HOUSE OF COMMONS

Environment, Food and Rural Affairs Committee

Oral evidence: Food Security, HC 926

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Written evidence from witness:

- Professor Tim Benton Professor of Population Ecology at the University of Leeds, and champion of the UK's Global Food Security

Watch the meeting

Members present: [Miss Anne McIntosh (Chair); Richard Drax, Jim Fitzpatrick, Mrs Emma Lewell-Buck, Neil Parish, Ms Margaret Ritchie, Mr Mark Spencer, Roger Williams

Questions [1-58]

Witnesses: **Professor Tim Benton**, Professor of Population Ecology, University of Leeds, and **Professor Ian Crute**, Chief Scientist, Agriculture and Horticulture Development Board, and Director of Rothamsted Research.

Q1 Chair: Good afternoon and welcome. Thank you very much for agreeing to be here today and contributing to our inquiry into food security. Could I ask you each to introduce yourselves, say who you are and what your title is?

Professor Crute: My name is Ian Crute. I am the Chief Scientist of the Agriculture and Horticulture Development Board. For clarity, that is the organisation that receives a levy from agricultural and horticultural production; somewhere around 75% of UK production pays a compulsory levy. We use that for, under the direction of the levy payer, research, knowledge transfer activity, marketing, market intelligence and that sort of thing.

Professor Benton: I am Tim Benton. One day a week, I am employed by the University of Leeds as a professor of ecology, working largely on agri-environment interactions. Four days a week, I work across the public funders on food security, heading up the UK's global food security programme. I go under the title of 'Champion.'

Chair: That is very northern.

Professor Benton: Today, I must emphasise that I am speaking as an academic because that allows me to represent the views of the literature, as opposed to the views of the funders.

Q2 Chair: Thank you very much both for being here. I remember a time when one Government chief scientist said that food security was the biggest challenge that we face, and another said that food security was the biggest challenge that we face. In your view, which do you think is the biggest challenge between those two that we face, and what do you think the relationship is between the two?

Professor Benton: You said "food security" twice.

Chair: Global food security and UK food security. I would say it is the competition between climate change and food security.

Professor Benton: It is almost impossible to differentiate between the two, because the impacts of climate change are going to be felt by most people most of the time around access to food as probably a first approximation. Clearly, there will be more floods, heat waves and so on, but, in terms of the impacts on everyday lives, we can buffer ourselves against the weather.

However, the issue to do with the amount of food that the world can produce is quite frightening. If you look ahead towards the middle of the century, although it is quite difficult to effectively produce a weather forecast that is accurate enough to understand what production is going to be like, under some scenarios of change, where the variability may increase detrimentally, it might be difficult even to produce the same number of calories as we do at the moment, yet alone the projected increase in demand of 100%. Certainly, climate change is going to impact on food security.

If there is enough food, broadly speaking, for 7 billion to 9 billion, and we have 9 billion or 10 billion, and the richest people want to eat twice the global share, what will end up happening? Wars are likely to happen, for access to land and water, and food prices are going to detrimentally affect a whole range of different things, so together they are quite painful challenges.

Professor Crute: I would add that climate change is clearly happening, but in terms of an issue that is going to confront significant parts of the population, you could argue it is just a bit further out in terms of the sort of catastrophic consequences. Food security issues, for the reasons that Tim has outlined, are very much closer in time.

Q3 Chair: If we accept what food security is, what do you see as the greatest threats to both the medium-term and longer-term food security in this country, the UK?

Professor Crute: You have to look at food security at both a national and regional level—by that I am talking about northern Europe—and then the global level. I do not think you can detach those things, because the global food system is so interconnected. The question of interest is: what is the role of the United Kingdom in its response to imbalance in supply and demand of food at a global or regional level? I would say the UK has quite robust supply chains. Tim will probably say more than me about the resilience of those supply chains, but we access food. There is no shortage of food on our shelves at the moment, but the volatility in global food systems mean that the price volatility can impact on poor people.

Professor Benton: I fully agree with Ian. It is very difficult to imagine divorcing the UK from global issues. Price is going to be a major determinant of future access to food. At the moment, with nominally 4 to 5 million people in food poverty in the UK and half a

million people or so accessing food banks, food security is already an issue for us in terms of the nutritious side of the diet. I would flag up that there is a very large difference between having enough calories and having the right nutrition. To a certain extent, the long-term impacts on the nutritional side are something we have under-thought about, but they are profound.

Q4 Chair: Professor Benton, you mentioned about diets changing. As countries like China become more prosperous, are they possibly going to cause an imbalance if they take more of our food? Might they create shortages elsewhere?

Professor Benton: Absolutely. You can certainly see, with respect to China, the dietary transition has been huge over the last 25 years or so, and the amount of meat and dairy that is being consumed has gone up about fivefold per capita. The end result of that is they are importing, for example, huge amounts of soy from South America. We also rely on soy, primarily for putting in processed foods—about 70% of foods in the supermarket have soy in—and for most livestock food.

If China, which economically is clearly growing in power, cordons more of the market—and we rely on an open market more than they do, because they have been quite canny, in a sense, about getting tight trade relationships and land grabbing issues that everybody has heard about—in a sense, the rest of the world is fighting over what China does not want. There is an issue there that, if China decides that it needs more food, prices are likely to go up. We have to think more from a UK perspective about the potential perturbations on the market for things that we want or need, like cattle feed. We need a plan B for protein and where it comes from.

Professor Crute: That makes the point that it is not just a UK issue; it is a European issue. Europe has become essentially dependent on South American protein sources, and we need policy redirection to ensure that we can take account of the eventuality where you may have a bilateral trade agreement between Brazil and China that cuts us out of the market.

Q5 Chair: Fracking is very much in the news, and we are told that the deep-well fracking involved will take a lot of water. We do not yet know what the abstraction policy of this country is going to be. Do you envisage a situation where water that would otherwise have gone to farming or industrial purposes might be—I am thinking of my own area of Yorkshire, with which perhaps you are more familiar, Professor Benton, than Professor Crute—diverted away from farm production? I am thinking in times of drought; I do not think it will be an issue this year. Might that be a problem?

Professor Crute: I am not sure that I can talk specifically about the demand on water for fracking in an authoritative way, although it obviously is there. However, you have put your finger on something that is of significance—that we do not have as much clarity as we need to have about a regional water demand for agriculture, as distinct from urban and other uses or industrial uses, and the partitioning of that water. To some extent, it is not only the spatial, but the temporal partitioning of that, in that demand for water in agriculture is seasonal depending on rainfall, and that can often coincide with other requirements. You have put your finger on something that is an important area of policy.

Professor Benton: In the east and south-east especially, there is a significant risk of not having enough water for whatever purposes and the extra burden from a new industrial source, like fracking, could be quite detrimental. Clearly, the answer is, people would say,

you just need to build more reservoirs to store the water that comes in winter, but that raises a whole host of issues.

Chair: We will not go there because we will get into all sorts of difficulties.

Q6 Mr Spencer: Is there a European equivalent of American soya to replace the protein in those animal and human diets?

Professor Crute: There was quite a bit of soy grown in Romania and it still is, but the yields in Romania have gone down since Romania joined the EU and was not able to use the GM soya they were previously using. So I guess the quantities are smaller. Some people would argue that cereal protein, particularly through the processing of cereal grain into ethanol and the dry distillers' grain protein from that process, would potentially fill the gap. However, there are then issues about the nutritional quality of that protein, which would need to be taken account of.

The answer is it comes down to one of those things where the sums need to be done in terms of quantity and alternative uses for land. It comes down, ultimately, to how land is used, because we would probably have to devote more land to cereal production if that was going to be a source of protein.

There are issues about what the knock-on effects of the land use change would be. Soya is such a convenient source, because soya beans are about 46% protein, whereas wheat is maybe 12% to 14% protein—you need an awful lot more land per kilogram of protein. It is a land use issue that has to be thought of. People talk about sustainability; it may be much more sustainable to produce the protein you want on land in Brazil that has already been cleared of forests than to clear more land in this country.

