I'm Roz Naylor. I direct the Center on Food Security and the Environment here at Stanford and we're really happy to have all of you here at our first symposium for the year and the symposium series on Food and Nutrition Security. Zack Nelson and Elizabeth Horn, who might be walking in late, don't mind if they pass you to get in the front row here have generously contributed to the symposium series. And it's a real pleasure to be able to gather such a diverse community around what we feel are some of the most important issues globally. So, today I have the real treat of introducing Professor Sir Gordon Conway. Sir Gordon is a Professor in International Development at Imperial College in London and you have his whole bio in the description that's on your seat. So I'm not going to go into a lot of detail on that, but I did want to say that we'll-- he'll be speaking for about an hour and we'll have about a half an hour for discussion and then please join us for a reception afterwards so you have a chance to talk to him directly. I want to engage you just in a brief thought experiment that we went through actually as you know when we got the gift to have the symposium series and we thought who would we most want to have you know if we could write the resume for the perfect person in this series who would it be. And you probably have a lot of thoughts in your mind, but of course, we had the thoughts of you know who has incredible stature and has made great contributions to the agricultural development and international development field who's really spent time in the you know field, in the soil, getting their hands dirty, really understanding the ecology. And I'd like to say even though Peter doesn't like it, hands in the dirt here, but at the same time shaking hands with Presidents around the world and advising governments around the world on these critical issues. Somebody who has led a major development organization of the par of the Rockefeller Foundation and also has really strong links with the private sector, a lot of different NGOs and is spending a lot of time now in Europe advising governments, major governments to reinvest in agriculture to go back into the roots where so much of the poverty around the world still resides. And so it's obviously no mystery that I'm describing Gordon Conway and we're really lucky to have his perspective in this field for the past 50 years. So, so we're really lucky to have a lot of his experience that he's going to talk to you about today. He's actually going to talk about can sustainable intensification feed the world. He's really the father as we see it, the father of sustainable development and sustainable intensification. So, Sir Gordon please come up.

[ Applause ]

