

	<p style="text-align: center;"><b>Ask the Expert Webcast: Implications for Food Production and the Countryside</b></p> <p>Soil scientist, Dr Paul Beckwith and crop physiologist, Dr Peter Kettlewell, both from Harper Adams University College, Newport, Shropshire, answered question put to them by students from Pershore High School in Worcestershire.</p>
<p><b>Information about the webcast</b></p>	<p>The event opened with a short video from DEFRA on the challenge of doing something about climate change. A transcript of the video is available from the <a href="#">DEFRA website</a>. The speakers were introduced by the chairman, Steve Horsfield of Wmnet, and gave a brief introduction to their areas of interest before answering questions from the students via a video conference. The event was transmitted as a live webcast. A recording of the webcast can be viewed from the <a href="#">Wmnet Climate Change portal</a>.</p> <p>This event was the second in a series of five Ask the Expert webcasts. It took place on 8<sup>th</sup> February 2006.</p> <p>NB. Unexpected technical difficulties prevented the students from joining in until part way through the webcast. Steve Horsfield put earlier questions to the experts on their behalf.</p>
<p>Chairman</p>	<p>I am going to start now by turning quickly to Paul who is going to explain to you his specialism and his particular interest in climate change.</p>
<p>Paul Beckwith</p>	<p>Good morning to you. I am a soil scientist and I am interested in climate change from two points of view. First of all the influence climate change may have on the quality of our soil; the quality of our soil is very important for the uses we put to it. Climate change could affect soil erosion, it could affect the amount of organic matter we have in the soil, and the way the soil behaves, and that could influence the way we grow crops. The other interest I have is in soils as a method of storing carbon. Soil organic matter is a very vast store of carbon, and worldwide it stores about 1,000 million tons of carbon, so it is a major carbon sink. So we might be thinking in the future about how we can use the soil more successfully to store carbon and reduce carbon levels in the atmosphere.</p>
<p>Chairman</p>	<p>Thank you Paul. Peter would you like to say briefly what your specific interest is in your particular area of expertise?</p>
<p>Peter Kettlewell</p>	<p>Yes. I'm a crop physiologist, which means that I'm interested in the science of how crops grow and develop. One of the most important things that affects how crops grow is the weather. Farmers obviously can't do anything about the weather, but they can adapt the way they grow crops, the management of the crops, to take account of different types of weather. So, I am particularly interested in what the effects of climate change will be on how the crops will grow and how the farmers will have to adapt to that, including growing new crops, of course, which could be used as energy sources.</p>

Chairman	<p>Thank you very much Peter. Now we are expecting questions from Pershore High School, Worcestershire, but at the moment we have got a slight technical hitch, so while we get that sorted out I would like to start off with a question please for you Peter. Can you tell us please <b><i>what are bio fuels and in what way are they renewable?</i></b> That's because I am sure many people want clarification on what renewable sources are, and how do they help us combat global warming?</p>
Peter Kettlewell	<p>Yes, well there's different sorts of bio energy crops. There are crops which will produce bio mass, that is just the dry, flat material which could be burnt instead of coal in power stations or, in fact, these days it's gas in most power stations more than coal, and that could offset the production of CO<sub>2</sub> by burning coal or gas. And the other type of bio energy crop which is often referred to as bio fuel, is a crop which produces a liquid fuel which could be used in transport fuels, so diesel is our main transport fuel that lorries use for driving up and down to transport everything around, and you can make bio diesel from the seeds of a plant called oilseed rape, which is this bright yellow flowered crop which you've probably seen if you've been in the countryside in May. That produces tiny black seeds, you crush them to get an oil, which just at the moment is used as cooking oil, but if we grew more of it, then we could crush it to make an oil and then you can use that to substitute for diesel.</p>
Chairman	<p>Thank you Peter. I'm now going to try and take a question from Pershore, and see if they've got the link working, so let me just test briefly. And very quickly I have established that we don't have any link to Pershore at the moment, so that's not going to work, so I'll move on quickly to a question for Paul.</p> <p>Paul, you've talked about the use of the soil as a carbon sink, briefly, can you expand more on <b><i>what changes in fact these people would expect to see as we start to use the soil carbon sink.</i></b></p>
Paul Beckwith	<p>Yes. Historically when we have cultivated soils to grow crops, we have lost a lot of organic matter from the soils, the soil matters decline throughout the world, causing major problems across the world. Now, if we want to use soils as a carbon sink, to capture CO<sub>2</sub> from the atmosphere, we must try and put some of that organic matter back into the soil, and within agriculture we can do this by changing the way we grow crops to perhaps reduce the amount of cultivations we use, because every time we cultivate the soil we aerate it, we burn up organic matter, so we could change the cultivations we do. Alternatively, we could make sure that we try and add more residues back to the soil, because it's plant residues, and animal residues going back into the soil that build a soil organic matter. The other thing that has happened historically, we have tended to drain wetlands for an important habitat, but they are also a way of storing carbon, because they build up carbon. Wetlands get very boggy, full of organic matter, so if we in fact revert to wetlands, stop so much drainage, then that will be another way of capturing organic matter back into the soil.</p>
Chairman	<p>Thank you. Turning again to Peter, <b><i>what kind of crops do you see being grown as the climate changes, and what kind of crops do you see being no longer possible to grow.</i></b> Is it possible to foresee that?</p>
Peter Kettlewell	<p>Yes. I think the main climate change which we are already experiencing, and will continue to experience, has increased temperatures, so that will allow us</p>

