Thank you very much, Lord Chair, and good morning to our witnesses and thank you for taking the time. I have no interests to declare.

How can the UK balance the desire to use agricultural nature-based solutions to mitigate climate change with other pressures for land use, not least food, or indeed other re-landscaping, such as forestry or peat bogs?

**Dr Lynn Dicks:** That is a huge question. Thank you very much. My answer would be to say only that we have some kind of red line or constraints on this: "Whatever we do, we must not ... ". I think there are three.

First, we have to maintain current production levels. As to overall nutrition supply to the population, maybe we can shift our food production towards more healthy foods, and maybe reduce meat consumption, but we cannot produce less food here, because the big global drivers are that we are demanding more food globally and, if you produce less food here, we are very likely to offshore our environmental

impact and therefore create a much bigger impact somewhere else in the world. That is red line no. 1.

The second is that, because we have a still declining biodiversity, although I do not think it is declining as fast as it was in the last century, for example, and we have a climate crisis, we have to retain existing natural habitats and preferably increase their quality.

Finally, in northern Europe a lot of our biodiversity is associated with traditional farmland and farm practices. We have species-rich grassland, which we have lost most of, and we have declining farmland birds. So we also have to find a way to take care of the biodiversity we have that is associated with farmland. This creates a really wicked problem.

One proposal that comes out from analysis of data from Andrew Balmford and colleagues at the Department of Zoology is that you have a three-compartment thing where you have saved land for nature, you have high productive farmland and you have traditional what they call low-yielding farming. That is written into the national food strategy as a direction in which we could go. If we are going to work towards that, we have to be very clear about what exactly low-yielding agriculture is, because, for me, some of the elements of biodiversity and climate, and what is good about low-yielding agriculture, can be incorporated into high-yielding agriculture, and that is the direction in which I think we need to move.

**Lord Holmes of Richmond:** Thank you very much. Dr Norton.

**Dr Lisa Norton:** You will be glad to hear that I agree with Dr Dicks on that, but we definitely need to consider the delivery of wider ecosystems services from agriculture as well as greenhouse gas mitigation on food production, because it is most of our landscape and it is important for all sorts of other services. The restoration of some habitats away from agriculture production could have wide-ranging ecosystems service benefits and minimal impacts on food production in areas where the land is not particularly productive. However, finding ways that can both mitigate against climate change and provide us with high-quality food on agricultural land is really key.

I already talked about improving grassland ecologically, but it would need to go hand in hand with dietary change. These things are not alone; they are all part of the same system. If we include leys and some animals back into arable land, that might have an effect on how much arable land is currently used to produce food for those animals, but having those animals on the land might improve the value of the soil for producing human food. It is a very complicated system and we would have to think and balance.

I heard you talk about the land use strategy in the previous session. I know that Scotland has had a land use strategy, and I am not sure that it has had an enormous impact on change, but maybe it is useful to have one so that at least you are thinking about how the different parts of ecosystems balance off against one another. That is all I have to say.

**Lord Holmes of Richmond:** Thank you very much. Professor Collins, please.

**Professor Chris Collins:** I support what has been said so far. We have talked a lot about land use strategy, but maybe we also need to have a strategy about what crops are optimal to grow in the UK. One research study I saw from Coventry University looked at different crops growing in the UK or abroad. Beans grown in Kenya versus green beans grown in the UK have eight times the footprint, principally because of transport. Summer lettuces in the UK are okay compared with Spanish lettuces, but if we grow winter lettuces under heated glass they have a much higher footprint than Spanish lettuces coming in for the winter, so maybe we also have to think about what crops we grow in the UK.

Q17 **Lord Holmes of Richmond:** Thank you very much. I have one quick supplementary to Dr Dicks. I think at the beginning of the session you gave a very clear, very purist—and none the worse for that, necessarily—definition of what would fit within nature-based solutions. How would you see things that are now naturally occurring species and flora and fauna potentially as a result of man-made interventions that would not have otherwise been the case? Would they potentially fit within NbS or not?

**Dr Lynn Dicks:** Thank you for that question. I suppose so. There are certainly things that are naturalised, which have been here for a long time, such as sycamore trees. You can argue about whether they are native or not, but they would be nature for me. It kind of needs to be a species-by-species thing. Of course we have crops, and some people would say that crop types are natural—they are domesticated by humans—but of course that is nature, too. So, yes, I was very purist—you are right—but I would be slightly more flexible than that.

**Lord Holmes of Richmond:** Thank you all very much indeed.

**The Chair:** Thank you very much, Lord Holmes. Lord Krebs, a very quick question, and please direct it to one of the witnesses. Maybe it was related to the previous question.