Professor Benton: I do not have anything to add other than field beans and lentils would be the obvious high-protein crops, other than wheat.

Q7 Jim Fitzpatrick: I have two questions, if I may, one following on from Mr Spencer's question. The anniversary of the horsemeat scandal has led to a number of stories headlining this week. One of them was the success of the brand label Quorn and the increased consumption by 20% recently. Is that sourced from UK producers, or is that just produced in the UK having been imported?

Professor Crute: Quorn is a fermented fungus, so I have a feeling it is produced in a variety of places, and I am sure there are production plants in the UK.

Professor Benton: It is only produced at the moment in industrial Teesside. There is an enormous fermenter that is about 18 metres high. It is enormous and it has a pipe that brings ammonia in from the ICI plant next door. It is a factory. It is a really interesting story but for another time, perhaps.

Q8 Jim Fitzpatrick: It is a UK product. The question I was going to ask was: you made a lot of reference to the increase in Chinese consumption and the strengthening of the relationship with Brazil. Is Africa an identical parallel, although not producing as much as Brazil? In terms of future production and the Chinese relationship, is it going to lead to a similar potential issue later?

Professor Crute: It is slightly different. My perception is, and you do not know for sure how factually correct this is, that China is broadly speaking attempting to be self-sufficient

in carbohydrate—in other words, cereal production. They have scaled up, in a very significant way, their potato production in the north of China, as being a very efficient crop for converting solar energy into carbohydrate. In one sense, they are outsourcing their protein.

As far as Africa is concerned, it is very much taking over and managing productive areas of land in Africa that are not being farmed in a productive way. Depending on the circumstance, you could argue that there have been some benefits there because it has created local employment, investment in infrastructure and all those positive things. On the downside, in one sense, at a national level in those countries, they have lost control of their own destiny in terms of land use for their own purposes. That is the strategy and I do not think it is tied in particularly with the relationship with South America.

Professor Benton: The real issue for Africa is climate change. Although, in an ideal world, aid will help them grow their way into financial success and economic non-dependence in the developed world, I think the impacts of climate change are going to make that quite hard. In the future, I cannot imagine them being a major food exporter in the way that other parts of the world could be.

Chair: Just a little advert for North Yorkshire: Quorn is produced at a factory in the constituency of William Hague in Richmond.

Q9 Ms Ritchie: Are there any more immediately pressing issues on food security that we should be considering or concentrating on?

Professor Benton: We are living in a world that is much more variable. The variability—partly climate, but climate interacts with so many other things—is making the supply of food on a global basis much more fluctuating. That leads to all sorts of issues to do with the resilience of our supply chains.

To go back to the horsemeat issue, one of the things about our current business model is that, effectively, we have pushed food prices all the way down, and food is relatively cheap from a historical perspective. We tend to over-buy, over-waste and margins are cut all the way through. Part of the thing about cutting margins is that, if somebody comes as a middle man and says, "I can cut a bit more off your cost," it leads to a proliferation of the supply chain.

The thing about very cheap food is that you tend to have more complexity in the supply chain, which is one of the constituent things of the horsemeat affair. Those two things together, the resilience of the supply chain and the length of the supply chain, mean that it might be more difficult in future to source the things that we want and are used to sourcing at the price that we can afford.

Professor Crute: At the national level, there were two things that I felt were missing from the questions that the inquiry was posing, although they were implicit. One was to do with resource use, and particularly land use, and the fact that we do need a joined-up land use policy—coming back to the point that was made about whether we are going to have to produce more wheat for protein—and, particularly, a joined-up policy regarding planning. There was a time when you would never get planning consent to build on grade 1 or grade 2 agricultural land. The truth is that land is going to be at a premium. We have to work

out how we are going to use land, both for water management issues as well as for food. There is a bit of an issue around resource use, which includes water and land.

The other important area is that of capacity that exists now within the UK for research provision and training in the specialist scientific and technical area where, to some extent, for the last 20 years or so, we have done a great job in terms of ploughing forward with scientific advance in genomics or what have you. However, in reality, we now have to start seeing some of that translated and applied. A lot of the skills base for the application and translation of science into practice has been eroded. That is another area of concern in terms of making sure that we have the right response.

Q10 Ms Ritchie: Further to that, then, what opportunities or limitations does EU farm and environmental policy provide to enhance the levels of our own domestic food security?

Professor Benton: The implicit answer to that depends on the timescale that you are looking at. If you are looking on only a very short timescale, thinking about things in terms of maximising production and being willing to put up with large environmental impacts is perfectly possible. If you are thinking about things in a 100-year timescale, we really do need to do more about making the environment better protected, rather than less protected.

I am thinking especially about things like soils—making sure that we are not losing soils and maintaining them in a good condition—the ecosystems services that are provided by margins and hedgerows and things like that, pollination, natural enemies and so on. Although, certainly in the fields Ian and I move in, there is always a debate around environment versus production, in the long term, sustainability requires both. The CAP was a little bit disappointing from both perspectives in terms of maintaining high productivity and high environmental protection.

Professor Crute: The UK has been at the forefront, within Europe, of recognising and promoting the importance of food security. Other countries in Europe have not yet, perhaps, caught up with the imperative that exists. The CAP is a little bit behind the curve in terms of the importance of looking at the efficiency of agricultural production systems. It essentially still rewards, for all intents and purposes, inefficient farming. It is more of a social policy, in some senses, than an agricultural policy. There is work to be done in that area.

In terms of the investment that is now put in to Europe through the next Foresight programme, which has just been launched, there has been a huge increase in the investment potentially into agriculture and food technology. The UK has the opportunity, as with other countries in Europe, to draw benefit from that.

Q11 Mrs Lewell-Buck: How useful is the concept of food sovereignty to the UK and what outcomes might you expect from the adoption of a "right to food" approach?

Professor Crute: "Right to food" is an interesting concept. I should also make the point that in giving this evidence, although I am sitting here as an employee of AHDB, I am providing evidence in a personal capacity, rather than on the behalf of the organisation.

"Right to food" is an important concept, but it is very difficult to translate that concept into a reality in a market-driven environment. The most important way of doing that is to

ensure the safety net is appropriately secure for those people, whether in the UK or elsewhere. As we have been talking about, price volatility will always impact hardest on people living in urban environments and the poorest people living in those working environments, which, thinking about the issue of security, is always likely to bring about civil unrest and disturbance. "Right to food" is an important concept in terms of ensuring that that is recognised.

Professor Benton: To add to that, the issues around food sovereignty are the most easy to translate into everyday life in developing world systems where you still have a largely agrarian-based economy. It is much more difficult to see how, given we import so much of the food that we eat, we can be responsible for our food systems on a personal basis in the same way. The UK level at which food sovereignty is perhaps most important is thinking about the localism agenda, in terms of where our food comes from and the choices that consumers have to source things from short supply chains that are locally produced.

Ultimately, it is an economic argument. If you want to do that, it is likely to come at a cost, and if you are willing to pay the cost, supermarkets and the food system will respond to that. As I put in my evidence, given that we do import food, making sure that, if the market fails for whatever reason, we have a diversity of products that are produced in the UK is perhaps a benefit in thinking about resilience into the future. That would imply that more of our food, potentially, would come from shorter supply chains than in the past. There is potentially a mapping, as we move into a more variable world, that we might want to produce more food locally as a bet hedge against the market breaking down, which will then translate into more people feeling they are controlling their local choices.

Q12 Mrs Lewell-Buck: On the back of that, do you not think we have that diversity at the moment?

Professor Benton: I do not think we have enough of that diversity, because we have reduced our agricultural produce broadly into cereals versus a bit of livestock, with some vegetables thrown in; whereas, if you look back at post-war days, the range of products that we produced was much greater. Our whole fruit industry has gone by the board, for example.

Q13 Chair: Do you think the horsemeat adulteration will speed up the process of producing more locally?