	to grow crops which at the moment, it's just not warm enough to, or will perhaps only grow in the very south of England. Essentially, I think the climate zones are tending to move north, so I think we will end up [with] crops which at the moment are grown in France, so one of the best ways to visualize what we will grow, is to actually look at a bit further south in France and there of course sunflowers are an important crop. Various farmers have tried growing them over the last 10-15 years, and it's just not quite warm enough at the moment for them to ripen satisfactorily, as it is in France. But I am sure that within the next 10-20 years, then as temperatures rise, sunflowers will become a sensible crop for farmers to grow, certainly in the south of England.
Chairman	If they can find the water?
Peter Kettlewell	If they can find the water. Now that is another difficulty. It isn't all bad news on the water because the climate change scenario is for wetter winters and dryer summers. Although it will be dry in summer, it will be wetter in the winter and some crops can rely very much on water which is stored in the soil over the winter, so we may still be able to grow that sort of crop. The sort of crop we won't be able to grow very well, particularly in the south and the east, is crops that need a lot of irrigation, so those are things like potatoes. It is going to be very difficult to get the water to grow potatoes and vegetables in the south and the east, and I think those crops will have to shift further north and west.
Chairman	Thank you. Sticking with that kind of pattern, Paul suggested that we cease the draining of wetlands; <i>bio fuels apart, are there any other changes in agriculture or horticulture that you expect to see used to combat climate change?</i>
Peter Kettlewell	Well, I think an important aspect, in Paul's area really, is to do with soil emission of carbon. [It] is reducing the amount of cultivation that farmers do, because every time they cultivate, it releases CO <sub>2</sub> , and there's already been a trend for that in producing crops, in that farmers do a lot less cultivation now than they used to do, and I think that trend will continue, and that will be good because it will reduce CO <sub>2</sub> production.
Chairman	That's great. Let's make one more attempt to see if we can get a question from Pershore High. [No connection available yet] We will proceed. <i>Apart from it being warmer, how else might climate change change the soil?</i> Paul, probably a question for you.
Paul Beckwith	Yes I said at the start of the broadcast that one of the things we are interested in is soil quality. Maintaining soil quantity is important to allow us to keep on using soil for a variety of different things. And one of the problems we have with climate change is that we can get now more frequent heavy storms and I think most of you will have experienced them. And this heavy rain is much more likely to cause soil erosion. Now, that soil erosion is serious, because not only does it carry sediment out of the fields, and block waterways, it also carries nutrients out, and that's one of the reasons why we get nutrification of water courses and algal blooms. So I think one of the things we are going to have to make sure we do, if we are getting more serious weather conditions, is to make sure we protect our soils more carefully. And I think that's something we are doing quite a lot to think about at the moment.
Chairman	Back to you Peter. We are being urged to reduce food miles. <i>Do we have</i>