Q18 **Lord Krebs:** Thank you very much, Lord Chair. I think I will direct it at Lynn Dicks. In the previous session we heard about the potential for forestry to sequester and store carbon. What we have not heard, or at least I have not picked out, is any comparison between the potential for grassland versus forestry particularly in relation to timescales. We heard that forestry might do very well in the long term, but it is not going to help us between now and 2050, because when you plant the trees it takes quite a while for them to get going. So in the short term would we be better off trying to sequester and store soil in grassland than in trees?

**Dr Lynn Dicks:** I would really like to pass that question over to Dr Norton, if I can.

**Dr Lisa Norton:** That is fine, yes. Yes, we would be better to do that. There is quite a lot of evidence that converting arable to grassland is a good way of storing carbon. It can very quickly build up carbon in soils

under grassland; even temporary leys in the arable land have been shown to help with that. We need more evidence as to how long that carbon sequestration or carbon storage in the soil lasts. Again, we need even more evidence about how much it enhances soil carbon when you have animals on those leys, but the likelihood is that that would make it even more beneficial as carbon storage.

Yes, I would say definitely the better solution is to go for grassland, but you could go for silvopasture. Why not plant some trees in there at the same time and they will have the longer-term benefits, too?

**Lord Krebs:** Thank you.

**The Chair:** You used the word “silvopasture”. What is a golden pasture?

**Dr Lisa Norton:** I am sorry? I do not know. “Silvo” is trees—silvoculture.

**The Chair:** Okay.

Q19 **Baroness Walmsley:** Given the interest that I declared a little earlier, you might understand that I am very interested in pollinators. Given the question that we had about productivity of land, I think we realise that pollinators are very important, but they are also under threat. Perhaps Dr Dicks might answer this. What policies or regulations do you think the Government might need to put into play to realise those benefits and minimise the threats?

**Dr Lynn Dicks:** The things that are declining most are wild pollinators as opposed to managed honey bees. There are quite a lot of things you can do to support wild pollinators in the wider countryside. We have a decline in diversity and the problems are mostly to do with floral resources—flowers in the wider countryside and habitats—and the loss of species-rich grasslands and the management of hedgerows, which means that they do not flower profusely, for example, in the spring; and the existence of flowering trees and ivy at the end of the summer in September. These things are all important and have been demonstrated to be lacking from the countryside, particularly affecting the success of things like bumblebee colonies.

There is a lot to do to increase the flower richness and to create nesting habitats. This is one of the major co-benefit areas for some of the nature-based solutions we have been talking about. Grassy field margins can be excellent for wild bees to nest in. We also have a whole host of solitary bee species. Most of those in agricultural landscapes are ground nesting. They like to use patches of bare ground, so they would really like to nest in field corners where it is not very productively managed, for example, and that is not captured in the current agri-environment scheme prescriptions. There are many different things you can do. It is about floral resources and nesting resources.

**Baroness Walmsley:** Thank you.

Q20 **Baroness Rock:** I have two questions, if I may. One is on silvopastures,



which I would like to direct back to Dr Norton. A third of agricultural land is farmed by tenant farmers, and I declared my interest earlier. You will know that most tenancy agreements do not allow tenant farmers to plant trees. What is a longer-term solution, given that you are already taking a third of the agricultural land out of that solution?

To the wider witnesses, if I may, what does the state of the art look like for the monitoring, reporting and verification of the impact on agricultural-based solutions? What are the core technologies and skill sets that we should be investing in now?

Could Dr Norton start with my first question and then I will go to Professor Collins for the wider question?

**Dr Lisa Norton:** That is a really difficult question, because you are essentially almost answering it yourself in that maybe the tenancy agreements need to change so that they are longer, although that is a concern, too. I know that the National Trust has large numbers of tenancies and some of them are multigenerational, and it has concerns about having those same people on the land for lengths of time and not being able to do anything about them. It will always be a very difficult one.

Maybe the option is to increase the trees in hedges and improve hedges in those tenancies, but, again, the short-term tenant is not necessarily going to benefit from that. There are problems anyway with planting trees. I know farmers who have planted trees in the past under schemes and then pulled them out when the 10 years have finished. It is a difficult question and I do not think I have the answer to it.

My answer would be that we need to have a much better understanding of interdisciplinary approaches to research—I think Lynn will expand on this—which help us to understand how farmers' behaviour and governance arrangements for land can influence its long-term potential as a nature-based solution. I am sorry that I cannot give you a better answer than that.

**Baroness Rock:** That is fine. I am sorry it was difficult.

**Dr Lisa Norton:** On the monitoring answer, again I think the Government need to invest in existing long-term monitoring and continue it rather than starting again and reinventing the wheel for the 25-year environment programme. The environment changes over very long timescales, particularly greenhouse gas or carbon sequestration, and it is common sense to be continuing long-term monitoring. It is not very sexy, because you have to use consistent protocols that existed 25 to 30 years ago, and that does not sound very exciting, but it is the only way to know what is really happening in the countryside.