Professor Crute: It has had a stimulating effect on retailers. They were already on a trajectory of recognising that, as Tim has just said, they were looking for shorter supply chains, but it has hastened that. It has provoked, particularly in the un-processed area of food, recognition and understanding of provenance and having some contact with how that food is being produced, whether it is meat products or other products; it has hastened the view of the retailer and probably the manufacturer as well.

Q14 Jim Fitzpatrick: Can I go back, Professor Benton, to the answer you gave to Mrs Lewell-Buck about the issues between domestic and imported? You made a very important point with that, in terms of resilience and being able to have local supply, especially in seasonally-produced foods, which historically there always was. Now, because we can scope it from anywhere on the planet, almost, how do we assure ourselves that there will be locally-produced food? If we could be buying it from elsewhere for a number of years, it could turn off the supply. How do we ensure that UK-produced food is still being

produced? Do we interfere in the market? Do we promote it as politicians and Government? Do we try and influence supermarkets to stock it? How do we ensure that it continues to be grown?

Professor Benton: There is an element of all of those. The popularisation of the locally-produced agenda certainly is changing attitudes. There are issues around planning and support for diversification. For example, one of the places that I absolutely love, following a visit there, is the big greenhouse complex, Thanet Earth, in Thanet, which produces about a third of our cucumbers and tomatoes on an annual basis.[1] That, effectively, is taking some land, putting it indoors under a big greenhouse. The computer-controlled irrigation system is really efficient, and is producing local fruit and vegetables at a price that is competitive with the rest of the market, but it is local.

Some of the issues there are, for communities like around Thanet, what are the incentives to embrace all those sorts of things? Going back, my grandparents lived on the south coast in Chichester, and many, many years ago there was a very large horticultural area and lots of greenhouses. They went by the board, and now getting planning permission to put greenhouses back is quite difficult. There are issues there. Then there are always going to be some regulatory issues.

Going back to the Thanet Earth thing, they told me that they could not use the same pest-control products as the sister organisation across the seas in Holland, so they were at a slight disadvantage. It was something to do with the way that the regulations were administered at the national level. So there are things around the national view of European regulations that make the playing field not always as level as we would want.

There is potential there, but also there is a lot of scope for innovation in this space. Stockbridge Technology Centre, which is up near York, has this super-insulated block house, which could be a cellar, underground, or in the town, where it is growing things, instead of in a greenhouse, with LED lights and tuning the LED lights. You can imagine systems where we encourage much more urban or novel production, especially in fruit and vegetables—stuff that we are probably quite short of.

Professor Crute: Let me take another angle on the question, and that is what the consumer is going to be looking for. In the whole area of sustainability, there is a consistency of requirement from retailers, manufacturers and the consumer to know, in the supply chain, firstly that the product is going to be there, and secondly that it has an appropriate provenance. In terms of the metrics for sustainability, if you look at the data for the way in which milk, meat or probably cereal are produced in the UK, such as the cubic metres of water used or the number of greenhouse gas emissions, in general our agricultural systems are efficient. We do not use child labour etc, largely speaking. These are important points from the point of view of people who are sourcing food globally for manufacture and they are increasingly important points for the consumer.

The key issue for UK agriculture in general is to recognise that resource-use efficiency all the way through the system is really important, to consider efficiency of production in those terms, and then potentially that becomes a saleable point. It is also to do with security of supply for retailers and manufacturers. There is no reason that you could argue why large food manufacturers that are UK-based need to be UK-based, in terms of the

[1] Thanet Earth has clarified that it supplies 12% of the UK market for cucumbers, peppers and tomatoes.

labour costs etc, but they are UK based because they trust their local supply, they have a continuity of supply and they know that northern Europe is probably going to be one of the most secure parts of the world for food production looking into the future. Those are the things that we play out strongly to the local community.

Q15 Jim Fitzpatrick: The sustainability question is balanced: even if there are some sustainability issues at the margin, the security issue counterbalances that. Going back to an old argument about food miles, we can produce stuff in the UK because of climate change or greenhouses; we have to artificially encourage the growth. Therefore, there is also a balance to be struck there in terms of the environmental cost of bringing it from abroad and growing it here. Those equations are much more level now than they used to be.

Professor Crute: In some sense, on the food miles issue, when you look at those numbers, they are quite trivial by comparison with some of the other numbers. In principle, you are right, in that we need to be able to produce comparable metrics where one could argue that it becomes clear that a litre of milk or a kilogram of beef that is produced on the hill in Wales, Northumberland or wherever, has an index of sustainability associated with it that means that it is a more favourable product from an environmental consistency standpoint than something that might be imported from Argentina or wherever.

That is why, within the context of the agri-tech strategy, which undoubtedly will feature in the Committee's thoughts, probably first off is going to be this notion that we do need in the UK a centre that can work through the informatics of agricultural production systems and devise metrics that allow us to make these comparisons.

Q16 Roger Williams: Up until quite recently, we have had agricultural policies that have been designed to maintain prices through intervention buying, import tariffs and export subsidies. What do you think determines British food prices at the moment, where it might vary across different foods?

Professor Crute: In broad terms, the bulk of our food is accessed from other parts of Europe and we are in a common market. In some sense, you could argue that our food prices are determined by that market and, to some extent, within the context of UK producers and the competitiveness we have in terms of our efficiency in that market, in some areas we are extremely efficient; in other areas we are probably less efficient. The EU market is the primary determinant, unless you are talking about exotic products brought in from further afield. With things like cereals, there is a huge global market subject to a lot of fluctuations, which ultimately impacts heavily on the price of livestock products as well, simply because a lot of that grain is used for livestock production.

Professor Benton: To add a bit to that, if you look over the last 10 or 15 years or so, the agricultural and financial markets have changed radically following large-scale deregulation. There is a reference in my written evidence to a report by Spratt. Effectively, he points out in there that, because there is natural variability in the agricultural markets driven by climate, financial speculation, which thrives on variability, has increased rapidly. It has gone up from about 10% in 1998 to about 60% of the finance that goes into the market being speculative. That has some sort of impact on the markets—quite how big, no one knows.

The other thing that drives the market, certainly for cereals, is input prices. Inputs such as nitrogen fertilisers are very energy intensive, so there is a link between input prices and oil

prices. Therefore, as oil prices go up, food prices go up as well. As Ian said, it is a hugely complex thing, but it is not just simple supply and demand.

Q17 Roger Williams: Some people have argued that speculation is a cause of higher food prices; other people would say that being able to buy forward evens out these variations. What is your view on that?

Professor Benton: I was reading Spratt's report again on the train on the way down. He says the evidence is somewhat equivocal, but it is likely that there is some aspect of speculation that creates some sort of amplification. That is partly, as you can imagine, that you tend to follow trends. If you are following a trend, if that trend goes over, and you are still following the trend, that tends to create an overshoot, which tends to increase volatility. Just from theoretical dynamic principles, you would expect speculation to increase volatility. However, I expect that, in some situations, you are absolutely right; it does not work like that and the benefit of forward buying is the main thing. But, because of that nature of the forward buying, as opposed to the speculation, which is very short term—buys and sells—it is probably prone to price volatility from speculation.

Professor Crute: I want to comment on something Tim said where the interpretation of the graphs can be looked at differently. Tim just mentioned things like fertiliser, which is dependent on energy; therefore you might say those input prices then affect the price of grain. Another way of looking at that—and I am not saying this is definitely the case; it is a hypothesis—is, in reality, very little oil is used in the manufacture of fertiliser. Oil is the major determinant. Fertiliser is mostly manufactured from natural gas.

Actually, natural gas prices are not necessarily following oil prices. What potentially could be happening is that, as grain prices lift, fertiliser manufacturers recognise that farmers have a bigger margin and therefore track the price of grain, rather than their own costs. That is a hypothesis, not a fact, but it is saying that you cannot always say that there is cause and effect when there is correlation. Correlation can have a number of different origins.

