CONVERSATION: AGRICULTURE AND CLIMATE CHANGE – PART OF THE SOLUTION

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Hans Herren – Co-chair, International Assessment of Agricultural Science and Technology for Development; 1995 World Food Prize Laureate

Good afternoon, ladies and gentlemen, friends. It's very nice again to be here together this afternoon with however few you are, but I am sure these are the hard-core, interested people, to look at the issue of climate change and agriculture. And as we heard a few times that agriculture is the problem, or part of the problem, to climate change, maybe we'll also see how agriculture can be part of the solution. To do this, we will literally go down to earth, because that's where agriculture has to contribute to the adaptation but also mitigation to climate change.

We have a formidable panel this afternoon, and we'll try to focus on solutions, but only after we state again the problem – because I think we have to understand the problem well in order to also look at the solutions and make sure there is a proper fit between what are the problems and what kind of solutions can we talk about. Really the idea is that we do understand the bottleneck which we have, in terms of agriculture being now part of the problem of climate change, and how we can turn it around, make it the part of the solution.

You heard earlier about thinking about outrages; there's many more of them. To me, one is the obvious fact of our lifestyle, how our lifestyle is contributing to make life not only difficult for us, in our own generation or my generation, but the one of our children and, even worse, so the one of the people in the developing countries, which will bear the brunt, I think, of our excesses in terms of contributing to climate change.

Our belief in technological fixes has brought us mostly into that situation. And I think we need to now, as we move forward, think that technological fixes would be part of it – yes, we need some. But I think we should not just rely on these tech-fixes, which usually are short-term and address symptoms. And that's what we've been doing since the Club of Rome told us, "Watch out, your resources are limited, and more people are coming," and that we should really try to handle our Earth with more care. Most of it was ignored.

Thirty years later, when there was a revision of the book *Limits to Growth,* it turns out that quite a bit of what was in there actually is sort of coming true – not everything; it's hard to predict 25-30 years ahead. But just the fact that many of the issues raised originally in that book actually came true and panned out show that people should pay more attention to what at least we say today about dealing with our future.

The Club of Rome actually tried at that time to alarm mostly our leaders, but many leaders chose to ignore it for the sake of growth – growth above all. Now, we need growth as [a way] out of poverty, but I think even way back then people were thinking, "So what about a different type of growth?" Maybe green growth, sustainable growth? And we are still struggling today with this.

UNEF is about to publish next year a new report on the green economy in which there will be a whole chapter on also agriculture – how to make agriculture green. And this is really something that we're going to talk about yet today with this panel: how to change, from black, as some people would say – it's not only brown, it's actually black – and to go all over to green. Because that is really, I think, necessary if we want to feed the world, not only for the next 5-10 years or through this crisis and another crisis and yet another crisis, but really to make sure that we use our science, our technology, and, above all, the knowledge of the farmers to make sure that we have all of us a future.

Just having heard Gebisa's essay, I could hardly have summarized the [IAASTD] Ag Assessment much better. Interesting – I don't know if he's here, but I'm sure he must have read a part of it; I was happy to see his analysis of the situation very much also in line with the Ag Assessment, which again calls for changing the way we do things.

So we will try to show you that, actually, we have tools in a toolbox to do better. Now, the question is, okay, what are these tools exactly? Do we need any more training to use these tools? Can they be used just at random, or is there a system how to use these tools? And so that's what we're going to get into later. And the way we'll do this – we'll start with a presentation, looking at the key issues, and then we have some panelists. The rest of the panelists will look at the problem from different angles – from the soil, from the soil microorganisms, and then from the animal side, and not the least, from the people, because the consumers are also a big part of the problem, and unless they contribute, I think we'll not go anywhere.

So let me introduce the different speakers. First we have Helena Paul. She is co-director of an organization called EcoNexus; I'm sure that most of you have heard about it, a not-for-profit based in the United Kingdom. Ms. Paul has worked for over 20 years on issues related to agriculture biodiversity and sustainability, tropical forests, oil exploitation in the tropics, indigenous people's rights, and genetic engineering. So you can see that we have somebody here who really I think can understand the issues which link agriculture to climate change. And the fact that she was involved also in international negotiation, with the UN Convention on Biological Diversity [and] also with the UNFCC, shows that we have somebody here really can talk from firsthand experience what's going on in this area.

Yyou have the detail, I think, somewhere in your documents about what else, where she comes from, what she's done. She has also authored a number of publications, particularly on agrofuels, for example, which is what's been probably one of your topics you've been dealing with in the last few years, but also biotechnology issues.

Then we will have Dr. John Reganold. He is the Regents professor of soil sciences and agroecology at Washington State University. And I emphasized the agroecology because he's going to bring in that aspect here, which I think has not really been discussed enough yet. He's one of sustainable agriculture's leading scientists. Dr. Reganold measures the effect of alternative and conventional farming systems on soil health – and it's important that health is in here, because when you think "health" you also think prevention, to be ahead of the game rather than behind – also crop quality, financial performance, environmental quality, and social parameters. And he has been a professor at Washington State since 1983 where he does research and teaches courses in soil science and organic farming. He spearheaded the development of the university's organic agricultural system major, which was the first in the United States.

So as you can see, he has been sort of a revolutionary in the system, also bringing organic farming, the study of it, into the university – because that was the big problem. There have been some things done at the edge without all the science, which actually needs to go into that aspect of agriculture also. And I think he has a lot, a huge amount of catch-up to do in terms of science to improve the understanding and the working and also the limitation of organic agroecology, organic agriculture, even biodynamic agriculture, agroecology.

Then we have Peg Armstrong-Gustafson. She is from Iowa, from right around the corner here. She is the owner and founder of Amson Technology. Ms. Armstrong-Gustafson brings 30 years of marketing and product-management experience to her strategic consulting practice. Amson Technology – sort of the interesting part here – specializes in climate change, sustainability, and carbon offsets involving technology and business development. So we'll hear about sort of technological ways of helping sustainable farming; that's very important, so we'll hear more about that from that aspect.

Then we have Dr. Anita Idel. She is a veterinarian, mediator, and also a lecturer at the University of Kassel in Germany. Here we're going to have the animal world represented.; we heard earlier that we didn't hear enough about livestock. The whole Ag Assessment didn't have enough about, I guess, livestock – although

she was one of the authors, but one of the few authors within the whole assessment dealing with livestock issues. So maybe the IAASTD-2 will work with you to get more people involved.