**Baroness Rock:** Thank you, Dr Norton. Professor Collins?

**Professor Chris Collins:** Thank you very much. I will give an overview mainly from my experience with soils. Lynn and Lisa can add their more agroecology views.

The state of the art in soils is moving towards cheap sensors, I think, where we are trying to look at things such as nitrates in the soil so we can apply fertilisers in the correct way and we do not get things like run-off and potential water contamination. Then we are linking those to things such as machine learning so that we can improve our management practices. It is low-tech in one way in that we want these sensors to be cheap so that we can deploy them, but then high-tech in the fact we are using quite sophisticated algorithms and equipment to interpret the data coming in. That is the state of the art.

As to where I think we need to go in our research, it has been mentioned a number of times that you very much need a holistic approach. I would say that we need to use platforms for our research. We might look at a particular catchment and we need to use the farmers, the policymakers and the researchers in what I would call an action-research paradigm, so the researchers are directly interacting with those practitioners and any learning is very rapidly being transferred between the different communities.

One of the main problems we have had to date is that Defra's research budget has been withdrawn pretty much and has gone to UKRI, and UKRI has a very different approach to research from Defra. A lot of the problems we have been talking about today are very much about practical solutions. If we took a lot of these to UKRI, they would not be seen as blue sky, they would not be seen as state of the art, and therefore they would not get funded, so I think we need to have a bit of a look at our funding model too. Those are my three key points.

**Baroness Rock:** Thank you, Professor Collins. Dr Dicks briefly, please.

**Dr Lynn Dicks:** Moving out to agroecology practices, state of the art on monitoring and verification is a combination of remote sensing with satellite data, for example, or aerial imagery, and citizen science. Citizen science is proving extremely useful in monitoring, for example, birds over the long term and starting to be able to monitor insects, and there are apps developing that can identify plants reasonably reliably. Those are the two directions that I really wanted to stress.

When it comes to nature-based solutions, it is not just the existence of them and where they are; the management of them is key. The way a hedgerow is managed and the way a field margin is managed makes a huge difference to how much carbon it can store and how many other co-benefits, such as biodiversity, water quality and nutrient retention, it can deliver, so we need to move those technologies towards being able to be sensitive to the management. That is a huge challenge.

The best map of hedgerows, for example, that we have nationwide was developed through modelling by Dr Lisa Norton and colleagues, and it is pretty good, but it hugely underestimates the area of hedgerows. So if you are going to incentivise farmers to produce hedgerows, they need to be able to demonstrate additionality—that they have added new

hedgerows. The data you have and what they have now is really quite important, so there is a lot of work to do.

**Baroness Rock:** Thank you, Dr Dicks. I agree about the hedgerows.

Q21 **Lord Krebs:** May I ask a question very briefly? We have not heard anything this morning about rewilding. There are those who think that the answer to all our problems on mitigation as well as enhancing the environment for nature in general terms is rewilding. Would any of you like to say, in a sentence, what the role of rewilding should be in reducing our carbon footprint?

**Dr Lynn Dicks:** It is not exactly my area of expertise, but obviously I have come across it quite a lot and I think we need more research on how well it delivers the outcomes we want as opposed to, for example, planting forests. If you just allow a patch of land to rewild itself, the succession and the ecological development you see could be marvellous, and maybe that is as good as planting woodland over time, but I think we need more research on that.

As to taking land out of production, what matters is how a rewilded patch compares. The benefits of it are that you then get a community that evolves there, that develops there, and that is very well adapted to that particular place. It might not always be native species, though; it will be whatever happens to turn up. There is a lot of research to do on rewilding as to whether it is a better solution than our current solutions, which involve planting.

From a pollinator's perspective, naturally regenerated field margins, for example, can be just as good as sown perennial flowering margins, but they are more variable because you do not have any control over what appears and you can end up with excellent nectar sources based on creeping thistle, which farmers do not really like. There is a lot to consider.

**Lord Krebs:** Thank you very much. That is good.

**The Chair:** Thank you very much. I think we have come to the end of the session, so I thank you, Professor Collins, Dr Dicks and Dr Norton for helping us today. It has been most interesting. If you have any further comments or information you would like to send us, it would be most welcome and will be recorded as evidence in our evidence session, so please feel free to do so, because it would be very helpful, particularly if you feel there are areas that we should be addressing in our recommendation following the discussions we have had today.

Thank you very much for today; it is much appreciated. You will get a manuscript, and you can correct it if there is any need to correct any of the evidence you gave. Thank you very much indeed and goodbye for now.

**Dr Lisa Norton:** Goodbye. Thank you.

***Dr Lynn Dicks:*** Thanks for the opportunity.

***Professor Chris Collins:*** Thank you very much.