Q18 Roger Williams: In 2007, there was a big spike in prices of rice and wheat and what have you, and various countries put bans on exports in order to maintain their own domestic supplies. Do you think that would have a real effect on the supply in Britain or do have we such a broad range of countries that we can trade with that it would have no effect?

Professor Crute: That point you have just made is an extremely important one. It was something that came out very clearly out of the Foresight report, which is that trade and open trade is probably going to be one of the major contributions to food security. The minute that you end up with the opportunity where people close borders and, as has happened in 2007, drought in Australia—maybe, a couple of years later, you had major problems in the Soviet Union as well—where people close borders in response to the local, political demand, immediately trade ceases and then you end up with the sort of problems that we see.

One of the conclusions from Foresight is that the world needs some more bread baskets. We have rather fewer bread baskets. If all those bread baskets fail, then we, as much as anybody else, are going to be on the receiving end. Coming back to a comments I made a little while ago in response to another question, it is where I think Northern Europe is not quite yet in the right place. Northern Europe, in which I would include ourselves, is in a strong position to scale up our productivity in terms of cereal production. We could

become a bread basket; indeed, we probably have an obligation to become a bread basket in the context of longer-range projections on climate and thinking about the way that CAP has not grasped the nettle in forcefully encouraging that increased efficiency and productivity.

Q19 Mr Spencer: To return briefly to the speculation, if you have forward bought wheat, eventually at some point, that grain has to end up at a mill. Then the speculators, if they push the speculative price beyond the market, lose a fortune, or for primary producers, when the wheat gets to the boat or the mill, there is an excuse, frankly, not to pay the speculative price, be that Hagberg or moisture. Surely the market overrides that speculative price.

Professor Crute: Some of it depends on global stocks as well. Where 2007 came from was that global stocks were probably at the lowest level that they had ever been. Therefore, to some extent people, did not dare take any risks of running out of supply; they went and paid whatever price they had to pay. That brings the question of, in terms of flapping out volatility, adequate stocks and knowing there are adequate stocks globally is an important contribution to that.

Q20 Chair: We heard yesterday that the rate of inflation in this country came down because we had been expecting, apparently, a rise in food prices up until the end of December. Is there any particular reason why food prices did not go up, bearing in mind a lot of the ground was flooded? Is there any reason why food prices would not have spiked in this country when we were expecting them to? It is good news; do not get me wrong.

Professor Crute: There were a lot of projections as a consequence of the really bad year that we had in 2012. There was a fair amount of forecasting that it would take at least a couple of years to recover from that, from within the farming industry. In actual fact, not universally, but in many areas, the 2012 harvest exceeded expectation. Whether that is the cause or not is a different issue but that was certainly something that happened.

Professor Benton: On a global basis, it was quite a good year, certainly relative to the previous year.

Q21 Richard Drax: Professor Benton, you argue that the UK can increase its food security by increasing the resilience of the international food supply chain, and that this will have a bigger impact on our food security than increasing productivity and resilience locally. Why is that?

Professor Benton: We can certainly increase our production locally, most easily in an unsustainable manner, so there is a trade-off between sustainability and production over the long term. With respect to the food that we import, which is quite a large amount depending on how you account for it—30% or 40% of the food and many of the things we eat on a daily basis are related to food that we import. We can increase our food security by increasing resilience and explicitly—and the food industry is certainly thinking very hard about this at the moment—diversifying where we get food from and making sure that, if one area drops out because of an impact, there is B, C, D and E to supply; and also investing more in longer-term relationships with suppliers.

The history has been that suppliers have supplied with relatively short-term relationships, always on the assumption that the supermarket, if it does not like that supplier, will find another one. Increasingly, that is not the case. So the supply chain is having to invest deeper in the sustainability of individual relationships with suppliers. They are becoming

more sustainable. They are becoming more climate adapted, so they will be able to produce a whole range of different things.

Those sorts of processes will increase our ability. The market is working to make sure we can resource what we want to resource. Our food security is not only about what we produce; it is about the resilience of the food we bring in, not just chocolate, cocoa and soya but all the other things that we bring in. It is also about buying sufficient food, not overbuying food and throwing it away, and buying sufficient food for a healthy diet and not overeating food and wasting it in that way. There are many ways in which we can increase our ability to cope with problems of production, and they are not all about growing more in the UK.

Professor Crute: I would add only one thing, which is that those supply chains that are well integrated vertically, where the benefit and the risk are shared more or less equally up and down the chain, tend to be more resilient simply because everybody has a vested interest. Those supply chains that are essentially adversarial, in the sense that somebody is trying to play a market relative to other people, tend to be less resilient.

If there is a move towards greater security, as there needs to be in the future, it calls for more vertical integration, as well as shortening of chains so that, effectively, somebody at the bottom of the chain, say the primary producer or even the person selling fertiliser to the primary producer, is not always going to be the cost taker, and there is shared risk up and down the chain.

Q22 Richard Drax: Chair, I hope I do not incur your wrath; I am going to slightly wander off, but it is to do with food resilience and security.

Maybe you are not qualified to comment on this, gentlemen, but would you say that the size of our Royal Navy, for example—which, in the event of some happening in the future, as you hinted at, has to be sustained to protect this important 30-40%, our imports, which we rely on to survive—is an element in overall food security that you would include in a report such as this?

Professor Benton: There is an element that protection of international supply routes is going to be really important into the future, partly because many things interact. As food around the world is constrained due to climate change impacts or whatever, people get hungrier, which leads to social unrest, leading then to breakdown of all sorts of things.

I was talking to somebody from Chatham House recently who was concerned about the Suez Canal. If the Middle East blows up and the Suez Canal closes—the food that we import from the east side of Africa and Southeast Asia all comes through the Suez Canal—how will that affect our ability to source things? One of the things about the modern economic world is that everything is just in time, so we do not have stocks of food. We do not have warehouses bulging that we just rely on. Our supply routes might be interrupted because of some event like that, some of which are to do with security in the sense of security.

Professor Crute: I am not sure I would want to comment explicitly on the use of the Navy, but it is a good question to ask if you are taking evidence from large manufacturers. My sense is that large manufacturing organisations are very dependent on global supplies of a variety of things, whether it is milk solids or meat products or anything. They are looking

very hard at the security of their supply chains, not just in terms of sustainability as we talked about earlier but things that do relate to interruption due to civil unrest or warfare or what have you. They are making decisions, not just on price, but on security on that basis.

That is in a multinational context, and I would not have thought they would necessarily be looking to national forces to secure those supply chains. But the point is well made that people who are in business and are dependent upon remote sources are taking decisions about where those sources are going to be most secure.

Q23 Ms Ritchie: What is "sustainable intensification"?

Professor Crute: "Sustainable intensification" is a term that has its origins in international development. In its simplest sense, it is being able to produce more from less resource, or with less impact. It is whether, if you produce five tonnes of wheat per hectare, to put a number on it, and have a certain requirement for total consumed wheat, you have to plough twice as much land to produce 10 tonnes a hectare. It is essentially a measure of efficiency. It says that, in broad terms, land is really important; resources are really important and you should get as much as you possibly can, because under those circumstances you can use those other resources, whether it is land, water or energy, for other purposes.

The term tends to come into focus on things like conserving biodiversity where, if you are using less land for production, it allows you to spare land for forests, biodiversity, amenity or recreational uses. If you have to plough every last piece of land in order to produce food, and you are doing it inefficiently, you are losing the opportunity for environmental benefit. That is the concept. It is effectively using land, which is the best land, to be as productive as possible, and that leaves you options for use of land in other ways.

Professor Benton: To add a bit to that, I would frame it in a slightly different way. If we have a finite land base, which we do, and we do not want to use any more land for production, which broadly globally we do not, and if demand is growing and we need to produce more per unit area—which is intensification by definition—and if we are going to intensify by definition, we have to do it in a sustainable way.