Well, thank you Roz for that introduction. I'm delighted to be here. I'm trying to remember when I last came to Stanford and I, it was a long time ago. I'm sort of Californian in one sense. I did my PhD at Davis and my son was born there and he is an American citizen and that's helped him over the years. I had a draft card but I was too old. And those are some of the memories I've got of living in California. We had a great time in Davis and loved it enormously. It clearly would have been fun if I was alive at that age now and was here at Stanford. I think this is a tremendous group of people that you have to give and I've had some chance to talk to some of you. Some of you, of course, I've known for a very long time. Roz is somebody I only met a few months ago and it's been great to be invited here and to meet with you at what is one of the great powerhouses of thinking about agriculture in the world today. Regrettably in Britain
our two agriculture universities that are left are Redding and Nottingham. They're fine, but we don't have the kind of powerhouse that you have here. So it's a great privilege. I always start by putting up these crises and every time I put them up I realize the crises are getting worse and the interconnections are getting greater. One of the things I love about the book that you've all produced, which Roz has been one of the editors and introduced us. The Evolving Sphere, is that you're tackling what I would call the nexuses. I don't know what the plural of nexus is and I'm sure as lots of you will tell me it's not nexi it's certainly something else. But the great thing about that book is that it does provide some really thoughtful approaches to these interactions between food security and energy and food security and water and food security and civil strife and so on and so forth and that is what we're dealing with today. Let's just focus though on food security. It's all I can do within this. We've got three great problems; food price hikes and the food price spikes, the billion or so people who are malnourished. It's a billion plus or minus several million and that we've got to increase food production by 20, 50, by probably 60 to 100%. These are food prices, nominal terms but you can see there quite dramatically the way in which the price of cereals, the red lines being, shooting up and down, but mostly up, the same with meats. This has enormous consequences for poor people simply because poor people spend a huge amount of their income on food. And it translates and I've been listening to some of you talk about this. It translates directly into impacts on people. The prices are, the global prices are translated directly into the kind of prices that poor people in Kenya spend on their food. We have about a billion people hungry. That's sort of an FIO statistic based on a normal distribution. The biggest scandal in the world, the biggest scandal in the world is the number of malnourished children. One in three of children under the age of five are malnourished. And by malnourished we mean that they're under height for their age. It means that they grow up stunted. As a result they may go blind, they may suffer from disease, they will develop slowly and they may die. And in Africa that figure is 40%. Forty percent of the children under five are malnourished. It's a huge scandal that still exists today. Then finally we have to feed the world by 2050. We've got a whole lot of factors, population, diets, biofuels, rising prices, climate change, land and water scarcity. That's the basis of the whole master's degree. And in fact if you listen really carefully by the end of the hour I can give you all a certificate. I'm not going to go all the way through it. I'm just going to pick a few things. First of all, population. The average person in the world believes that the biggest problem is the population increase. It is true it's an important factor. We're going up to nine, ten billion by 2100, before it begins to level out. It's actually going up much faster in Africa. You can see on the right-hand side there the figures for east Africa and West Africa. East Africa is the red and West Africa the purple, rapid increase in population that shows no signs yet of leveling off. That's a huge problem. But in general it's not the population increase that's the biggest problem. If it was only the increase in numbers of people we're on track to feed them with what we're producing now. The biggest problem we face is that diets are changing. In countries like China and India and Thailand and South Korea and Brazil and so on are shifting towards western style diets. They're eating more hamburgers if you like. Even in India they're eating more hamburgers. They're shifting more to livestock products, eggs, meat, milk, and so on. And the problem is that to produce the eggs, meat, milk and so on you need grain. And very crudely you need seven or eight kilos of grain for every kilo of meat you produce. I mean that obviously depends on the kind of lifestyle system. But that's the order of magnitude of relationship. And that's a huge demand on us and a growing demand on us. On the right down there you can see the rise in meat consumption and the green is pork and other forms of pig meat. It is consumed by China, most of that is consumed by China. China is a major consumption of livestock products, in particular pork and pig meat. As you all know, I assume you all know China has just recently both Smithfield, the biggest pork producer and processor in the United States. They import something like 60% of all the soybean that's on the world market. So dominant effect and we have to think, and I'll come back to it. We have to think hard about what will happen into the future. This is a major part of the challenge we face. And, of course, the issue is what do we do? Well, you know the general reaction says oh we all want to become vegetarians, right. How many, I always ask this question. How many people in the audience are vegetarians? We got a way to go, right. It's about seven and some won't admit it at the moment, so maybe it's 10. I, I did the same question in China recently at the China Agriculture University. I said, "How many of you are vegetarians?" There was about...
three to 400 people in the audience, right and two in the front row put their hand up. They were both American women. [laughter] The chances of getting Britain to become vegetarian or the United States to become vegetarian are relatively small. The chances that China will become all vegetarian is very small indeed. What answer is there? Well, one of the answers is to start producing meat-like products that aren't meat but are made from soybean and other vegetables, vegetarian matter. These are called faux meats, right. These are actually American ones. They're all from Sophie's Kitchen, for example. Probably some of you know about Sophie's Kitchen. The Chinese meal in the top right is all vegetable base. The crab cakes apparently are fantastic. Everybody says the crab cakes really taste like crab and the woman who reviewed them got really upset because she thought she'd actually had crab and she was going to sue them and do all these kind of things. You can buy sort of vegan prawns up there. They're not really that great but, to look at anyway. You know we need, we need langoustines that look like langoustines, talk like langoustines, dance like langoustines, right. And then people will start to buy them. I gave this lecture recently to the Board of Waitrose, which is one of Britain's top supermarket chains. It's just a very high quality end of the supermarket in Britain. And I said to them, "You've really got to start marketing some of the really best examples." In Thailand and China you can buy them. You can actually buy langoustines that look like langoustines, but ain't. I think we may be able to at least modify our diets so we aren't eating quite so much meat. That may be the only way we can go forward. But I leave that with you and you can, in questions you can come up and say this rubbish or there's an alternative. What we have to do is intensify. We've got to produce more. If you look at the slide, in Africa the average yield of grain like maize is only about just over a ton per hectare. It's been level for years. It's just begun to go up in the last three or four years. One ton per hectare of maize is what we produced in Britain at the time of the Roman Revolution, the Roman, it wasn't a revolution, the Roman Empire. We had a revolution and it kicked them out, but basically it was the Roman Empire. We've gone downhill ever since I have to say. It's a not a [inaudible]. I can give you all a lecture on that but maybe you'd like to hear that elsewhere. Compare it with South Asia where the average yields are two and half tons or with China where they're up to four or five tons per hectare. At least in Africa we've got to produce more. If you take for example this woman, Mrs. Namaruanda [assumed spelling]. She's a widow. She's got a son who sort of lives in Nairobi and now and again turns up particularly if there's a photo shoot. He sometimes turns with some money. He sometimes doesn't turn up with any money and she's got four little children there and you can only see one, two, three, yes you can see four of them now. And she lives on one hectare of land. And she's typical of African farmers, single mother looking after a family with one hectare of land. With the grain she's got she might be able to get two tons per hectare, but along the weeds, along come the pests, along comes the drought and she gets less than one ton and with less than one ton she can't feed her family. It's that simple a problem, at least in theoretical terms. If we could simply get the grain to her, the seeds to her, that will give her three tons. Do something about the weeds and the pests and disease and do something about the drought, she can get two tons per hectare. She can feed her family on half a hectare and use the other half hectare to grow bananas for sale or something else. And then she can get some money because she needs money. She needs money to send her kids to school. It's not entirely free, even though it appears to be entirely free and she needs money to buy medicines for when the kids are ill. At the very least she needs that amount of money, if not some extra. So she's got to be able to feed her family and to have some land on which she can produce crops by-- get the cash that she needs to keep the family going. That's the essence of what we're talking about when we say we're going to intensify it. The other point is that we're running out of good quality land and water. It's interesting if you look at the production of crops all the different categories you've got cereals at the top. You've got-- down at the bottom you've got roots and tubers and sugar crops and pulses since 1960 and it's level. It's only oil crops, oil palm and soybean where there's been an increase in the amount of land. That's the Cerrado of Brazil for the soybean and it's Amazon and so on, but more importantly Indonesia for the oil palm. There isn't the land out there, despite what everybody says. You don't see expansion of land except in terms of oil crops. So we have to feed the world on the existing amount of arable land we have now, but we have to do it sustainably. This is the essence of sustainable intensification. We've got to produce more on the existing land and existing water and we've got to do it in such a way that we are prudent in our use of inputs. For example, the pesticides