Since 2002, Dr. Idel has been leading the project-management consultancy, Animal Health & Agrobiodiversity, so you can see the connection there. She works in a complementary way as business mediator in the fields of animal health and welfare and natural-resource protection. Since 1986 – that's been quite a while – she has been a lecturer at the University of Kassel in topics including genetic engineering in agriculture, long-term considerations for animal health, and ecology and socioeconomics. So she has looked at the whole issue of biotechnology but also in the animal sector. We always hear in this event here, it's usually crops, a lot of food crop discussion, very little really about soils and even less about livestock. So we'll get that view into our discussion here this afternoon.

And then we have in a minute Michael Hansen. He is a senior staff scientist of the Consumers Union. He will talk to us from the consumers' side, because we need to know a bit more about what's happening on that side. He has been responsible for developing positions on safety, testing, and labeling of genetically engineered food; was involved with this "mad cow" disease and food-safety issues from Consumers Union, who publications the *Consumer Reports*, and I'm sure many from the United States here know the *Consumer Reports* – something we do consult regularly before going and buying something. I'm not sure we go looking there [first] for when we go buy our cereals, and maybe we should. He will tell us if there is something there on the website about that.

He has served on the USDA Advisory Committee on Agricultural Biotechnology, on the California Department of Food and Agriculture Food Biotechnology Advisory Committee, at FAO/WHO, so you can see that he's been very much involved in all this genetic engineering over the years, and I think he will give us some insight also – not only about biotechnology but the consumer view, on consumption issues and CO_2.

All right, so I don't want to take too much time here with the introductions – you can read more yourself – so we will start. It's a bit different way of the other panels; we'll have a few paramount dissertations, so the others will just present ideas. And then we will try to get the public here, the plenum, involved with questions and a discussion, hoping that we have a bit more time than we had this morning to discuss some of the questions. Okay. Helena, please.

Helena Paul – Co-Director, EcoNexus

Great. Well, it's very good to be here, and thank you for the opportunity. And I have a number of slides here. This is a very complicated issue in the sense that there are a lot of factors. So I shall go through the slides fairly quickly, picking out particular points that I think may be key to this discussion that we're going to have this afternoon. But I do urge people to look into the issue, because it's an extraordinarily important one, obviously, right now.

So agriculture's impacts on climate change, and I've taken [it] from two main areas here. As you can see, many of the greenhouse-gas emissions arise from non-energy sources – 14 percent from agriculture, they say, and it's mainly nitrous oxide and methane; and 18 percent from land-use change, which according to the Stern report is mainly deforestation for agriculture.

But I think we should be clear that many of these figures don't actually accurately reflect the reality of what's going on. First of all – the food system is hugely expensive in energy consumption. It's 17 percent of a very large total; that's the U.S. total energy consumption – so that's an important one. And also we don't really know enough about the emissions from the soil and particularly from peat destruction. I don't believe emissions from soil are accurately reflected in those figures.

So now we have the impacts of climate change on agriculture. Well, I'm sure many people here will know about the more extreme climate events, some of which we're already experiencing: unpredictable seasons –

we talked a bit about unpredictability this morning; changes to pest and disease patterns are extremely important, and they're bound to be a real challenge in the future; water stress has to be included, I think, here on people, crops, and biodiversity; then, of course, we have desertification; and we also have a reduction of the land that's available for agriculture. This is one of the things that the IAASTD mentions, the report that Hans Herren mentioned earlier, is the damage to the natural-resource base on which agriculture depends – and that is the soil. It's many other things, but we have to be aware of the fact that climate change is going to add to the damage that we have done. I mean, it's possible that there may be some improvements – I'll show a few ideas about that later – but probably only temporarily.

Ecosystem resilience – the ecosystem is weakened, and that's so vital to agriculture. Biodiversity lost – we can't do without that biodiversity, especially the agricultural biodiversity. And the conflicts over land and water and other resources. We've already seen the beginnings of some of those with some of the river-dam projects that have been affecting the Middle East, for example; those are going to get more serious. Food security – when temperatures go up, you may get productivity marginally rising in some places, but when it goes beyond three degrees up to five degrees, it will have a negative impact everywhere. And you get considerable species loss, 20-30 percent by some calculations. Higher temperatures, CO_2 levels – this leads to the pests and diseases that I mentioned earlier, the greater extremes also. So you're going to get big declines in crop yields in much of the global South, and food prices are bound to rise.

Now, I took some figures from IFPRI, and I just want to comment on the fact that they mention wheat, rice, and maize. And I've given these figures as examples, but – my goodness, how limited those figures are, just limited to the main, staple crops that we all accept as being staples. And yet there are many staple crops in other parts of the worlds about which I have not been able to find the information as yet. And I think it's vital that we look into that, too.

So I thought I'd look at just five regions, because I was asked to look at the regions that IAASTD talks about, so I will be fairly brief in this. Just want to say that the rate of change is greater than previously thought of, realized, because of the Arctic melt being faster than anyone had previously realized. And I'll be talking about some of the systems effects later.

Central and West Africa: Here I'm not going to pause in detail, but we have the problems that I mentioned before, the drought and desertification. One of the things to note – I was talking to someone called Melaku Worede, who is an amazing Ethiopian, and he said that even the well-adapted farmer varieties may fail and that, therefore, in a sense some of the land that's close to where farmers work, where biodiversity can continue to evolve as the climate becomes more intense, that's going to be very, very important. And as you can see, the declines projected by IFPRI are quite considerable.

East and Southeast Asia and Pacific: Well, they say that the worst impacts on rice and wheat will happen there, worldwide, and be decreased yields that could threaten the food security of many. I won't go into the details again. The scarcity of fresh water, however, was something of a surprise to me, especially in the large river basins in that region – that's being predicted.

Latin American and the Caribbean: Again, a similar story. One of the main things, I think, is the gradual replacement of tropical forest by savanna in eastern Amazonia. And I want to say something more about forests in a little while. Significant biodiversity loss. And also the unpredictability. I talked to people in Argentina who said they're already suffering a lot from unpredictable climate change, due to the destruction of the Chaco, which happened very suddenly when soy reached the Chaco. And climate change, massive floods and droughts, have been noticed by people.