One thing that was slightly missing from Ian's description was that the sustainability has to have equal emphasis to the intensification. We are talking about not only providing food now but being able to provide food to generations to come. Certainly around soils, which are something that I often talk about, if we carry on eroding soils at the rate that we are eroding them, eventually functionality will go down. Then there is practically nothing you cannot do about it. I cannot imagine a global agricultural system without soil.

Q24 Ms Ritchie: Playing devil's advocate, would it be more sustainable if there were to be a reduction in beef, dairy and sheep production in the lowlands on rotational or temporary grassland in favour of greater crop utilisation of the land? What impact might that have on consumption patterns?

Professor Crute: Livestock on productive lowland pastures is essentially there to produce protein. We need protein in the diet. They are primarily going to be grass fed, so if you were going to measure just joules of energy, you might be right; it would be appropriate possibly to produce carbohydrate and cereal on that land, assuming the soils were right and all the other things are correct. But if you are interested in producing protein for the diet, production of livestock in those areas is probably appropriate. You have to pose the

question: what is it that you are trying to produce? You cannot just generalise it in terms of one system being more efficient than another. It has to be determined by what you are trying to get out of the land.

Professor Benton: I would take a slightly different view from Ian's again, although we are good friends, of course. There is an issue that the carbon footprint and the broad metric footprint of meat production are quite high. There is an interesting statistic, which I will qualify in a moment—it is a calculation by an American NGO—that states that, if every family in America ate one beef burger less a week, it would save the equivalent of 91 billion car-use miles. Therefore, the impact in terms of growing food, feeding it to livestock and then eating the livestock requires an awful lot of land and resources.

The caveat is that some areas of land are best for production of livestock. Certainly, low level grazing in the uplands is producing food that we can consume, but we would not produce any other food stock up there. If it is low level grazing, it is a perfectly rational thing to do. If you have very highly productive grassland, it is probably more efficient to grow the grain for human consumption, rather than for cattle consumption or bioethanol consumption. If you look at our overall health statistics, the recommendation is that we eat 500-700 grams of wet red meat a week, and across Europe we eat about three times that. By changing the diet, it can radically change land use and sustainability statistics. In the long run, changing the diet is a possibility.

Q25 Mr Spencer: You are contradicting what you told us earlier: that we are going to have to grow more protein to supplement the soya produced in the Americas, and we need to find more land for that production. Those two do not marry up, do they?

Professor Benton: What I said with respect to soya is that, given our current livestock industry, they need feed from somewhere, so we need to find a way to feed the livestock if we are going to eat the livestock. The question I have just addressed is whether we should carry on thinking that we need to produce as much meat as we currently consume and there are many public health, as well as sustainability, issues that say seeing meat as a treat rather than something we eat twice a day is probably a good thing.

Professor Crute: In the specifics of that question, though—and it comes back to what I said earlier about land use being a key determinant of sustainability in the whole food security area—there are likely to be hardly any areas of this country that I can think of where grass and livestock production is being conducted in preference to cereal production on land that could have been put over to cropping. For the most part, you are talking about livestock production on soils, whether in the lowlands or uplands, where the best use of that land is improved pasture or semi-permanent pasture. Essentially they would be inappropriate, either because of slope or soil type, for grain or crop production. The simple economics of it are that, these days, anybody who has land that is anything like appropriate for cereal production is likely to be producing cereal.

Q26 Mr Spencer: Is UK agriculture fit for purpose? Are we in the right place to deliver this sustainable intensification and, if not, what do we need to adapt?

Professor Crute: That is a very fundamental question: whether we are doing as well as we should. As I am sure you are aware, there are yield gaps between the best producers and the least good producers. Those yield gaps can certainly be filled. Some of that is a skills issue; some of it is probably an investment issue, in terms of upgrading our capacity whether in terms of farm livestock and housing or equipment.

The answer is that we are only in relatively recent years recognising the importance of increasing productivity, and yet for the last 20 years, to some extent, we have been disinvesting in a lot of the skills, research and translation of that research. It will take us a while to get back up on to the trajectory.

As I said earlier, the UK has been at the forefront of getting the right messages out but I am not yet 100% convinced that we are necessarily taking all of the action that we need to in order to translate some of the rhetoric in all of the good messaging into practice. That is probably a longer-term view for the next generation of farmers and new technology that will be applied and essentially the markets, which will undoubtedly also be a driving force.

Professor Benton: We can do better, both on the intensification and the sustainability, by a long way. I would like to flag up the issue of climate change again, because if you look 20 or 30 years ahead, north-west Europe, as we have already said, is likely to be less impacted by climate change than many other parts of the world.

The economic possibility of over-production in the UK and north-west Europe and exporting that is going to be greater than it ever has been in the past. That might swing the pendulum in a way that is economically good but, from a sustainability perspective, bad because it would provide much more of an incentive to grow more in an unsustainable way and get the financial returns of marketing that. Thinking about the sustainability and the intensification together and the way they are likely to evolve over the next 20 or 30 years is a fruitful exercise.

Q27 Mr Spencer: Today, 80% of the food is produced by about 30% of the farmers. Is that just scale or is that efficiency as well? Is there a connection between scale and efficiency, or do we have very efficient small farmers and very inefficient large farmers?

Professor Crute: We certainly have the former; there are very efficient small farmers. I do not think there is necessarily a correlation between size and scale. Scale tends to go with the capacity to have capital, invest in people and invest in the sort of thing I was talking about a moment ago. So there is an association, but that does not mean to say that, if you are a small farmer farming on small areas, you are less efficient. As a general rule, those people who are farming large areas, have capital and have been investing tend to be, generally speaking, at the high end of productivity.

Q28 Mr Spencer: AHDB are charged with the responsibility of educating those farmers and making them more efficient. Is that sufficient? Can you do it on your own or are we short of infrastructure?

Professor Crute: The answer is that we do our best. In times past, when there was a state advisory service, there was an awful lot more access. Now, the bulk of technical advice into farming, whether it is, in the livestock sector, through veterinary practices or through distributorships in the arable area, is primarily a commercial activity. Speaking for a moment with an AHDB hat on, what we would like to do—*[Interruption.]*

Chair: We will break. I am so sorry you were mid-sentence; I will come immediately back to you, Professor Crute. We stand adjourned for the period of the Division. If there is one vote, it will be 15 minutes or slightly less.

Sitting suspended for a Division in the House.

On resuming—

Q29 Chair: We will resume. Thank you very much for your patience. Professor Crute, you were mid-sentence and I apologise.

Professor Crute: That is okay. I was responding to a question from Mr Spencer about, essentially, the area of knowledge transfer and translation of science into practice. I was making the point that, certainly in the arable sector and, to a degree, in the livestock sector as well, this is now a commercial activity. It is not something that is delivered for free. There is nothing wrong with that.

The role of AHDB is very much as an independent body that would, to some extent, want to ensure that any information being transmitted through third parties—whether through distributorships, veterinary practices or commercial consultancy companies—is of the highest quality and is uniformly messaging in an appropriate way. We have an amount of resource at our disposal: in the dairy industry, we have advisers in the regions doing face-to-face advice with dairy farmers, but in the arable area as an example, we would work almost exclusively through third parties, consultancy organisations and distributorships, making sure that we are putting really good information at the disposal of people who are in direct contact with farmers.

Q30 Mr Spencer: Would you share that view as well, Professor Benton?

Professor Benton: I certainly share the view that there is a bit of a valley of death between upstream information and farmers necessarily getting hold of it. It is not helped by the fact that they have to pay. To go back to your earlier question about farm size, one of the issues is that the bigger you are and the greater your financial flows, the more you can afford to buy into the information culture and have a crop consultant or some other means of getting advice. There is lots of scope for new ways of delivering advice, so not reinventing an extension service, but I do not think that we really have the nuances of where exactly the cutting edge of advice is and how it should be delivered, partly because we have not thought enough about it over the last decade or so.