or herbicides or fertilizers. We reduce the greenhouse grasses, methane, nitrous oxide, carbon emissions. We increase the lateral capital. That means we build up soil, moisture in the soil. We build up the enemies of pests and we strengthen resilience. That's what sustainable intensification is about. And for all of you who were involved in the green revolution, this is orders of magnitude a bigger problem than we faced then. That's not to belittle what we achieved at the time of the Green Revolution. But to say to you it's not just about producing more, it's producing more in a really sustainable fashion. It goes well beyond what I wrote about in The Doubly Green Revolution. It's a tall order. It's frightening in some respects, but for all the younger generation in the audience this is a great challenge. It's a great adventure to try and make that happen. One way is through precision farming. We can now map the nutrients we have in our fields in the west here. In Britain you can see the phosphorus deficiency mapped on a field. On the left they-- a tractor with remote sensing that can go round the-- with a GPS system that can go around the field and it'll say okay more phosphorus here, less phosphorus there and so on. Eventually we're going to move towards these little tractors here, little robotic tractors that are being developed in Britain at Harbor Adams. These are little tractors, wonder around the field and if they see a weed, they zap it and then they come back to the corner of the field for their rewards. Surprisingly the great John Deere and all the other great tractor companies aren't interested in investing in these. I can't think why, but there they are. The principles of precision farming are applicable in developing countries. So, for example, here's precision farming in Niger. Instead of spreading fertilizer all across the field, you take the fertilizer, you put it in the cap of a Coca Cola or a Pepsi cola or any other cola you like. The cola doesn't matter, right. But you take the cap, put the fertilizer in it and put that in the hole. That way you only apply a very small amount of fertilizer on the field. You don't get massive amounts of fertilizer washing off into the rivers. It's very precise. It's very targeted. It's just in a way like the precision farming using GPS. The principle is there. We were talking earlier on, talking to Bill here about trying to get lime and I was wondering whether you could just put some lime in each of the holes and he was a bit skeptical. But you know I think we could work on this in some way. Being targeted is important. It's another example, this is from Ethiopia. On the left there they're growing a pioneer hybrid on farms in the south as an experiment. And on the left in the foreground they put diammonium phosphate. Diammonium phosphate is what every African government knows about. It's what they give farmers and that's it, bang, period; diammonium phosphate or nothing. And you get about three tons of diammonium phosphate. In the background there they've applied exactly the right amount of NPK, natrum phosphate potassium. The soil samples that land needs and boron because they discovered that that land is deficient of boron. They're getting six tons per hectare. That lady there, she's standing in front of six tons per hectare of maize. That's the European average for maize. I know in Iowa you get 11 tons at average, but you know six tons is pretty good. It's pretty good when all you get is one ton otherwise. It's being targeted. This modern agriculture we need has to be much more precise, much more targeted, much more scientific than it's ever been before. There are four approaches to sustainable intensification. One is ecological, one is genetic, one is socioeconomic and then this integrated approach on top of all of those. I could spend hours talking about each of those. I'm just going to give you a flavor of them. So first of all we're talking about, sorry, sustainable ecological intensification where we use ecological principles; agrofostery, integrated pest management, organic farming. Here's an example of conservation agriculture which I expect most of you have heard about. It's used in the-- in the United States. It's used all around the world now, a good example here in Britain. So a farmer here in Britain is growing wheat, but he doesn't till the land. That's the core of conservation agriculture but it's not everything about conservation agriculture. If you don't till the land, leave it undisturbed, when you've harvested the wheat you cut the straw and leave it on the surface of the ground. And you sow the next crop, in this case beans, in that mess of wheat, of straw underneath. And that's also part of conservation agriculture. You've got to keep the soil covered and protected. And you really need a rotation with a legume crop. If you put all those things together conservation agriculture works and it works in lots of parts of the world. Here's an example in Zambia. You can see the maize has been cut down in the middle, the farmers digging some holes. Actually the farmer is the woman on the right, but the man digs the holes. She runs it and it works quite well. The classic example of ecological approach is the home garden Indonesia, Java for example. This incredible little miniature forest around the house with bananas and
citrus and palms and down at the bottom all kinds of herbs and, of course, it's a little pond with fish and chickens running around and ducks and all kinds of things. It's like a miniature forest, but of course, it's not a miniature forest. It's human created and it's run by a woman. That's the key to its success. That was a serious point. It's not funny, it's true. And another example is agroforestry we talked about today. There's this wonderful tree called Faidherbia. It's [inaudible] originally called and it's a leguminous tree and it grows up as you can see quite a big tree. But it sheds its leaves in the wet season. Don't ask me why, I roughly know but it sheds its leaves in the wet season. So you can grow maize underneath and you can get three tons of maize there because it's a leguminous tree and so it provides the nitrogen you need. And that is doing pretty well, but of course, you've got to get the trees to grow first of all. Okay, so those are ecological approaches. What are the problems with ecological approaches? I'm an ecologist by training, is they often take skills. They usually take a lot of labor and in many cases, for example, organic farming you've got a yield penalty. You lose something like 20% of the yield you would otherwise get if you were growing the crop conventionally. I would love to think we could grow everything with just ecological approaches, because I'm an ecologist and they are fascinating to ecologists. We love these things, but there are real limitations. And in many respects if you want to sustainably intensify you've got to build those things that I talked about, less inputs, less emissions of greenhouse gases, increasing natural capital, resilience into the seed. Because when you've got a seed you could put all those characteristics in there one way or another. And farmers will buy seed and they'll buy good quality seed when it works. And so it's a great way to get those attributes out and around to farmers. This is one example. These are the new rices. These are a cross between the Asian rice and the African rice; two different species which you can cross without any interference but it's tricky. And what you first of all have to do is to put them in a medium, into a culture to get the embryo to grow into a plant. And a great plant breeder, Monty Jones from Sierra Leone came to us at the Rockefeller Foundation. He said, "I can't get this damn thing to grow in the medium. What shall I do?" I said, "Why don't you go to China. They'll know what to say." He said, "Okay." So we gave him the airfare to China. He went to China. He went to see the Chinese and they said, "Oh, it's very simple. You just put some coconut oil in the medium." And he put coconut oil and it worked. And I think it cost us you know a couple of thousand dollars at the Rockefeller Foundation. It was the best money we'd ever spent. And now these large amounts of this new rice, and you can see it in the bottom right. Most people from Asia look at that picture and say what on earth are those Africans doing in a rice field? Well they're in a Uganda rice field and that's Africa, the new Africa rices growing in Africa. And those are now spreading quite rapidly in Nigeria and elsewhere. You can also intensify the characteristics in seeds through-- to produce more nutritious crops. In many cases like the orange flesh sweet potato you cross the yellow sweet potatoes which you know here in the states with the white sweet potato that's common in Africa. You get a yellow-fleshed sweet potato which has got vitamin A in it. And a brilliant African plant breeder, Maria Andreotti has done that and it's now growing in large amounts in Mozambique and Uganda. In some cases you don't have the gene and then you have to turn to genetic modification. So, the example on the right which everybody's read about and knows about and so on and so forth, golden rice, because the gene for beta carotene which produces vitamin A is not in the grain. It's only in the leaves and they are also, this is Uganda. They are working away at golden bananas, mostly for fun actually because the problem is the more golden they get the less photosynthesis they do, so it doesn't really work very well. I'm just going to show one other picture about GM and then move on. Everybody thinks of GM as being a great creation of Monsanto who are the evil, evil hand, people out of Mordor and everybody loves to hate Monsanto. But you don't have to have Monsanto. You don't even have to have any private company to produce a good GM crop. This is in Uganda. There's a great disease called Wilt that's come into Uganda to attack bananas. You can see what it does to a banana up in the top left. They have the genes from academia sinica from Taiwan which is publicly funded. It's funded by money from the United States government, from the British government and most important from the Uganda government. So it's entirely publicly funded research. And the new strains that come out will be distributed through distant culture and will cost just the same or thereabouts of any other new banana varieties. And then thirdly we have socioeconomic intensification, which is partly about getting, intensifying the links between farmers, through farmer associations, through coops and contract farming
or something of that nature, getting that to work better. But it's also about intensifying the links between farmers and markets. Lady up in the top left sitting by the road with a little pile of tomatoes that she's selling as people drive by. No other form of selling in that village in Kenya. On the right is our village store where I live in Sussex. Nice village store with cats in the doorway. All the meat comes from the local farms. The bread comes from a bakery in the next door village. We all own the shop. Bottom left, typical market in a village in Tanzania with the prices that somebody's selling. We also need links just not to output markets but to input markets. People need to be able to get fertilizer and seed and micro-insurance and credit. I usually put this picture up mostly for Africans. The top left hand is my grandfather who used to go round, he ran the coop in Kent. He used to go around the villages selling seed and fertilizer. And his descendent in some metaphorical sense is the lady down on the right there, Joan who runs an agro dealer, which is a little store in a village where you can buy seed and fertilizer in small quantities. And one of the things we did at Rockefeller was to stimulate the development of all those agro dealers in eastern and southern Africa. And then of course you need to link people not just to the local market but up to the international markets. This is the Ethiopian quality exchange. In this case they are bidding on coffee. You know they ring the bell and everybody starts yelling at each other and after about 20 minutes or 10 minutes they start yelling at each other and they've all done their deals. What is interesting is that screen up there. In the middle are the prices that coffee is being traded at that moment. On the left is the prices that coffee is being traded in Chicago. Somebody today was talking to me about the transmission of prices. Well that's a pretty good transmission of prices there. Farmers begin to see what they could be getting if they were in Chicago. They're beginning to say, "Look what I'm producing is this kind of quality. I can make this kind of money." Just briefly and I can talk more about this, once we get into markets we're talking about value chains. Value chains that go much beyond farm to fork, value chains at the bottom go up through rural livelihoods to regional, national markets to urban livelihoods. Value chains are a new topic of research. Both for big companies, for supermarkets and so on. We're doing a lot of research on value chains and also for academics. There's a growing field for academics I recommended to some of you. There are really interesting question here. For example, we talk about value added. Who gets the value added? Who assumes the risk? Now in general we assume that it will be the farmer who gets the value and the big corporation who carries all the risk, but actually what happens is the reverse. I don't know what milk producers are doing in this country but I know milk producers in the United Kingdom are being slaughtered by the low prices they're getting. They're not getting the value. Somehow we have to make that happen. We've also got to build resilience into value chains. I'll say something about that. We could also look at things like nutrition and waste and land tenure and so on and so forth in that value chain context. I'll only do it for just one of those topics and that's in terms of waste. I won't talk about waste in the west. You can talk about that afterwards if you like. But typically farmers store the grain in a little container like that one there. So the grain is sitting quite happily along with lots of rice, lots of rats and mice and beetles and maggots of all kinds. And the farmer is very lucky if that grain stays the way it looked like when he first picked it. On the right is a warehouse, a warehouse I went to see in April in Uganda. I went to Ginger with Emily who works with me. And this warehouse had been set up by four young Ugandans with banks that get some from money from relatives and friends. What happens here is the farmers in the farmer associations in the villages produce five metric tons of grain or more and deliver it to village collection points within two days of harvest, that's the rule. It's picked up and brought to the warehouse. It's graded. It's cleaned. It's dried. And then while we were there the World Food Program came along and said we want to buy 500 metric tons to ship out to South Sudan. So the World Food Program people sat in the warehouse and the representatives of the farmer associations came into the warehouse as well and they bargained about the price. When they agreed on the price the grain was taken away and the warehouse was paid for looking after the grain. The grain was owned by the farmer associations and by the individual farmers. If you were an individual farmer and you didn't like what was going on you could come in and take a grain bag. And it was all transparent because the prices the warehouse was going to charge were advertised at the beginning of the season. The advantage was the farms got more money for their grain because they didn't have to sell it when it was harvested. They could wait and sell it later. And secondly there was no waste, virtually no waste at all.