Sub-Saharan Africa: I think we're all aware it's particularly vulnerable to climate change. We have the dependencies, what's called the "low level of human and physical capital," which I put in inverted commas because it is an expression much used, but in my own mind it has a question mark next to it. But it is a regularly accepted expression for one of the problems that Africa faces. With land-use change you get regional climate change. There's some very interesting work being done predicting what might happen if you

turn pastoral land over to crops in East Africa – you would get unpredictable and extreme climate change in some areas.

North America and Europe: The northward and upward movement of crops and biodiversity. Increasing photosynthesis and CO_2 fertilization; that would mean some of the pest problems that have been mentioned. And I thought it was particularly interesting, for this audience, to see corn, cotton, soybean – it depends whether you take an IPCC high estimate for high fossil-fuel fast rate increase of emissions – 30-46 percent for the low ones, but 63-82 percent if you take a high one. And with the ozone concentrations, certainly we have that problem in Europe already, and that has significant negative impacts on agriculture. And of course one point I forgot to make was that if you have increased CO_2, you also have nutrition declines in crops.

The crucial role of forests – I just want to touch on this because I think it's absolutely vital and introduces a whole area about systems. If you take the Amazon as a carbon sink and biodiversity store and more – we know about that already, most of us, but the recycling activity of rain through evapo-transpiration is extremely important in the Amazon. It's not just important for rainfall in Sao Paulo region, to which it directly contributes, but also you have an energy issue. And you have the water vapor. You have energy release that doesn't remain in the region but actually [has] effects right around the world. And I have read, with the idea of teleconnection – which there is isn't enough time to go into at the moment – that it may increase droughts in North America.

So now we begin to see the systems aspects of this – the climatic systems moving energy around the world and affecting different areas that you would never think had a connection with each other, and also the extra pressure on the United States under such circumstances. So Amazon clearance or collapse means huge impacts for all of us, and that's a vital thing to remember.

Now, I just wanted to touch on some proposed solutions. I won't take long on this, but this is something I've been doing a lot of work on in the last year or two, and I think it's also critical, because many of these proposed solutions are what I would describe as silver bullets. They are a desire to simplify the problem and, therefore, simplify the solutions that might be available.

Number one is conservation tillage, and many of you will know exactly what that is, because I'm sure there's a great deal of it around here. Different versions are promoted; what I would call chemical no-till, very often involving genetically modified crops, is one of the main ones – a hundred million hectares. It's really not clear how effective that is for carbon sequestration because the figures are very variable according to who you listen to. And I think there are some grave problems with it as well, certainly with the genetically modified version of it. So I think that that is being promoted in a number of quarters as a major solution, but in view of the herbicide-tolerant weed problem, which seems to be particularly clear in the United States and Argentina, and the other problems that I outlined, we need to be clear about that.

So the next one is biochar; this is charcoal produced by burning biomass in the absence of oxygen. Many people will have heard about that. I think for me the problem here is the big claims being made on the basis of very limited research and the fact that I have not seen anything that really shows what biochar conclusively does in any long-term way. It's very difficult to know how long it's going to stay in the soil in reality, how effective it is. One thing I'm very skeptical about is – and I've actually read this on websites – people saying, "Oh, biochar is just the same as *terra preta*, which is this Amazonian black earth. Well, I don't believe that it can be – in no way, because the processes for creating the two would be completely different from the start. And also there's a problem of black carbon when airborne.

The intensification of livestock, massively extending confined animal-feeding operations, is how this seems to be being presented – because I believe this is about to happen to the pig industry in China. The production of grain for animal feed already uses one third of global cropland. One of the problems is also that, if aquaculture is also shifting to grain feed, grain feed competes directly with human food security. But this is going to be talked about at greater length later in a positive way, so I shan't discuss that any further.

Marginal land – I've heard a lot over the last couple of years, or even longer, about how many millions of hectares there are of marginal land, and all we need to do is exploit it with, say, biofuel crops or advanced biofuel crops, which can somehow improve the land. I just wanted to draw attention to the fact that marginal land is very often untitled land, which is used by local communities in a way that may be invisible to people from the outside looking in. It can also be a crucial hedge against emergencies, and it can help to stabilize, or keep stable, ecosystems.

I want to also make sure that you realize the final point is extremely important. Land-grabbing is a major issue worldwide, whether it's for biofuels, whether it's for the food security of wealthy oil-rich countries that don't have much agricultural land – and it's going on as we speak, in many different areas of work in many different parts of the world.

Genetically engineered crops are being promised in order to help with climate issues to increase yields and to extend the geographical and climate range of plants, tolerate salt, drought, and so forth. There really isn't time to go into these, but I think that it's very clear that some of these solutions again are being promised in a rather "This is the solution" manner rather than looking more carefully at other things that are possible. I was particularly interested to see the last thing, the GE enzymes for producing biofuels that you may have heard about. The GE rhizobia for genetically engineered Roundup-ready crops is something new to me, and I have not been able to trace how that is developing. But what is the impact of releasing genetically engineered rhizobia into the environment? I don't think we have any idea.

(I'll skip over developing the new bioeconomy. I want to finish with the last slide, which is just simply to say –)

Here are some ideas about agriculture and climate change being friends.

In South America peasant agriculture still produces 41 percent of food for domestic consumption. Polycultures are incredibly important worldwide, and they have huge impacts, positive impacts. They do actually have very high yields, especially if you don't take brute grain yield as your only measure, and they can help to conserve soils and build and retain them. Diversified crop systems often have been measured to yield more than the monoculture, single-crop systems of the same crops. And these people actually keep genetic diversity where it matters – in the fields – and they're watching it and collecting it and sifting it through and swapping it around between different regions of countries in a way that has been going on for a very long time.

Finally, with the grassland, Anita will be addressing this one. But one-third of terrestrial carbon stores are in grasslands, mainly in root mass. Cattle have a very important part to play in this. And pastoralists, much maligned as they are, are a crucial aspect of the management of these systems.

So thank you very much.