Q31 Mr Spencer: Correct me if I am wrong, but what I am hearing is that there are several ways to increase, if you like, productivity: either looking at scale and efficiency or pushing up yields, both of which, I presume, would mean an increased carbon footprint, in effect. If you have larger machinery travelling greater distances and if you want to push yields up with fertilisers and agricultural chemicals, both of them have a fairly high carbon footprint. How are we going to get to this panacea of intensification without being unsustainable?

Professor Crute: Let us tease some of those points out that you make there. On the one hand, you have the genetic potential of, let us say, the livestock or the crop. To some extent, then, one route to increasing productivity is something to do with increasing the genetic potential. Of course, animal-breeding companies as well as plant-breeding companies are doing that. That is in terms of your environmental impact, impact-neutral, unless you need to drive that productivity through greater impacts; in most cases, you would not.

The other side of that equation is then to realise that genetic potential. You have increased the genetic potential and you want to realise that genetic potential; sometimes, that might

require you to put more resources in to realise that potential, but your output, as measured, say, in terms of greenhouse gases per kilogram of protein or per kilogram of grain produced, may be less—in other words, per unit of production, you may have much less of a footprint.

The third dimension of that interaction is, indeed, your environmental impact. In some senses what we are trying to do through the question that was asked about sustainable intensification is look at those interactions—in other words, elevating genetic potential and ensuring that the practices used, whether in rearing livestock or crop production, are efficient. To some extent, your output per unit of environmental impact is reduced, and that environmental impact can, of course, be measured in different ways, depending on where you are. If you are in a water-deficient situation, you might be most concerned about your water use; if you are talking about greenhouse-gas emissions, they might be your unit.

This is where understanding better the science of sustainability surrounding production systems and understanding how you optimise those things is really at the nub of sustainable intensification. It is not necessarily the case that, simply by increasing your productivity or increasing your production, you are necessarily increasing your environmental impact. Sometimes, it is absolutely the opposite.

Professor Benton: Just to add to that, we also have the situation that the environment provides so many different services, and they are all wrapped up in sustainability, but working on a piece of land affects carbon, biodiversity, the look of the landscape, the water-flows, flood risk, water quality and the ability to use water and so on. Many of those services are valued by people but they are not costed by people, whereas the economics of production on a farm has a clear financial benefit to the farmer. Part of the issue here is how to get the most out of your land in a way that is sustainable and societally acceptable for all the other services.

It relates, in a sense, to the sovereignty question: how can the people in the UK manage their land in the way that people in the UK would like to see the land managed? How much control is there over that for producing food here, recognising that, if we do not produce the food here, we have to buy it in from overseas? We are then, potentially, exporting environmental impacts somewhere else. It is not simple and straightforward, as Ian has outlined, and that is where we need to have some more in-depth thinking about how to optimise across all these different services.

Q32 Mr Spencer: Is it credible, though, to, in effect, export that sustainability somewhere else, which would be very intensive in certain parts of the UK, in order to protect, globally, somewhere else which is more environmentally sensitive?

Professor Benton: Theoretically. The issue that will always be thrown back is: what is the Government's mechanism to make that happen? Certainly, if you look about, in the sense of Defra's Green Food Project, exploiting the comparative advantage, you should be putting your intensive agriculture on the land most suited to that intensive agriculture, which has the lowest environmental impact. If everybody does that, on a global basis you would move towards something that looks credible.

Q33 Jim Fitzpatrick: A question I was going to ask later follows on from what Mr Spencer was asking and your response, Professor Crute, about maximising genetic potential.

Are you talking about genetic modification or about maximising the advantage of conditions for output? Is there one way or the other, or is there a mix to be followed?

Professor Crute: No, I am not talking explicitly about genetic modification, although that might be one tool that would be used. Essentially, if you think about dairy cattle in terms of the increased milk yield that has been achieved over the last 15 years, you might say it is a plateau. If you think about grain yields, up until about 10 years ago, they were on a steady 1% or 2%-a-year increase in yield. To some extent, that is optimisation of genetics, but the genomic tools that are used are increasing in efficiency. You made reference to GM in the case of crops and livestock. Genetic modification, in the strict sense, is one tool that has been used in some crops.

Q34 Neil Parish: Professor Crute, you said, "The right solution is to increase our productivity on a per hectare or an area basis. We need to ensure that we are looking after our soils and that we are investing in soil science, crop nutrition and soil-management practices." My question is: is there sufficient funding for research and technology transfer into protecting the quality of our soils?

Professor Crute: There are still soil scientists, both in the UK and outside. I suppose, at the level of farm and field, probably there is less work being done in soil biology, soil physics and soil chemistry at that spatial scale than has been done in times past, and probably now is the time to get back to doing a bit more. If you look at things like soil science, which would be looking, say, at soil processes at the fine scale, there is a lot of that work going on. It is still very important. It has informed, for example, the climate change mitigation area in terms of things like nitrous oxide emissions from soil.

If you look at the global scale, things like the whole area of carbon emissions modelling globally also have a soil dimension to it. What we are specifically focusing on is soil management at the farm level, and that is an area that, in recent times, has been underinvested in. We could probably do with getting back to it.

Q35 Neil Parish: Leading on from the answer that you gave to Jim Fitzpatrick, if you take minimal cultivations, for instance, you can reduce the amount of nitrous oxide released into the atmosphere—the carbon. Very often, if you want to do that, if we were to be able to use a Roundup Ready crop in this country, there is an argument that the soil structure would be better and that crop production would be produced in a more environmentally sensitive way. Are we holding ourselves back without being able to use this technology?

Professor Crute: There are a lot of people doing minimal cultivation without recourse to Roundup Ready crops, because there are other ways of doing it. I would say that there are still some debates to be had about whether or not minimal cultivation, from the point of view of things like nitrous-oxide emissions, is a good or a bad thing, because, if you have a highly microbially active or highly organic surface, when you get water-logging, you could probably get very significant nitrous-oxide emissions. The greenhouse-gas-emission side of things is—

Q36 Neil Parish: That depends a lot on the type of soil, as to where you can minimally cultivate, but surely there is also the argument that, if you are going to plough and do major cultivations, you also have the extra fuel and everything else that you use on this land. Do you think, perhaps, we are not using minimal cultivation enough in this country?

Professor Crute: My sense is that, on land that is appropriate to manage soil in that particular way, it is being used pretty extensively—not zero tillage, but minimal tillage is being used.

Coming back to your point about the use of herbicide resistance, I tend to agree with you that it would be beneficial for UK agriculture if we did have access to herbicide-resistant wheat and herbicide-resistant oilseed rape. It would make our ability to control major problems like black-grass rather easier, and, with the benefit of hindsight, we would probably use the tools rather more effectively and efficiently, with long-term views in mind, than they have been used in parts of North America.

Q37 Neil Parish: What about Professor Beddington? Do you have a view on the matter?

Professor Benton: I would love to be Professor Beddington, but I will tell him.

Chair: You are the warm-up.

Professor Benton: Thank you.

Chair: And infinitely more, may I say.

Professor Benton: With respect to the issue about soils, we have a fundamental lack of understanding about some of the important processes, and I would like to flag up the fact that two of the research councils—NERC and BBSRC—have recently invested in a new soils programme, partly to recognise this gap.

There are many things that we do not know and we have just let soils fall off. If I were to pinpoint one aspect that concerns me most about the sustainability of production, it would be maintaining our soils in good condition, because we have that basic knowledge but we do not have the detailed knowledge, as we have been talking about. I certainly think, with respect to min-till, there are a lot of low-tillage systems in the UK. The issue of weed control is really important and, at the moment, farmers are still ploughing periodically, partly for weed control, and we need new tools to deal with that now in a sensible way.

Q38 Neil Parish: Even down to the stages where, especially, you have land where you get quite a lot of run-off—this is the opposite to minimal cultivation, if you like—there is a need for sub-soiling, and some farmers are still not doing it enough, I do not think, or know the benefits of not only the drainage but then getting the root structure and all those things. Many farmers do the right thing out there but there are still quite a number of farmers where you see the wrong practices going on. How do we get that over? You would get better production, probably, from fewer chemicals and less fertiliser, with a better soil structure. How do we get that over?