There's one of these in Uganda. They need 15. If anybody's got any money I know some people who would love to build a warehouse. It's called after you. Let me just say something about integration. I'm going to begin this with a little comment on soils. We recently produced a report on soils. One of the things I do as part of my work for the Bill and Melinda Gates Foundation is I run something called the Montpelier Panel. It's called Montpelier because that's where we first met. It's a quite reasonable thing to do. The Yalta agree in what was called Yalta, because it was in Yalta, right. The French to begin with were rather cross that we'd taken the name Montpelier but then when we did well they thought it was rather nice. And we have about 15 experts, half African, half European who come together, names many of you will recognize and produce these reports, quite short, quite succinct reports. And I think there's-- I hope there's a little pile of the source report in the back. If there isn't you can download it from the website. So it's about what's happening with soils and one of the things is that the soils in Africa are degrading extraordinarily rapidly. This is research done by the University of Bonn run by Jurgen Von Braun [assumed spelling] you will know from his days at IFPRI. Twenty six percent of the land of sub-Saharan Africa is seriously degraded and degrading. It's a huge amount of land. The losses are about 68 billion a year and about 180 million people are affected. And the report that we've written describes what's happening. It talks about solutions, but one part of the solution is to have an integrated approach and in particular, integrated soil management. This is what we're trying to really underline because if we're going to really do something about soils, we need an integrated approach. And that means you have to combine the best of organic and conventional solutions. You can't just rely on organic solutions for this problem. You've got to apply some amount of nitrogen in there. You can see the top one there is farmyard manure plus nitrogen and phosphorus. They're all declining but at least the top one is keeping at the top because there's a certain amount of nitrogen. And the reason for that is about soil organic carbon and the fact that you need nitrogen and phosphorus to build up soil organic carbon in the soil. If the amount of soil organic carbon gets below about 1.1, 1.2% your land will go on degrading. If you can get it above that amount you can improve the quality of the land. So you need a certain amount of nitrogen, more than is necessary for the actual crop to grow to build up the soil organic carbon. You can get it, of course, from manure. You can get it from legumes but in many African situations that's very difficult. You need to apply a sole amount of nitrogen. And one answer is to think about some combination here of an organic approach, such as conservation agriculture and a precisional use of nitrogen so it's microdosing. That's a good example there of integrated soil management, putting the two things together in that way. Okay, coming towards an end now. I want to just say something about climate change. I assume that everybody in this room believes that the climate is changing and that human beings are largely responsible for that. Maybe some of you aren't, but by and large that is true and some at least increasingly accepted, at least in Europe. We're on track we hope, the word we hope is there for a world that's two degrees centigrade above pre-industrial. That's on the left, all nice pale colors. In practice we're heading forwards a world that's four degrees greater than pre-industrial. When you get to four degrees above pre-industrial if you look at Africa there, that deep purple in the north and in the south, that's six degrees above pre-industrial. You only have to think a little bit about what's that going to do to crop production in Africa? It's horrendous, really horrendous. If we're going to get to two, we've got to follow that blue line at the bottom there. We're adding for the red one. It's a massive change. And that's why this great conference that's being held in Paris in December is so important. The French are really playing a leading role here in trying to get the industrial nations and others together to come up with a new policy for dealing with both adaptation and mitigation. We know the climate is changing and we can see it changing in Africa now. On the left hand side is the changes in growing season. I was in Ghana two years ago. The rains came a month later and they ended a month early. So they only had 100 days to grow a rice crop and it's very tight, really tough and it's happening all the way across the [inaudible] and also down there in southern Africa. And on the right is the average annual maximum temperature above 30 degrees. And we know because of the work of David who is supposed to sit there that once you start going above 30 degrees the maize yield will start to fall very rapidly. An interestingly at 30 degrees seems to be a universal temperature. If you look at the mortality in New Delhi the mortality does that and then when it gets to be about 30 degrees in New Delhi the mortality goes up, human mortality. There's something about 30
degrees. In the UK it is changing and we know it already. My winter camellias are all over. My spring camellias are flowering even though there's frost out there. What's going to happen is that the southeast of the UK is becoming hotter and drier. The rest of the UK is going to become wetter. So we're going to have more livestock in the west and in the southeast we're going to grow more exotic crops. We're doing very well with wines now. I know you all snicker and think this is not true but let me tell you this, we have vineyards in the southeast of Britain producing incredible quality in quite “champagnes.” Nyetimber is our "best champagne" in quotes and it retails in Britain at $60 a bottle, that's how good it is. So, we're going to survive. We're going to drink ourselves silly, but we are going to survive in the southeast of England. It's not going to be that tough a problem. But you've just seen what it's going to be like in Africa. And in addition more than that change, that gradual change we've got extreme events, 2010-2011. Look at the weather extremes that we've had over the last 50 years or so, more than that. Picture of Britain, it looked like that last week, pure ice the whole of the country. So we're getting hotter and drier, but he extremes are getting greater at the same time. They're all part of a phenomenon and they're interlinked. This what their-- what happened in the rest of the world. Well you know what happened in 20, 2011. We had the worst drought in the United States since 1936. Had heat waves in Russia, there were floods in Pakistan, had floods in China. You had incredible drought in the Murray River Basin in Australia. If this happens again maybe with another couple of extremes added into it and if world food production really drops, what's going to happen? You know what's going to happen. The Chinese are going to go on the market to get the soybean they need for their livestock. Nobody knows what the stores are in China, what the grain reserves are. It's a state secret, that's fine. But it means that we could up for a real problem with something like this happening again. And it is going to happen again. The probability of these kind of multiple extreme events in the world is very high as time climate change bites. To cope this we need resilience. Resilience is a complicated phenomenon. It's about how you respond as individuals or as institutions or as countries to extreme events of stress or a shock. Do you recover in that way? Do you go to a new level or do you collapse? Complicated dynamics. How do we build resilient livelihoods? This is the answer. We have to stop thinking about farmers being farmers. We have to think about farmers as being in charge of their own livelihoods. But they're not just to do with agriculture. Very few farmers are 100% farmers. In fact, I've never met one who's 100% farmer. This lady in the Sunderbans of India, she's got a rice crop but she also grows these root crops which she sells. She's got a husband who raises fish fry and sells them. He's also got a little sort of like a taxi on the back of his bicycle and he rides around the village and he takes people all goods and so on and he makes some money that way. And then I was going out of the farm and I looked up and there was a solar panel on the roof, on the thatched roof. And I said, you know one of the tricks of going in to talk to people in the village is to ask them a dam full of questions. So I said, "Oh, you've got a solar panel. What's that for?" And he looked at me and said, "Electricity" he said. [laughter] And I said, "Why do you want electricity?" He said, "lamps" he said, "light bulbs." And he didn't say dummy or stupid or anything. You could tell that's what he meant. And then I said, "Why do you need light bulbs?" And then he said, "So the children do their homework." Children do their homework, they graduate from the local school, the get a job in a nearby town. When the next cyclone comes and it did only three years after that, took those pictures, this money comes in from that next generation that can bail them out. So that family has created a livelihood which in one of the most cyclone prone parts of the world has got some chance of surviving and going on and that's what we're talking about. Finally it's all about people. All of this is about people and, of course, it's about women. I've got three pictures of African women scientists. Woman on the left, Maria Andreotti who is the one who developed the vitamin A sweet potato. She came to meet us at our hotel. She's a great-- she's like Norma Balogh [inaudible] was, a great plant breeder, a [inaudible] plant breeder. A great implementer of what she's produced creating distribution systems and also a great publicist. So she turned up in an orange Land Rover, actually wearing an orange dress and insisted that my wife and I put on orange t-shirts and we drove around the country. Down the bottom there is Victoria Okot who's-- sorry not Victoria, Josephine Okot who's created Victoria Seeds in Kampala and has got a great business selling seeds. And top right is a woman called Dafrose Harper [assumed spelling] taken in her lab in Uganda. And we knew her at Rockefeller, because we gave her a grant to go and learn more about
biotechnology and she's one of the great biotechnologists in Africa. I always show that picture, it's inspiring, here's a woman probably one of the best biotechnologists in the world. She's African. She's doing this and I was talking like I'm talking to you in Kigali and Rwanda and I showed a picture of her and I said, "Here's a great African woman" and the whole audience burst into laughter. And it's not very funny that picture and then they all pointed down to the front and she was sat there. And I said Dafrose what are you doing here? She said, "I'm the minister of agriculture." And, of course, she'd been a Rwandan refugee in Uganda when we met her and gave-- I'm not sure we knew that when we gave her the money, but she went on and did that. And then finally, and most important of all, for all you political economists in the audience of whom there are large numbers, it's all about leadership. The Green Revolution originally was about leadership. President Khan in Pakistan and most importantly we were talking about him today, Subramania in India; great political leaders. This is one of the recent great political leaders. People recognize him here? No. John Kufuor, the President of Ghana until recently. During his time the average growth of agriculture production went up five percent per year for 20 years. And most important malnutrition dropped. You just look at the orange lines from 30% in 1989 down to 17% in 2008. That's what he achieved by his leadership and we're going to need more leaders like that if we're going to feed the world. Thank you. [applause]