Hans Herren

Thank you very much, Helena. I think that's a very good start, some very provocative thoughts here about what the problem really is and also some ideas to move forward. Now, we'll hear from John Reganold the place of the soil and how to solve this whole issue and what can be done from that end.

John Reganold – Professor, Washington State University

Earlier today, the session before lunch, a famous soil scientist asked a question and made a comment. His name is Dr. Daniel Hillel, and he mentioned that with soil we have such a tremendous opportunity to mitigate climate change. It's one of the ways, it's one of a number of ways; and that's what I'm going to talk about today. So, Daniel, I hope I do it justice. And I'm going to try to do this in about eight or nine minutes.

So I'm going to be talking about soil-carbon sequestration, soil's role in sequestering carbon. And I think everybody has seen probably many times the carbon cycle, but if you would just look at the left side – the three pools that I'm most concerned with for this talk are: the soil-carbon pool, the atmospheric pool that we hear so much about, and the biotic pool.

The atmospheric pool roughly is about 750 gigatons – a gigaton is a billion ton; these tons are metric tons, so 1,000 kilograms. Some people like to think in terms of petagrams; a petagram and a gigaton are the same. So the atmosphere has about 750. The biotic pool, which would be mostly vegetation and everything else living on the surface, is about 610.

The soil is 2,530; it's more than twice what's in the atmosphere and what's in all the vegetation on the planet. So it's a big pool; the main part of it is in organic form, and that's the part that we really can manipulate. The inorganic forms are mostly in carbonates, and that's more difficult to change. So when we talk about soil-carbon sequestration, we're talking about changing, adding to that organic component.

And the figures that I'm going to give take into account soil to a 1-meter depth, okay? So about three inches more than a yard, for those of you who don't think metrically. The figures, they range from, as far as the soil carbon pool, 30 tons per hectare in dry climates climate, all the way up to 800 tons per hectare in organic soils in cold climates like up in Alaska, tundra areas – that's where we have our greatest chunks of soil carbon. And we use kind of a range of 50-150 tons per hectare across the landscape.

Now, conversion of natural areas to agricultural areas, or what we call agricultural ecosystems, has caused a big depletion in soil organic carbon over the years. And in some cases, like in temperate areas – which would be here in Iowa; where I come from, the Palouse in Washington State – the amount of carbon in the soil has been depleted by as much as 60 percent. So we have rich soils that produce wheat in the Palouse region. Those soils were once 4-5 percent organic matter; they're now 2 percent, and some are even lower than that. In the tropical areas it's even been a little bit greater. We've lost in some places up to 75 percent, and there are a few places we've even lost more.

If you're wondering, well, how did that happen? Well, we degrade soils; about a third of it is from degradation and erosion, and about two-thirds of it is from mineralization. Organisms eat the organic matter. So you have earthworms eating the organic matter; you have microbes, like fungi and bacteria, when they consume it, they respire just like we do, and they give off carbon dioxide, they increase the pool. So that adds significantly to the environment.

The soil sequestration – by soil-carbon sequestration, what I'm talking about is soil organic carbon pools – through judicious land use and recommended management practices, which we call RMPs – that's the way we can increase it. Then you might say, "Okay, well, how much can we increase it by?" The historic loss of carbon – and these are estimates, but they're pretty good – is between 55-78 gigatons, and most of that has happened in the last 150 years since the Industrial Revolution.

So then you might say, okay, can we get that 55 to 78 back? Well, the estimates are, by soil scientists, that we can get back between 50-66 percent. Some estimates – this was in 2004; I just looked at a paper that came out this year, and it's up to maybe in some places 75 percent. It's difficult to get it all back because, to put more carbon into an agricultural soil, it has a limit; it's not the same as a native soil like a forest or a grassland, which has a greater limit. So we can't likely put it all back, but we can put a lot back, the greater part of it.

Estimates of soil-carbon sequestration vary from about 0.4-1.2 gigatons of carbon per year. That's about how much we can bring in. And if we do that, we can probably hold that rate for 20-50 years. We could fill up the sink with that 50-60 percent of the historic loss. We could do it in maybe 40-50 years; it may take 70 years. One of the problems is that, with climate change, that actually exacerbates carbon sequestration in the soil because some areas are going to be cooler, some areas are going to be warmer. More will probably be warmer – so it's going to be a little bit more difficult, so it may actually take longer.

But the issue is, we can actually sequester carbon in the soil, and that actually helps mitigate climate change. It is cost-effective, it is environmentally friendly. And strategies include adding high amounts of organic matter. There's no other way around it, I'm sorry. If you want organic material in the soil, you have to add it. It doesn't mean you can't use synthetic fertilizers, but you have to add carbon to the soil. And it also means using practices where you minimize the disturbance of the soil and you conserve the soil and the water, because you're going to need that water, and you improve the structure.

So then you might say, "Okay, well, what are some of the strategies?" And I think many of you have heard of some of these. Residue management is one. We've all heard of conservation tillage, where you leave 35 percent of the surface covered by residue; no-till is an extreme form of conservation tillage. Growing cover crops; managing nutrients efficiently; diverse crop rotations; complex crop rotations, 3-4-5-year rotations, not 1- or 2-year rotations – that helps with the carbon pool. And then of course adding compost, green manuring, animal manures, biosolids – they have great potential. And, although controversial, biochar may play a role too. So those are strategies.

More strategies. Efficient irrigation is a big one – wasting water, in a sense, wastes carbon. Water conservation and harvesting is another means. Growing energy crops on spare lands, marginal lands. We have about 40-50 million acres of marginal lands in the United States. It's possible that some of those could grow grasses; deep-rooted grasses could benefit the soil. Improved grazing, agroforestry practices have potential; woodland regeneration on parts of farms. We need to start thinking of farms on the landscape as a mosaic, that we have not just monocultures – we have trees and we have diverse cropping systems on those fields. And then of course restoration of degraded soils.

So those are kind of the strategies, and then if you were to say, "Okay – well, what farming systems include some of these strategies?" And the one that comes to mind first is what Europeans like to call "integrated farming systems," and integrated farming system is not integrated pest management. Integrated farming systems are farming systems that blend the best of organic with the best of conventional. So you have to build the soil, you have to add organic materials, and then you bring in any synthetic fertilizers you might need additionally to get those yields. You use biological pest controls, and if you need to use glyphosate or some other herbicide, you can do that, but it's a combination. And they actually have certified integrated systems in some parts of Europe.