Professor Crute: What you are putting your finger on is, in some senses, a consequence of the fact that economics have driven specialisation in agriculture, like many other activities. To some extent, what we have are specialist livestock producers, primarily, as we were referring to earlier, operating in the east of the country on land that is appropriate for growing grass, and we have our arable systems in the east.

Coming back to the soil issue, many of our soils have become deficient in organic matter. We need, in a way, to start reconnecting livestock-production systems and arable systems, not by recreating the traditional mixed farm, although that clearly had its advantages, but

thinking about the juxtaposition of production systems that allow us access to sufficient organic matter and so to restore soils. Of course, some thought is going into that but it is a major issue about how we reconfigure agriculture looking forward. It does come back to what I was saying earlier about the whole area of land use and the optimisation of land use. This is another aspect of that optimisation.

Q39 Richard Drax: Just a very quick one on this question of putting muck back on to the land, which farmers are now doing; many farmers are recognising it is desperately needed. Timing is key. Many farmers are finding that the restrictions on them are not allowing them to put it on the land at the right or relevant time. I know there is this fear of drain-off and everything else, but timing is key. Would you say that this is an area that needs to be looked at, with better joined-up thinking and better co-ordination? These zones are quite—

Neil Parish: Could I add to that? The timing of when you spread slurry depends on the climatic conditions of the year.

Chair: Could we have two answers—or, even better, one?

Professor Benton: I think Mr Parish has answered the question, because predicting the weather is just difficult.

Q40 Richard Drax: What do we know definitely about the probable impact of climate change on the UK's food-production capacity between now and 2050?

Professor Benton: What do we know definitely?

Richard Drax: Yes, about the probable impact. Perhaps it is not definite, but can you give some indications as to what you think it will be?

Professor Crute: We definitely know the temperature will elevate.

Professor Benton: The difficulty, with respect to the UK climate, is that we do not have a good understanding of what is going to happen to the jet stream. That has been what has upset our climate for the last decade or so.

Q41 Chair: Is it nothing to do with climate change at all?

Professor Benton: No, it is, but predicting how locally our climate is going to change is crucially dependent, where we are, on the position of the jet stream this winter and summer and for the last few years. It is very difficult to be highly probabilistic. The forecast, ignoring the jet-stream issues, as Ian has said, is that winters are going to get wetter, rainfall is going to get more intense, and summers are going to get drier and hotter. Between all of those things, there could be a positive or there could be a negative, but it crucially depends on the variability in the weather. If we have more summers like we had two years ago and more winters like we are having now, it could be quite bad.

Professor Crute: I think what it poses is the need for adaptation, which is already happening. By that, I mean that, looking at the future, we do not always have to grow the bulk of our potatoes in East Anglia, for example, where potatoes are a water-intensive crop. Indeed, people are moving their crops according to their experience of climate. You have seen maize crops for silage being grown north of the border now whereas, at one time, they might not even be beyond the Bristol Channel, almost. Adaptation is taking place, and learning where crops perform, and I think we will see more of that.

Q42 Richard Drax: That rather does answer the next question, which is: is the cropping system and the farming fit for purpose, bearing in mind what you have said? I think you were both saying that things are adapting, farmers are realising, and the whole thing is changing to meet this.

Professor Crute: The areas in which I have my greatest concern, looking quite long term, is the fact that the variables that are under change are carbon-dioxide concentration in the atmosphere, which does impact on photosynthetic efficiency, so potentially could increase yields; temperature, which we know something about; and water.

At the end of the day, what does not change is irradiation and latitude in terms of day length and rate of change of day length. Plant and crop development is very determined by latitude, so it is not going to be just a simple matter of moving genotypes of crops from the south to the north to adapt to temperature and to water relations, because these interactions of these variables have never been seen before, and we could not go anywhere on the planet to get this combination of these variables.

The question is: adaptation will work to a degree, and is clearly happening now, but we have to think ahead in terms of needing the crops and the plants with the physiology that acknowledge the continuous irradiance levels and the day-length levels, despite the fact we are going to be in higher temperatures, with higher concentrations of carbon dioxide and possibly different water regimes. That probably requires some very fundamental work on modelling of systems, modelling the plant physiology, constructing those plants and testing those hypotheses in controlled conditions. That is very basic science and is not something that is going to happen just by chance; we are going to need to plan to have that.

Q43 Richard Drax: That answers the next question, which you have just touched on, but perhaps you, Professor Benton, could comment on it. How better can we be prepared for these, taking into account climate change?

Professor Benton: Ian concentrated on the understanding of biology. I would say we need to understand better the environmental system. That includes investment in decadal-long weather-forecasting, so that farmers can plan water resources and infrastructure, and includes thinking about soils and how soils will be impacted and the whole range of plant/environment interactions.

It is not just about how the plant will respond; it is about how all of the other systems will respond. How will the pests respond? What will happen to the weeds? How will weed control respond? How will transport systems respond? It is about thinking through the systemic response to climate change and having a likely scenario that you are working towards, whether it is four degrees, or understanding better the extremes of and variability in the weather, and then just planning for those.

Q44 Richard Drax: Are there already technologies, crop varieties and farming systems elsewhere that we could adapt?

Professor Crute: I think this is what is happening in terms of the general adaptation that we see happening at the moment. If you take maize or sunflowers, people have been trying to grow sunflowers in southern Britain, so there are those things going on, but there is going to be a limit to that. That is the point: these things are already happening. We will almost certainly see new crops moving into southern Britain, and crops moving north, but there is going to be a limit to that, for the reasons I explained earlier.

Also, just to reemphasise something that Tim said, we will see changes in the incidence and severity of different pests and diseases, which will change, because of the environmental circumstances. There will be some diseases that will become more important and some which will probably become less important.

Q45 Roger Williams: Professor Benton, you say that increases in UK yields will have little effect on food security but may increase our economic security. Can you explain what you mean by that?

Professor Benton: This is because we have a very strong import/export trade, both in the science—so the science that we do to increase the yield is exportable around the world—and also in the ability, as I outlined earlier, that, under some climate-change scenarios, we will do relatively better, so we could produce food excess to our needs and export it. A lot of the potential for that, however, will depend, broadly, on the global market.

If the global market is functioning perfectly, we should produce what we are really good at, sell on what we do not need and buy in other things. If the global market is not functioning, we have to diversify more as a better hedge against being able to buy those things in. Quite how things evolve in response to climate change is not entirely clear, but it is not just about our local production for us.

Q46 Roger Williams: You also go on to say that we could improve our food security by reducing demand. Can you explain a little bit more about that?

Professor Benton: This is a bit of a convoluted argument. If you look at our obesity statistics, the rate at which, on average, people are gaining weight is equivalent to overeating by 10% to 20% of calories on a daily basis. If you look at the amount of food that we throw away uneaten, that is equivalent to 20% of the food that we buy. Add those two things together and you have an awful lot of scope for making better purchasing and consumption decisions to reduce our overall food demand perhaps by as much as a third. I cannot imagine us easily increasing our food outputs by a third, but I can see us reducing our demand by a third, especially under times of stress. I would just urge thinking about the demand side, as well as the supply side, in thinking about our food security.

Professor Crute: Having said that, if we are talking about the UK, our population is likely to elevate to around 70 million, so, to some extent, simply in population terms, the demand is likely to increase.

Q47 Roger Williams: Which do you think? If there are going to be scarce resources for research and development, should we be looking at basic science or should we be looking at the use of science through technology?

Professor Benton: We need to do everything because, as the Foresight report said, there is not a silver bullet. There are interventions needed throughout the food supply chain here and overseas, in the short timescale, which is technology transfer from what we know now, to the long timescale, where, if we are going towards a four-degree world by the end of the century, it will be globally quite frightening. We need to be starting to really think about that now, because a lot of the genetic research that Ian has been involved in through his life has a 40 or 50-year lead-in time, so I think we need to be doing a bit of everything. It is such a global challenge that we do need to think about increasing investment in this area.