>> I'll just thank Sir Gordon for his comments. I learned today from him that Bill Gates and I share one thing in common, which is that we're both inspired by the [inaudible] Green Revolution. He started a multi-billion dollar effort. I didn't do much but it did inspire me quite a bit. And I think in my years you know traveling a small fraction of what you've done you know a lot of similar lessons have emerged in terms of the importance of combining ecological, genetic, socioeconomic approaches. At the same time sometimes I think that maybe it's overcomplicating things a little bit in the sense that everywhere I've gone where I've seen successes it's either been in the presence of water, irrigation or it's been you know like I was just in Australia for six months. It's been in the presence of large field allocations. U.S is another example. You know so sometimes I wonder if you were to go to the U.S. or Australia, would there be sophisticated technologies and in the U.S. very good soils and you were to then say here's a half an acre or an acre to farmland. Or if you would go to some of the acre and half acre fields in Asia and you were to take away the irrigation, I wonder with all the best political leadership and all of the genetics that we can muster, if that's enough. So this is maybe a round about way of asking something that in FSC we, we talk about a lot which is how pivotable, how pivotal in Africa given the small field sizes, how pivotal is irrigation in your view in bringing this all together and helping it achieve those production increases that you said probably were necessary?

>> [inaudible participant comments]

>> Well, I think that's true.