	<b><i>the capacity in UK to grow enough food to significantly reduce the greenhouse gas emissions caused by food transportation?</i></b>
Peter Kettlewell	Well, it would cost an enormous amount of energy to try and grow strawberries in the winter in glass houses and polythene tunnel houses in this country. So, at the moment, if you want strawberries in winter, they are imported from places like California, which of course produces huge amounts of CO <sub>2</sub> – as they are airfreighted over here. And similarly, in the winter, if you want green beans, they come from Kenya, again airfreighted over, again producing huge amounts of CO <sub>2</sub> . But to actually try to grow them in this country, would involve so much energy input to keep them warm enough to grow, because they need high temperatures. They also need light as well. There isn't enough light here in the winter, so you'd have to have artificial lighting, so you are using up electricity which has produced CO <sub>2</sub> at the power station. So those sort of specialist, luxury crops, then I don't think there's much difference in the amount of CO <sub>2</sub> that is being produced. I think what really needs to happen is people need to get back to having foods in season, so that we have strawberries throughout the summer, and if you grow the right varieties, you can have strawberries from about the beginning of June right through until October. And by using polythene tunnel houses, you can extend that earlier in the season, you can get strawberries in as early as April if you like, and you can get strawberries going through into November or almost December, without any artificial inputs of energy. I think we need to get back to just accepting that you don't eat strawberries in the winter. I don't know if you've ever tasted any of these strawberries that come in from California in the winter, they taste awful anyway! I don't know why people eat them!
Chairman	I am sure that other Californian's wouldn't see it like that! The next question I have got is, <b><i>do the same crops grown in different parts of the world give off the same amount of CO<sub>2</sub> and if not, why is there a difference?</i></b>
Peter Kettlewell	Right, just to clarify that, crops themselves are taking up CO <sub>2</sub> in photosynthesis, any CO <sub>2</sub> that is produced during the growth of the crop is because of the farmer using energy inputs to grow the crop in fuel diesel, usually with the tractors. And there are massive differences between the developed world and the Third World, because the Third World isn't using tractors, which consume diesel. They are using hand labour for cultivations, weeding and harvesting, whereas in this country, we use tractors for everything. We are using bigger and bigger tractors, which are consuming more and more fuel, and emitting more and more CO <sub>2</sub> , because there are fewer people wanting to work on the land in farming, so farmers are moving to bigger machines, so they need to employ fewer people. But that's a vast difference to the small scale farmer in Africa, who's using hand labour. They are producing very little CO <sub>2</sub> from fossil fuels in the process of growing crops, if any.
Chairman	Perhaps a question for Paul. <b><i>Is there any difference in the energy consumption used by using advanced artificial fertilizers?</i></b>
Paul Beckwith	There is. Artificial fertilizers do require a large amount of energy to produce them, and that requires a large amount of CO <sub>2</sub> or emits a large amount of CO <sub>2</sub> . The thing at the moment is that those fertilizers actually produce more crop growth, and as Peter just said, that will take up more CO <sub>2</sub> . And sometimes, when we are looking at emissions to the atmosphere, we have got

	to look at whether the emissions are greater per area of land produced or per tonne of food produced. And artificial fertilizers certainly do require a lot of CO <sub>2</sub> , but they do produce more yield.
Chairman	Right. So let me get this straight. So what we mean is, the production of the fertilizer creates substantial CO <sub>2</sub> emissions, but there is compensation for that because the crops they produce absorb that CO <sub>2</sub> .
Paul Beckwith	Yes.
Chairman	So what has to be looked at there is what is the balance?
Paul Beckwith	The balance is very important.
Chairman	Turning to you again Peter, <b><i>could bio mass make a significant difference to energy production? What would we need to do to capitalize on this benefit?</i></b>
Peter Kettlewell	Yes, it could make a significant difference. We'd have to put more land over to growing energy crops, and farmers would have to get used to it, and the public would have to get used to seeing energy crops, particularly bio diesel – lots of fields of bright yellow oilseed rape, miscanthus grass grows up to 20ft tall and some people might not like the size of that crop in the countryside, but if we can get used to these sort of crops, then yes, agriculture could make a significant input to reducing CO <sub>2</sub> . I think at the moment, we understand a lot about how to grow these crops. It's the economics. It's down to the economics. We have just installed a bio mass generator at Harper Adams and we are aiming to grow – originally we are aiming to grow our own 'purpose' energy crops, and we have put some miscanthus grass (that is elephant grass) to fuel the boiler, but in fact the economics of growing miscanthus, they don't just add up to the benefit you get in terms of the energy output. So these crops have got to become a lot cheaper to grow, or the other alternative is instead of growing specific energy crops, we grow crops which have got a dual use. For instance oilseed rape; you could harvest the seed, make bio diesel from that, and then the straw, with the rest of the bio mass, we could burn in the bio mass generators, and we could make two uses of that crop and I think that's the way forward to make it more economic. So at the moment, it's cost, because coal is relatively cheap to import. Although natural gas has risen in price recently, it's still relatively cheap, compared with growing energy crops specifically for burning.
Chairman	I am afraid, unfortunately, this is also another question for you. <b><i>Are there any types of agriculture more resistant to the impact of climate change, for example animal husbandry rather than arable farming, cereal crops rather than fruit and veg, or larger farming units versus smaller units?</i></b>
Peter Kettlewell	Well, to think of it the other way round, the types of farming that are most susceptible to climate change will be dairy farming, which already predominates in the west of the country, rather than in the east because of needing a lot of water to get grass growing in the summer, so dairy farming is not very resistant, and irrigated production of potatoes and vegetables as well is not very resistant. It's the things like growing the cereals and the oilseed rape, they are more resistant because they can to a very large extent still grow a reasonable crop based on the soil water that accumulates over the winter. So when you encounter a very dry summer, you still get a moderate yield out