Professor Crute: I would liken it to a canal: a canal is a very good way of delivering things, but you have to make sure that things continue to come on at one end in order for them to come off at the other end. What we have tended to do is close the lock gates. We are still putting stuff on at one end but we have not recently been opening the lock gates and taking stuff off at the other end.

Q48 Jim Fitzpatrick: Can I ask something different that was referred to by Professor Benton earlier on: the different application of European regulations on tomato growing in Holland as opposed to here? When I was Minister of State at Defra, one of the big issues that year was the battle with the French over dairy subsidies. Going back to what I think Mr Spencer said earlier—the efficiency of British farming compared to some of our European neighbours—is it your sense that the European Union is getting to grips with sustainability, production and food-security issues, or do you think it is not really in the same area that we are in terms of recognising these issues?

Professor Benton: The UK has been a world leader in thought leadership, especially in food security and also, I guess, in sustainability. I would say, at an EU level, they are probably 10 years behind where we are, simply because there are so many other agendas and it depends on how that is pushed locally. In the next CAP, maybe they will be having much more of the discussions that we would have liked to have seen, perhaps, in the last CAP.

Professor Crute: Just a comment there: I do not think you can generalise about all the countries in Europe. I think the Swedes are in exactly the same place.

Jim Fitzpatrick: Forgive me—there are alliances with different blocs on different issues.

Professor Crute: There are officials in the Commission who are recognising it but, in broad terms, the Parliament is a long way behind.

Q49 Roger Williams: I believe the GM thing has been handled very badly by scientists, farmers and politicians. Setting that aside, are there any less controversial methods on the horizon that could lead to real breakthroughs in increasing productivity?

Professor Crute: We have not yet seen, in any sense, the benefits that are going to accrue to engineering in general terms: sensor technology, remote sensing, precision approaches in terms of disease and pest forecasting, as well as all of the mechanisation that comes in livestock-production systems, sensors that will be able to detect animal performance, health and welfare. We are at the beginning of seeing many of these technologies having a major impact on management: soil management as well as the management of systems in general.

Professor Benton: GM, as defined by the regulations, will soon be old-fashioned. The ability to use new technologies to speed up genetics, which is what we have been doing for thousands of years, is going to really blur that line between what is genetic and what is genetic engineering.

Q50 Chair: Can I just come back to something you said earlier on in-season and out-of-season crops, just to pursue that in answer to something you said to Mr Fitzpatrick? This is a leading question, so you can answer it as you wish, but how much do you think

supermarkets are to blame for block-booking foreign apples, for example, that compete with in-season, British-produced apples and other fruit?

Professor Benton: If you talked to the supermarkets, they would say that they supply what, broadly, the consumer wants.

Q51 Chair: I am asking you as an academic.

Professor Benton: I do not think it is as straightforward as "it is a push from the supermarkets to out-compete our local."

Q52 Chair: When I was an MEP in a soft-fruit-growing area of East Anglia—they also produced apples and made cider, but sold some of the apples—they were absolutely convinced that the supermarkets did it as a deliberate policy.

Professor Benton: I find that hard to believe, having had the in-depth conversations that I have had with many people in the retail trade recently. The issue is much more around what we want and the price that we are willing to pay. In a sense, this is a social-science thing, in that we want to have locally produced, high-welfare, low-environmental-impact but cheap food available all year round, and we cannot have all of those.

From the consumer-demand perspective, what we need to do much better is to articulate the choices that, if you want local, it implies this; if you want overseas, it implies that. We have not been, either academically or the food industry, good at articulating those choices. From the consumer perspective, it is all things being equal but all things are never equal, so opening up that dialogue would be good.

Q53 Chair: Following that logic through, what are the implications of imports of more out-of-season fresh produce for food security?

Professor Benton: Importing out-of-season?

Q54 Chair: What we have seen is a strong growth in imports of out-of-season fresh produce. If I give you examples: strawberries, beans, peppers, leeks and asparagus. What are the implications for sustainability and food security?

Professor Benton: Sustainability there is less of an argument, because it is not where you produce it but how you produce it, because the transport miles are always a relatively small component of your carbon budget. It is much more to do with the resilience of the food system. If we rely on importing things throughout the year and we do not do anything to produce them, and because we are importing our own industries fall by the wayside, like the apple industry, it becomes difficult if things go wrong. To go back to the Thanet Earth example, they grow peppers all year round in an environmentally sustainable, low-carbon way, so it is perfectly possible to source thing locally, although it comes at a cost.

Q55 Chair: You mentioned Planet Earth and you mentioned it is in an urban area. I forget the venue.

Professor Benton: Thanet—Thanet Earth.

Q56 Chair: Do you think it would be possible to build that kind of plant in a rural area or do you think it only obtained planning permission because of being in an urban area?

Professor Benton: It is in a rural area, just outside Thanet, on an old cabbage farm, if I remember rightly. The issues of how the local populace saw it were quite interesting in terms of the discussions that went on and the degree to which people saw it as a good

thing or a bad thing. In the end, because it employs quite a lot of people and it also generates some energy, it is seen as a positive local thing.

Professor Crute: Can I make some comments about soft fruit in regard to your question about seasonality? It would have been the case not so very long ago, and certainly most of us here would probably remember when strawberries were only available during the June/July/August time.

Chair: And they had taste.

Professor Crute: In reality, however, one of the successes of British agriculture—or horticulture, at least—has been the extension of season on our soft fruit. Our soft-fruit production has, in terms of yield, and thinking about the sustainable-intensification argument, probably almost doubled on a per hectare basis as a consequence of innovations of growing systems, polythene protection and all sorts of things.

The innovation has, to all intents and purposes, kept the foreign competition at bay, and I think the supermarkets would much prefer to be able to promote British strawberries all the way through to the end of October and even into November than to be shipping them up from Spain or Brazil. There is a preference for that and you might say that we have responded to that by extending the season.

Professor Benton: Just a quickie: you mentioned the taste issue. We have talked about yield generically but, often, it is quality. One of the things about taste is that selecting for high yield and long shelf life has tended to reduce the quality of the taste. There is a trade-off there: if we want to have things that have low waste or live a long time, we import them from somewhere else and one of the corollaries is that taste goes down and nutritional quality—

Q57 Chair: Just from a policy point of view, for food security, should we be encouraging consumers to buy more seasonally available, home-produced food, particularly fruit and vegetables, in preference to imported?

Professor Benton: The diversification issue is the most important for our long-term resilience. How do we encourage diversification? We have to ensure that there is an economic stream that goes into farmers for producing a range of products.

Professor Crute: In terms of security, it clearly is important to have control over your own supply chain.

Chair: Yes or no?

Professor Crute: I would say not necessarily.

Q58 Neil Parish: On food security linked to GM, there is a blight-resistant potato out there now for starch production; very soon, we will have one for human consumption. There will be huge advantages in growing that and yet we are denied it. Why is it that, when we go to hospital, they will inject us with all sorts of things that have probably been genetically modified, yet we go up the wall as soon as we think that there is—

Chair: Mr Parish—

Neil Parish: No, I want to make this point. To you as scientists, how do we get over to the public that it is not Frankenstein?

Professor Benton: If I knew the answer to that, I would be shouting it from the rooftops. It is very complicated.

Professor Crute: Ultimately, the market will determine it when there is a product that is really demanded by the buying public or, alternatively, when it is so obvious that it is a really important thing, and when the regulatory framework in Europe is appropriately constructed in such a way that it operates with evidence rather than conjecture.

Chair: Professor Crute, Professor Benton, you were here in your own right. You have not been here as substitutes or as a warm-up act for anybody else. Can I thank you for your help with our inquiry, being so generous with your time and answering our questions as fully as you have? We are very grateful to you. We stand adjourned until the next meeting.