>> I think there's a good point there. I think water is crucial. That doesn't necessarily mean that in Africa you need huge great irrigation schemes like they had in southeast Asia, although some of those are on the way. I mean [inaudible] and Mozambique they've got plans for quite a large irrigation scheme. But water is crucial. And it may be that we need to invest much more in ground water and even perhaps in deep aquifers that we can bring water up and we need to invest much more in small scale water harvesting. I've no doubt about that. I think that is a key component of what we have to do. I, I get a little worried when you say it's too complicated or maybe I'm, maybe I'm making all the younger people in the audience think God it'd be easier to go and make airplanes or cars or something than trying to do this. I don't want to think younger people in the audience got to sort of take all of this on board. I think what is important is to take either the ecological approach or the genetic approach or the socioeconomic approach, find what you're most comfortable with. I'm trying to look out beyond the older people at the front of the audience. There's a curious stratification you've go here. But I'm trying to look out further. Take whatever of those you're most comfortable with and you're interested in. Find something in there you can do something
really good on in terms of research or development or entrepreneurship or whatever it is you want to do and do that, but all the time you're doing it think about the bigger challenge of sustainability, right. That's all I'm really trying to say. I'm not trying to say that everybody has got to take all these things on board. You've got to be much more aware that's all when you're doing your brilliant bit of molecular engineering or you're doing your really fine work of biological control of pests or whether you've got some great electronic marketing gimmick. Whatever of those things you do, they're great but they must be within that larger context.

>> Yeah that's fair enough. You know I think, I think what a lot of us like to think about is where is our time best spent? Where is our energy best spent? And what are the-- what are the returns on those and I guess the following question and I'll open it up in a second, but you've gotten the opportunity to work a lot with these organizations and these donor communities. In your perspective on what dimension do you think they are let's say most out of line of what you think needs to happen in terms of how they're viewing the solution set?

>> It's easy to answer the question where they're most inline.

>> Are we videotaping, is that why?

>> No, no it's just that-- it's like many of these, I mean what is certainly happening is that there's greater donor interest in-- what is certainly happening is there's greater donor interest in food security and nutrition security in particular. I mean that's true whether we're talking about USAID, if we're talking about the British or the French or the Germans or the European Commission, talking about if and in the World Food Program. And there's greater interest in Africa. There's a program called CAADP, the Comprehensive Agricultural Development, Comprehensive African Development anyway it's called CAADP and where countries have committed themselves to major strategies for agriculture. And there's about a dozen African countries that are moving in that direction. I think one problem is that all the donors are doing different things and they're often overlapping with each other. They're not working in any kind of integrated fashion. What I've described it seems to me it's only going to work when you do the key issues, which may be about water, may be about all-weather roads to farms. It may be about those particular drivers, but in a particular area they've got to be integrated with other approaches. And you've got lots of NGOs doing all their own thing in a particular village and not necessarily taking it to scale. And you've got donors doing their own thing and not integrating with each other. And so in a way I would say that's the biggest problem we face is the fragmentation of what we're doing. For example you've got anglophones that don't talk to francophones. I mean I don't just mean they don't talk to each other but we don't learn enough from each other from those countries with an anglophone basis or francophone basis, don't learn lessons that each other has gained. So I would say that's a generic answer. There's lots of specific ones.

>> Okay we have a microphone. I have some more questions myself but I'm going to give the audience a chance to weigh in and when the microphone gets to you maybe if you could just briefly state your name and briefly state your question.

>> Okay, [inaudible] thank you. Actually during the intensification process in China, Chinese indeed increase their [inaudible] but also a huge share of agriculture pollution has occurred. So actually for the [inaudible comments] as reaching a top level and they're decreasing again, because of tipping points in the 80s and in Europe and U.S all go through the tipping points [inaudible] during the intensification process. So do you think that intensification process in African also have to go through the increasing first and the pollution and then decrease again?

>> Okay.
>> Okay.

>> When you would talk about yields it depends what crop we're considering. Yields of maize of corn have gone on increasingly, don't show any signs of tipping point. That's true of rice too in part because of Chinese work on hybrid rices. With wheat it's different. With wheat the yields have begun to plateau particularly in Europe and they're also highly variable. People are arguing as to why that's true. But it's not a general phenomenon. I don't agree that it's a general phenomenon that yields are going down.

>> No, no. I mean the--

>> Let me just paraphrase it, if I understood is that it-- what he's saying is that there are trajectories where systems intensify to the point of very large over-pollution.