Organic and biodynamic, you're adding a lot of organic matter. Mixed crop-livestock systems, where you're growing both crops, usually grain crops, but not always, with livestock; you may have four years of cropping and then four years of livestock. Conservation agriculture, no-till – conservation agriculture is more than no-till. It's something that they use in parts of Brazil and Africa. No-till, low-input, agroforestry.

And I have there perennial grains – "Oh, my goodness. What are perennial grains?" This is my really pretty slide, and I actually think that 66 percent figure might go up because of this. There are breeders now at the Land Institute in Kansas; we have breeders in Australia and also in China. And they want to perennialize our grains. Our grains our annuals – so we plant; six months later, it dies, we harvest it. They want to perennialize wheats, and they've done this, but they're not high-yielding yet.

So, for example, for wheat, it has a wild relative, intermediate wheat grass. This picture goes from September, December, March, June – look at those roots. At the left is the regular annual wheat plant. Look at its roots in June, and look at the roots of the intermediate wheat grass. Those roots go down three meters – that's more than 9 feet; it's almost 10 feet. And it's those roots that are, basically, building the soil.

If you were to ask pretty much any soil scientist, "What are our best soils?" – in fact, I was even talking with a farmer today from Iowa about this, and he was saying, we were talking about how prairie soils are the best soils, they produce the best soils. And with perennial grains, we would have those roots, we would have yields, and we could leave the plants in the ground for 3, 4, 5, 7 years – lower the energy, lower the inputs of fertilizer, and yet we would still have a yield. Perennial grains, in particular wheat, could be ready as early as 10 years; it may take 20. It depends on the breeding. And they're doing this for rice, maize, sorghum, etc.

Finally, additions of organic matter – I'm a soil scientist, so I'm a big proponent of adding organic matter to the soil. It does all these great things: it improves soil structure; it increases water storage, it increases the nutrient storage, the nutrient supply, organism activity, fertility, productivity. It gives the soil better structure, makes it less erodible. It's fantastic, and most gardeners know this.

With that I leave you with this picture: two soils, southern Minnesota (a colleague of mine took this), two farms side by side. Took a spade, the soil on the left – both fields were growing corn – took a shovelful of the soil on the left, a shovelful of the soil on the right. The one on the left was basically growing corn and soybeans, sometimes coming back with corn after corn, so almost a year and a half, 2-year rotation. The soil on the right was in a 3-to 4-year rotation where the farmer – not an organic farmer; the farmer was integrated – would sometimes actually apply some animal manures but, more importantly, had a green manure crop, which he would plow under, so it accumulated more organic matter. My colleague took these two spadefuls and then took a garden hose and ran the hose for two minutes over both of them at just a gentle to moderate rate. And within a minute all the soil was gone into the corn roots on the left. All the soil is still together on the right – and that is because of carbon.

Thank you.

Hans Herren

Okay, thank you, John. Peg? Let's just move on right away.

Peg Armstrong-Gustafson – Founder and owner, Amson Technology

I'll try to help us catch up on a little bit of time, Hans. Good afternoon, and my purpose today is to speak to you today about how a small, little microorganism and an international process can actually demonstrate and provide for an example of how agriculture might provide a solution to the climate-change situation – and so, in a small way, hoping to be able to share that it can actually be done.

Now, every good story, as we all know, must really have a great plot. And so the story is how agriculture can participate in finding solutions for climate change. And we definitely have a good plot, as we have already had established here by the earlier presenters in the World Food Prize dialogues, as well as reading and the information that's been presented. So the plot is there. So now we need to answer the questions – who, what, where, when, and why?

Each of us is actually writing the history of how agriculture will or will not participate in being a solution to climate change. So each and every one of us will write our own story, and then that will collectively aggregate up to the history of how we approach this issue. So I'm hoping that by sharing my own small, personal story with you of the who, what, where, when, and why, it may cause a creative thought process for you to explore the possibilities of the solution.

My small story starts with the "who." And I'm going to share with you right now that the "who"s are not going to be very recognizable to you. They are not going to be by the many, large multinational companies that you've heard representatives of address you at this conference. They will not be people who are of the recognition of the esteemed experts that you have on this podium this afternoon.

Instead, we are more like the small landholders that have been referenced day in-day out for the last three and a half days. We are like those small landholders – people that you do not know but they exist – but collectively, I believe, in our small story have come forward to take an opportunity to show how, when we work together, positive things can happen.

The first one is my own company, and believe me, I am not offended when I introduce myself and you ask me who I'm with, and I tell you, and your eyes kind of glaze over. That's quite all right; I don't take it

personally. You wouldn't know me. I'm a small company, a person of one who uses some contract labor to help me – not unlike some small farmers who use contract labor to help them with their farming operations.

The next partner that participated with me in this small, little story is a small company called Becker Underwood. It's 35 miles north in Ames, Iowa, and it is a company that produces inoculants that come from naturally occurring bacteria – rhizobium – and they also have natural colorants that are used in some of the agricultural seed business and in landscape colorings.

And then the other small group is an entrepreneurial group out of Hamburg, Germany. They have just, within the last couple of months, because they were very productive, been purchased by a larger company called Point Carbon. But they were a small entrepreneurial company of about four or five people in Hamburg, Germany, who had a unique expertise in climate-change policy and understanding the true process of working with the UN Framework Convention on Climate Change to develop things called methodologies for clean-development mechanisms. So this is the three, little, small landholders who collaborated to build this small story that includes a small, little microorganism called rhizobium, a bacteria that's used to inoculate legumes.

Well, what is our little story? Well, our luck is that we received approval from the UN Framework Conversation on Climate Change and the Emissions Board for what's called a Clean Development Mechanism. And I won't go into all the details; you can look at it up. Maybe many of you are already well versed in this topic. But to just really kind of summarize what it is: it is the official approval process that one goes through for projects that create greenhouse-gas-emission reductions, and those reductions are certified by the United Nations and can be used in some compliance efforts for meeting Kyoto Protocol reductions. And these must be certified by the United Nations, and they're called certified emission-reduction [CER] carbon tons.