	of them, so I think the east of the country will be much more dominated by those crops, and the irrigated crops will probably have to move further west and north.
Chairman	Thank you. I want to change the focus now, from your own particular areas of specialism to think about our audience. Now, our audience for the webcast are obviously top Secondary students Years 11, going on into 6 <sup>th</sup> Form, so aged roughly 16 to 18, many of them preparing for higher education and degree courses. Lets turn to you Paul, <i>what advice would you give in terms of subjects, preparation ... someone who wants to work in this field or in your field?</i>
Paul Beckwith	I think it's very useful if you want to work in this environmental field to have a good knowledge of biology. Chemistry is a subject which perhaps is not so popular nowadays at A level. That's a useful subject, but generally speaking, we at University can actually teach that side of the work, and maybe most of the students can understand it, so I don't think chemistry is so much of a problem. But biology is good, and so is geography, because geography gives you an understanding of the world as a whole, and I think that's a very useful subject. Fewer students now do environmental science, I think, but I don't think that's perhaps quite so important. If you can stick to the main science areas I think probably those are the ones I recommend.
Chairman	<i>And the organisations they should be joining?</i>
Paul Beckwith	Well, it depends on their particular interests. If they are interested in more environment generally, then working with conservation trusts, etc. can be very useful; any experience with Habitat Management, and getting out there and doing some practical work in that area. It is more difficult to get experience at 16/17 in the pollution side – the environmental science pollution side - so I think it's probably more useful to get some experience of how our countryside works, what the rural land use is, how we manage the countryside, how we manage conservation areas etc. if you want to go into this type of area.
Chairman	Thank you Paul. We think, belatedly we have got a late Pershore!
Pershore	<i>Sea levels are rising, market gardening areas in the UK are usually in places of low lying flat land, for example, Norfolk. Will these areas be flooded, and will our produce have to come from abroad with climate change?</i>
Chairman	I am going to look at Peter for the answer to that question.
Peter Kettlewell	Well yes, there's no doubt that the ice is receding. There was one report published earlier this week about how the ice in Greenland is receding much faster than was previously thought to be occurring. I think the big question is how long it takes to raise the sea levels, but I don't think there's any doubt that sea levels will rise. And you are absolutely right, I am sure that areas around the Wash in East Anglia, they will have to go out of production because it's far too expensive to put barriers up. That's been known for a long time - to prevent erosion of cliffs by putting barriers up is usually too expensive. So yes, we will lose some low lying land, but there's not a lot we can do about that.
Chairman	Thank you, and back to Pershore for another question please.
Pershore	<i>Rising CO<sub>2</sub> levels could speed up photosynthesis, counteracting some of the effects of enhanced global warming, therefore yields could be increased?</i>

Chairman	I will ask Paul to answer that question. Could yields be increased as a consequence of greater levels of CO <sub>2</sub> ?
Paul Beckwith	Yes indeed they could, because CO <sub>2</sub> levels in the atmosphere are not optimum for crop growth very often, so actually increasing the CO <sub>2</sub> levels could actually increase crop yield.
Chairman	Back to Pershore for another question please.
Pershore	<i>How can we manage the amount of methane released into the atmosphere?</i>
Chairman	I'll turn to Peter. A question about the amount of methane.
Peter Kettlewell	Well, one of the dominant sources of methane is from cattle, and unfortunately, there's getting to be more and more cattle, as places like China move towards a western-style diet. As they increase their prosperity, they want more meat products, and so we are going to end up producing more methane from having more animals, to satisfy the rising needs of countries like China. It is difficult to see any prospect of reducing it at all. There has been some research done, in Australia I think, on various ways of changing the diet of cattle to reduce methane production, but I think the effects are fairly small.
Chairman	Thank you Peter. I think there's time for one really quick question. One more question from Pershore.
Pershore	<i>Will climate change put crops at a higher risk of tropical diseases, and pests because of temperature increase?</i>
Chairman	Thank you, and that's one for Peter.
Peter Kettlewell	Yes. There's no doubt about it. Pests for instance, Colorado Beetle on potato, are not a pest in this country at the moment. It is a pest from countries like North America where it's warmer. If it's inadvertently brought into this country with transported food, then it will stand a much better chance of taking a hold in this country and it will cause immense problems. And there's all sorts of diseases like that which our crops will become susceptible to.
Chairman	Thank you Peter, we are running out of time now. I must apologise to Pershore for the difficulty with the link, but thank you very much for the questions. Thank you very much to Margaret, James and Lee for the supporting the students in Pershore.