>> Oh okay.

>> And then they become more efficient in their use. And is that in Africa should be worrying about efficiency at all?

>> Oh sorry. I misinterpreted your question. It's-- you're quite right. I mean there is points at which the excessive use of inputs, particularly fertilizers and pesticides of course is enormous problems. And that's true in China where there's a massive overuse of fertilizers at the moment. And we're now getting increased use of pesticides in Southeast Asia where we knew how to control [inaudible] with integrated pest management and that's been working well for 20, 25 years. But now there's an aggressive sale of pesticides again and all of those ground plant hoppers and leaf hoppers are all coming back again. So what you say there is correct and of course, we've got considerable problems of pollution arising from fertilizers in the United States in many places. And that, and that is threatening our capacity to feed the world. It may happen in Africa but it's a long way off because the amounts of fertilizer that are being applied are very, very small indeed, incredibly small in Africa. And the amounts of pesticides applied are very, very small. So I think the trajectory could be the same but they're white down at the bottom and into the curve. Thanks.

>> Thank you.

>> Sorry to misheard you to begin with.

>> David Abernathy, political science retired. In different parts of your talk you referred to climate change and you referred to genetically modified plants. In both cases they are let's call them science deniers. We are familiar with people who deny the science on climate change. They tend to be seen on the political right of the spectrum. At the same time you might say there are science deniers on genetic modification who generally think of themselves as progressive on the left but just don't want genetic modification either because they're against Monsanto or for some other kind of reason. And my question for you is since the left tends to be more interested in the kinds of issues you're talking and in favor of development, poverty reduction and so forth what kinds of arguments and what kind of science could you use to persuade people to the benefits of genetically modified grains because it seems to me in terms of drought response, etc. they make plenty of sense.

>> It's always interesting to get questions on genetic modification. I've been giving talks like this one for the last oh 20 years or so, roughly the same about 50-60 slides of which there are two on genetic modification. And in Britain when I started doing this an audience like this, that was all they would ever talk about was the genetic modification to and from. Doing Britain now and nobody even raises the
question. Things have really shifted in Britain. It's a lot of different reasons. I think one is a general sense that we've gotten so many problems in the world we need every tool we can get. Another is a belief in modern technology. Many of you will have seen that last week, week before last the British Parliament voted for measures that would allow a woman to provide the DNA from her mitochondria into a fertilized egg of a man and a woman. In other words, it was called three parents. Not really three parents but it was called three parents. It's the only country in the world that's now going to make that legitimate. It was voted two to one in Parliament even though the Church of England was against it. And that's a real shift and I think Britain will actually release genetically modified crops within the next couple of years or so. How you make it happen, how you get the agreement to this I don't know the answers. It's not to do with science. It's to do with much more intangible importance. Do people in the audience think that GAM crops are unnatural? Yeah. Hands up all those who think it's unnatural; quite a number. This is the point at which I admit that I'm a creature of Frankenstein. I often do this. I did it in China recently with that audience of three or 400 people and the audience went completely silent. I did it in Berlin last year with an audience of 2000 people and you could hear a pin drop. Who is this Frankenstein in the front of-- I've got a pig valve in this heart. I'm part pig part human, right. That's not natural. Not natural in any sense of the word at all. You don't go out there and see half pig half humans or even a little bit of teeny bitsy wits of pig and a human walking around. But why, why, why, why is that okay? Why is it alright to inject GAM insulin in your arm or hepatitis vaccines? Why is that alright but it's not okay for food? I mean I talked about this at the European Commission. People said well you know because at the mass we eat the Body of Christ. That's different you know. I don't get it. I don't get it in any sense. I'm not the right person to ask the question. It's not about science. It's not about logic. It's not about reason. If it was you'd all get up and crucify me now right.

>> That's at 5:30.

>> That's at 5:30. [laughter]

>> Yeah just go, [inaudible]. Thanks for the wonderful talk. I just want to think about 2015, nine, ten billion people and one of the really unique characteristics of this growth is urbanization so that urbanization comes. You know the need for tracking huge demands of food into, into the cities. So I guess the question is that you know how do you see the temptation of all these wonderful things that you've been involved, which-- you know would certainly, would not feed a large urban sprawl into a season which is you know sustainable and have the productivity and have the characteristics of you know the countries that would want to have food security, excess food and this humongous tracking into food into this urban world?

>> Well, there's a sort of plus and a minus side to this urban growth. One of it is that it's creating in Africa, but still in Asia and places like India, it's creating enormous [inaudible] of poverty within, within those areas slums and so on. But with the growth of an urban population you're getting a gross of a population that's demanding food, particularly in Africa demanding more food, more nutritious food and more diverse food. There's a pole factor appearing there. The urban populations and increasingly regional populations, regional trade in Africa is still a complete mess but it's beginning to happen that you're getting regional pulls. And once that manages to get down to the farmers, particularly if it's the right kind of roads and the agri dealers and all the rest there they will produce for that and I think that's what's happened, will be happening into the future. I think there is another issue though about as it were quasi urban food production or semi-urban food production. The margins of those urban areas and to what extent you can produce food to the urban areas in the fringes around the towns and the cities and that I think is a big challenge. Is that-- have I answered our question or is--

>> I guess I'm thinking about these food systems that are going to provide this humongous amount of food that's--
Right.

Required [inaudible] and at the same time trying to embrace this paradigm [inaudible] and you know they are vulnerable and we want to be sustainable. We don't want to create huge demands [inaudible] and all these things that we're dealing with you know super high tech in the U.S. and Saudi and everywhere else and so how we can actually do it for places like Africa and not having to go through--

Well it's-- the answer is it's not going to be easy. That's what the challenge is and it's going to be different for different parts of Africa. I-- I'm not claiming that any of this is easy, but that's-- we've got to try and do it along the lines that I've suggested is all I'm arguing for.

Hi, Christopher Gardner. I'm a nutrition scientist on campus. Really enjoyed the talk, very impressive integrated approach. So I have a question about crop staples across the world. Humans love the taste of food. It has to taste good but we're also a little hung up on familiarity. And I'm curious with all the modeling that you've done and some people like maize and some like sorghum and some like yams and some like wheat. With changes in water and changes in soil are any of the staple crops that we're growing in different parts of the world the wrong staples? Are they out of whack given that we're taking an enormous shift for a whole population of culture to shift to a different staple crop. Do we know enough that in all the hybridization at GAM there's still some underlying flaw that really rice should not be grown there or soy should not be grown there? Are there any staple crop challenges?