So we were looking at a Clean Development Mechanism, and many of the other methodologies had been in the area of energy. They'd been put through by governments in order to bring about hydroelectric power plants; they'd been methodologies relating to landfills and methane reductions. So really this little kind of unusual, quite possibly irritating, process was an agricultural methodology going through. And quite honestly, it really wasn't well received – we weren't really informed enough to know that it wasn't well received; we just kept getting responses back that were rather negative, until we finally figured out they really didn't want us around. But that really didn't stop us.

Just to make sure that you know I'm not lying, here's all the information – you can go look it up on the website. The title of it is, "Offsetting of synthetic nitrogen fertilizers by inoculant application in legumes-grass rotations on acidic soils on existing cropland." Wow, that's an awfully long title, and basically what it is, is it's basically saying that we are substituting urea by the use of the technology of inoculants for legumes.

Now, many of you are going to sit there and say, "Well, Peg, everybody knows that legumes fix their own nitrogen. So therefore this is another one of those fluff environmentalist methodologies to claim that you're reducing carbon so you can make a lot of money in the carbon market, and you're really not reducing any greenhouse gases." Well, that's true – except if one starts doing the research. The fact is that, yes, legumes do fix their own nitrogen by taking nitrogen out of the air and working in a symbiotic relationship with bacteria where they use the sugars and the bacteria supplies the nitrogen. But the facts are, according to the most current report from FAO on fertilizer statistics and its use around the world – and it's done by crop – you can find that urea is actually applied to many legumes. And there are 18,000 of them as we know today – there may be more – that we've identified in our biosphere.

Now, I won't stand up here and tell you that in the United States they use 200 kilograms on legumes; they do not. It's more in the range of 5-10 on average, and that's true with Canada; actually it's more about 25 there. But you start going to places like China, and it's 200 kilograms, on average, according to the reports and talking with the fertilizer industries there, on, primarily, soybeans. So I just wanted to share with you that, yes,

there's a wide range; but every ton of urea that's produced puts an equivalent ton of nitrous oxide into the air, which is 312 times more warming than carbon. So it does have some value in the marketplace.

(I think I'll keep moving on. Looks like we've started over, or I have. We'll just keep going and possibly you can get me caught up.)

The why: The real reason of the why is because we really believe that instead of the world claiming, not even acknowledging that agriculture had a role to play in the carbon and the climate-change situation, we said, "They're overlooking an opportunity." The second thing that we wanted to acknowledge, in our reasons why, is that we wanted to be the first true agricultural methodology. There had been a couple of agricultural projects out there that really were done with methane flaring that had been done through a methodology through landfills. And we wanted to prove that, in production agriculture, we had a right to be at the table and that we could provide that it could be done.

The final reason that we wanted to do this was because we really believe – and this is probably the most important statement that I'm going to make, and that I expect many of you will challenge – but my hypothesis is, and in fact now I firmly believe, that, after having gone through the UN process and regardless of how you feel about it, I will share with you that there are some very fine and important points that we can use in that process to actually accomplish the many things that we've been talking about at this conference – which is the direct transfer of technology to the farmer. And I say that because of this: First of all, we as a technology provider – and in this system, the technology provider invests in the research – that research hopefully produces a technology that can be useful to an intended recipient; in this instance, the farmer. In this instance, it's the identification, purification, and then the formulation of the inoculant to be used specifically to certain legumes.

According to the CDM process, we must then provide that technology to farmers – not in the United States (we're prohibited from doing that), not to the developed worlds of Europe or Canada – according to the process and the expectations and the policy, we are compelled, if we want to be in this rigorous process, that it must go to an emerging economy that agrees that they will try to help and participate to reduce climate change, or greenhouse gases that contribute to climate change. So we are required to go to many of the countries that we've been talking about here and that many of the folks in attendance represent.

And the most important thing – we must show, down to the farmer, because it gets audited, who received the technology. And you must not be able to show that it makes business sense, but there is really the additionality comes from the carbon ton being available to us. So as a result, in our project, the farmers that we enroll will receive the inoculant free. They must not have used inoculants in the past. They will receive it free, and we, in turn, will be deeded back the carbon ton, which will probably be the equivalent of one-fifth to one-third of a ton, which they could never monetize anyway.

But the key point is: The technology must go to the farmer. They will not have to pay for it. And, in our instance, they receive all the savings that come from not having to buy fertilizer. They receive the savings that come from increased yields, because we find that between 20-40 percent increased yields can occur with the plants because they prefer bacteria and that biological nitrogen fixation to an exogenous source. Plus all of the other additional components with improved water, at least not leaching of nitrogen into the water, and nitrogen not being available to the weeds, so they get to receive savings if they have less pressure for weeds.

The final point is we then take that one-fifth or one-third of a ton; we aggregate those from the farmers in the process that are engaged in our project; we then can take a larger number, monetize those in the trading community, and then take that money and reinvest it back in research. So there's really no currency exchange between the farmer and us. The currency has now become a carbon ton.

Technology directly to those small farmholders that we were talking about; improved productivity; less of an environmental footprint; and hopefully a way to monetize the carbon that has been identified and be CER and monetize that to reinvest in research. I'll conclude very quickly by saying that we didn't start out

understanding that – we started out with the belief that agriculture should be at the table, that we have solutions to offer, which is the discussion that we're a part of today. And in that journey and in that story we found out that, in fact, it could create a new model for the redeployment of technology.

So I offer this small little story and our small segment of it, not because, in and of itself, it will become particularly large but instead to demonstrate to you an actual example so that it can create for you a creative thought process of how many other processes in agriculture might be able to engage and provide solutions in mitigating the impacts of climate change. Thank you.

Hans Herren

Thank you, Peg. So we can see that we can also bring the private sector into this operation; yes, that was very interesting, and we'll talk a bit more after the last two talk. So now Anita Idel, and she will now go above ground for a while and look at the animals and their impact; there was actually a big deal in the Ag Assessment to bring more animal talk into the CO_2 discussion.

Anita Idel – Mediation and Agrobiodiversity

Thank you, Hans, and I'm glad to be with you this afternoon. While I will be focusing mostly on environmental issues, please have in mind what we heard in the morning in the gender panel. I have in mind access, the question of access. It's always playing a huge role, and so please have it in mind.

And now it's up to me to bring the animals to the discussion. In doing so, I will be connecting what's usually looked at as rather disconnected. The soil, the growing plants above and in the soil, and the plant-eating animals – it's a whole-system entity. We can call it the "soil-plant-animal complex" because of its relationship, the obvious interdependencies and interactions of these partners.

We are living in times of climate change we heard about. We are becoming more and more aware of the detrimental effects of greenhouse gases for the climate, generated and provoked by humans and, at a relevant amount, man-made by agriculture. So agriculture is one of the most important drivers for climate change, and doing so mostly by animal production.

In addition, livestock is actually the fastest-growing sector in agriculture. FAO documented, in 2006, the detrimental impact livestock can have, named *Livestock's Long Shadow*. The externalization, of course, is connected with huge amounts of industrialized kept animals, regards especially the consumption of resources; the destruction of soils, mostly by erosion, is connected with the release of greenhouse gases; the consumption and pollution of water, loss of diversity. That means animal breeds and plant breeds and the wider biodiversity. We're facing a dangerous loss of pollinators, of bred and wild bees. And with the loss of genetic resources in animal production, we are facing the decrease of fossil-energy resources, because the industrialized way of producing is extremely energy-costly.

So no question – we have to reduce the amount of meat, of milk products. It's a must. While the world, the environment, and the climate profit on a higher rate of vegetarians, it is not the case that we should stop totally rearing animals. It depends on breeding goals and the way, how we are keeping our livestock.

To make the relationship, the obvious interdependencies and interactions of the partners of the soil-plant-animal complex more and better visible, I will be focusing on cattle. Why cattle? Cattle are ruminants, and no other livestock species is actually more under pressure as cattle are. For decades, oil production – for example, for our everyday and still-increasing car use – has been delivering huge amounts of greenhouse gases; amongst others, methane. Methane is 23 times more effective (that is, dangerous) for the climate than carbon dioxide is. But the methane that came with the production of fossil fuel for almost one century to the atmosphere has so far not been a topic in the public discussion. Instead, the cow – as cattle are perceived by a growing number of people as climate killers. Why could that happen? To understand this, we have to realize

what the common understanding of productivity in agriculture is. That means as much production as possible in a minimum of time. But we have to have a look at the output and the input, the externalization of cost, the input of resources.

So what does that mean for cows and for cattle? Feeding them intensively with human foodstuff – corn, soy and grain – leads to the consuming of huge amounts of resources – soil, water, energy – and the release of greenhouse gases, causing social and environmental cost. A sophisticated, system approach is needed, but research is mostly focusing on technical ways to reduce the damage caused by "livestock's long shadow." But real alternatives are often not yet enough of a scientific focus. So most of the data scientists are dealing with are coming from, and are based on, industrialized livestock-keeping systems. That's the case for cattle when fed every day with huge amounts of corn, soy, and grain.

To be protective for the climate, cattle need good grasslands. And good grasslands need cattle. And both need good grazing management. The good grazing management is key; otherwise, we have the problem of erosion and degradation connected with the release of greenhouse gases. [But] the good grazing system is rare. And – here is the dung beetle. The dung beetle's home is actually more on the Red List of endangered species than the grasslands. Soils are an important part, we heard, of the carbon cycle, with some two to three times the terrestrial biosphere carbons and plants; it's simple.

The key to sequestration in soils is good management of them. Grasslands cover some 70 percent of the global land area – the dry lands included. Because of the extensive nature of grasslands, they hold enormous potential to serve as one of the greatest terrestrial sinks to carbon.

Again, why cattle? Being ruminants, cattle can do what we can't – seems to be simple. We would die being fed on grass and hay. But cattle don't only survive this way, digesting grass and hay; they are producing milk and meat. But this phenomenal ability is sinking into oblivion since industrialized agriculture has been raising cattle on human foodstuff with corn, soy, and grain. Fed with grass and hay, cattle are not in competition with human food needs; fed with corn, soy, and grain, they are. Fed with corn, soy, and grain, the ecological footprint is so high that FAO called it "livestock's long shadow."

Freely adapted from Einstein, we can say, "If we do what we did, we would get what we got" – we heard it already in the opening session, you remember. It's just for that simple and complex perception that the International Assessment on Agricultural Knowledge, Science and Technology came to the conclusion that business as usual is no more an option. And that is especially the case for intensive animal production. "Livestock's long shadow" is what we get if we do what we did.

So the positive effect of grazing results from the effect that it has on grass plant species, composition, and litter accumulation. Given an even distribution of urine and dung, regarding climate change, its crucial management tool is to enhance the vigor of mature perennial grasses. This effect is decreased, and even stopped, by intensive fertilization, which promote short-rooted annual grass species instead of deeply rooted perennial ones.

The options for grassland-based milk and beef economy are to be explored for healthy animal products as well as for healthy animals and for the production of the climate, resources, and the environment – and last, not least, human health. There are opportunities and possibilities of regional grassland economies, old ones which should be revitalized and new ones which should be developed. Thank you.

Hans Herren

Thank you, Anita. So we can see that we have some defense of livestock. When it comes to the technical discussion, we can discuss this later, cattle in particular. So, Michael, give us a consumer perspective here, now that you've heard all what we said.

Michael Hansen – Senior staff scientist, Consumers Union

Yes, thank you. In some ways I have the most difficult task, because there is not much science involved in the consumer perspective. Besides representing Consumers Union, I also work for Consumers International or represent, sometimes, Consumers International – that's a global network of consumer organizations; there are 230 members in 113 countries.

And basically, what consumers can do is work at the policy level and then – besides changing laws in their own countries – work through their buying decisions. And, basically, in terms of globally, Consumers International did help with this whole process of the IAASTD and does support the vision of agriculture that is laid out there; that this ecologically rational, social, local, sustainable agriculture is actually the vision for the future, rather than the high-input, industrialized kinds of systems we've seen.

Hans this morning mentioned that FAO has seemed not to be paying attention to this as much, and it should be pointed out that a whole range of civil-society organizations, including Consumers International, sent a letter to FAO a couple of months ago, concerned that this high-level expert forum from FAO on How to Feed the World in 2050 that happened on Monday and Tuesday of this week was not going to focus as much on the vision of agriculture that came out of the IAASTD, and there was a response finally from FAO that said, "Yes, this is important – we will focus on this issue." So that's one of the policy things.