Well one obvious example is maize. Maize corn I have to keep remembering where I am. What you guys call corn what the rest of the world calls maize, it's because you speak an old form of English. You realize that don't you? Anyway corn in Africa is really at its limits. Most corn suffers in Africa because of drought at certain times of the year. It's a very risky crop to grow in a lot of Africa. And there's quite a considerable move to try and see it replaced into the future. What is interesting is that farmers do respond to new crops. I mean when I say new crops, new crops to them in Kenya just recently there's a major outbreak of a disease called maize lethal necrosis and farmers have stopped growing maize because of this. And I was talking to some farmers who were growing finger millet and the women were really encouraged by the finger millet. They said it got really good yields and it made wonderful porridge and the children loved the porridge. So I don't think we're fixed on these crops. It's not just middleclasses who love to change whatever crop, eat the latest what-- the latest it's a kind of kale isn't it. It's a kind of funny kale called what's it called. It's a new kind of kale with a Japanese name to it that everybody is now eating. I'm surprised none of you know about it. But it doesn't have just to be middleclass people that want to swap. It can be ordinary farmers who quite like to grow a new crop and see, see what it's like; we'll try it out. I don't think that's a big barrier in practice. It depends on how much the crop is built into the culture and that is one of the issues with rice. Rice is very built into the culture of southeast Asians in particular.

I think we're going to have time for two more questions for folks waiting in the front. Then we'll wrap it up just to--

Thank you Gordon. Wally Falcon. I'm wondering if you could talk about scale and scalability and the question has two parts. A lot of the ecological approaches seem to me are quite small. They don't scale very well. They're location specific and yet the kind of organization and skill set that you need to spread them are one of the most scarce resources out there. So could you A speak about scalability and different approaches and I'd be curious if there are one or two examples from Africa that you have seen that you think have great scalable potential.
Well, you know as I said I'm an ecologist so I tend to have to learn as I go along about the rest of the world. And I think the general answer to scalability is markets. We've got to somehow link what individuals are doing in terms of an innovative approach to a market. They've got to be able to sell what it is they're producing, which of course is why if you've got a new organic way of producing cocoa or whatever else it is, you can have it certified to be environmentally friendly, wonderfully tasting you know, rat dropping free cocoa. And you can sell it and so your production method will increase because you're getting a premium for the price. And so I think that's one way that you're going to get that to happen. I think examples that are working are in particular conservation agriculture, conservation farming, no till farming is spreading quite rapidly in Africa. It's spreading because it doesn't in practice take a lot of labor, because you can dig the little holes for six months before the next crop. And you get the benefits fairly quickly and farmers see other farmers doing it and they copy them. It's a good example of that kind of transmission. I think the Faidherbia is spreading, but that's largely because big aid agencies are simply planting lots of Faidherbia trees all over the place. I think you do have to have government intervention. I mean that's what the Chinese have taught us. The Chinese have a great approach to experimentation you know [inaudible] made the point the scientific approach. And the scientific approach in China is you try lots of things and you see which work. I saw this in [inaudible]. I went round all the municipalities in [inaudible]. They were 26 different experiments in water conservation in each municipality. They are all competing with each other. The best ones were scaled up. The ones that didn't work were thrown away. They often threw away some good things but it did work and that approach of taking the best and scaling up with government behind it has worked incredibly well in China. And there are some countries in Africa that are trying to do that and I think that's another way of making the scalability. But in the end I think somehow it's got to be tied to markets. You can answer that better than I think that I can.

Hi. So I guess I get the last question. Rachel Garrett and broadly define social scientists folks and sustainable agriculture, Boston University. And you started to just touch on it just now with markets, but given the increasing role of corporate actors and sustainable agriculture I'm wondering where exactly in the value chain you think there's the most incentive for corporate actors to intervene and also the most leverage that they can actually have on sustainable agriculture. So from the farm, distribution, storage, you know rule setting where do you think that that point is that's really relevant for corporate actors?

Well, I mean I think if you think about the value chain the way I was describing it you talk about the warehouses. You talk about small scale food processes, you know there's a lot going on now with producing snacks. Snacks are one of the first signs of a middleclass growing in a country. People love to buy little plastic bag of dried bananas or whatever else it is. And there's a lot of that going on. All of that it seems to me is something that can be done by local entrepreneurs and will work. I think where the big corporations come in is in terms of their demand for certain kinds of product. Coca Cola at the moment is involved in a major program in West Africa buying up mango and I'm not sure what the other, maybe passion fruit. But it's mango and something else which they're going to bottle and market internationally. They're being helped by quite a good NGO that develops these systems. You then, once you get to that scale you've got a major demand for products which will really help to transform agriculture. So it's at that level that I see the major corporations having a big role. And what I want to do is to see them have that role with the kind of sensitivity that allows them not to get involved in taking up a small hold of land but to help to create small hold cooperatives that nurtures the value chain but looks at the top. The company in Britain that does this is a company called Waitrose, which most of you probably won't know. It's a partnership. All the employees at Waitrose are owners of the company. And it's an incredibly successful high level of company and they have long-term agreements with their suppliers. All the beef in Waitrose is British beef so it isn't contaminated with horse meat, which is our problem. You can create big corporations like Waitrose. It's not one of the biggest in the world, but it's reasonable sized on these partnership principles which extend all the way to helping to encourage farmers into cooperatives and how to create transparent stable value chains where farmers know what they're going to get from year to
year. That's the kind of model. I know it's kind of idealistic but there are places where it's working already.

>> Okay right on time. Before we thank Sir Gordon I just want to make a couple of announcements. I think Roz might have mentioned, we have a continuing series and the next topic in this series will be on genetic resources and genetic diversity in agriculture. That'll be in May. And the other announcement is I think Roz mentioned we have a reception waiting outside. So, I'd like to thank Sir Gordon not just for comments today but for really 40 plus years of saying such sensible things. And I think you're being modest about you know some of the turns towards more sensible conversations on GMOs and I think our thanks to people like you. So, thank you for that. [applause]