So as I said, besides the work at the policy level, at least in the United States, consumers are working through their buying decisions. And you see this in both what consumers are buying and in the increasing importance of a whole range of eco-labels that are coming out.

For example, to try to decrease the environmental footprint, there has been a huge increase in the United States in this movement toward buying or producing at the local level. We've seen, in the last 10 years, over a tenfold expansion in both the number of farmers' markets and CSAs (that's community-supported agriculture), where the consumers pay upfront for farmers; and this does focus on local, small agricultural systems. There's also been a huge increase in what's called the peri-urban agricultural movement, and that's people doing backyard gardens – there's tens of millions of those.

But even in the urban areas, in New York City, we're seeing people not only doing little bits of agriculture on their decks but on rooftops and in schoolyards. There is a movement throughout the United States to get school children in local schools to start growing, and this is happening in urban areas in New York and Chicago and San Francisco, where increasingly elementary and other schools are starting to grow some of their own food that will be used in their school cafeterias. It improves the quality of the food that is eaten, moves away from the junk food that is often served in schools, and it reconnects urban students with agriculture.

We also see that there has been this strong – they call it the "locavore movement," where people that try to eat as locally as possible, because they're concerned about the long distances through which foods are often transported. For example, a head of broccoli and cauliflower is transported on the average of 1500 miles in the United States from field to market. So there are folks that are concerned about that and want to decrease that level of movement because that does use energy.

So one other thing – we also heard that grains are increasingly being fed to livestock throughout the world and that, in fact, one-third of the grains are used for this purpose. That's where we see this increase in the United States, and I think elsewhere, in this whole movement toward grass-fed, and this is happening for sheep and cattle and other grazing animals.

And it turns out there's health reasons. Work has shown that these low-input, grass-fed cattle and other animals, when you feed them on grass – which is what they've evolved to eat – rather than grains, there are significantly lower levels of the saturated fatty acids, significantly higher levels of the conjugated linoleic acids [CLAs], which are considered beneficials, the omega-3 fatty acids and various fat-soluble antioxidants, the

carotenoids, the alpha-tocopherols. These all have a beneficial use. It's been demonstrated in the meat and milk of cows from these grass-fed systems. And a couple of years ago work in the Netherlands also demonstrated that pregnant women and nursing women that eat meat and dairy that come from these low-input systems versus conventional meat and dairy – you do see changes in their breast milk, in terms of the omega-3s and the higher CLAs, and the fat-soluble oxidants. These are all very healthy advantages. So you see that movement.

And of course there's also a much better environmental impact from these grass-fed systems. There is less grain consumption, and so there is a benefit there. That of course leads to, at least in the United States, we're having fights over some of the labeling. Since a lot of the consumers want some of these products, part of the only way, unless they know the farmer, is they have to rely on the labels. For example, the grass-fed label that the U.S. Department of Agriculture came out with, they initially were going to allow a grass-fed label to be used on meat that was produced with 80 percent grass through the diet – 75-80 percent of the diet being grass-fed.

The problem with that is, if you look at it in an industrial steer-type system, what you're doing is after the cattle are born, they live about the first 12 months of their life on pasture, and then you move them into a feedlot and you basically feed them grains to fatten them up – so that if you do it right, and that animal goes out at about 14 or 15 months, you can actually say that, technically, 75-80 percent of their lifespan was being on grass, so you could label that grass-fed. And of course the folks that commented on this – particularly Consumers Union, we did very extensive comments – said that a label such as this is highly misleading, that "grassfed" should functionally mean virtually 100 percent grass-fed. There's also the [American Grassfed Association] that is growing by leaps and bounds in the U.S.

And so there's this whole movement toward labels, but you really have to look. That's were one of the big fights are. We have the established labels – so labels like organic are very important. Organic has been growing at the rate of about 20 percent a year for the last 10-15 years. But some of these other labels, they're problematic. There's been fights over grass-fed. In the regulations for organic in the United States, for example, there have been fights over what's actually meant by "free-range," because people want to buy animals that have access to pasture or that have been free-range. But the way that the language has been allowed to be used on labels; for example, chickens can often be raised in coops, and if they just have access to the outdoors – sometimes that means, in a big, conventional chicken facility, you can literally have a balcony on one level or a little, tiny area where they can walk outside – those are allowed to be labeled as "free-range." Again, that is highly misleading.

There's also been a huge fight over the label, "raised without antibiotics." Many consumers actually want this. We've done surveys showing that 75-80 percent of people say that they're interested in labels such as "raised without antibiotics." And even the chicken industry realizes this. Tyson came out with, announced about a year and a half ago – they started putting on their chickens a "raised without antibiotics" label. It actually did very well in the marketplace. The only problem is – first, it was revealed that those animals were getting ionophores, which is an antimicrobial and is, technically, an antibiotic, and so that should not be allowed. So what happened is the USDA stepped backward, and they were allowed to say "raised without antibiotics," and then there was a clause that said "that have importance in human medicine." So that still permitted the use of ionophores, which is misleading. But then it got revealed that every single one of these eggs they were injecting with gentamicin just before hatching. That happens in the big battery cages. And technically they argued, "Well, they're raised without antibiotics. We only inject the eggs the day before they hatch." So those animals are indeed exposed to antibiotics, and to say that – you're putting that on a label, that it's "raised without antibiotics," the average consumer will think that that means that no antibiotics have been used during the production process. And so that "raised without antibiotics" label had to be removed from Tyson's. The Department of Agriculture right now is in the process of coming back and trying to figure out – they will be going through a process to figure out what the "raised without antibiotics" means, and they'll be going through a notice and comment period.

But the last of the fighting that his happening over these labels are because they're of importance to consumers because consumers want this information because, compared to 10 or 20 years ago, there's much more interest in how food is raised, what its environmental impact is. So consumers want to make ethical buying decisions, but they need the information to be able to do that.

And then there are these new labels coming up, such as "food miles," "our carbon footprint." Both of them are highly problematic in their ways; in a certain sense, the devil is in the details. But I guess I can say that on a positive side, what you do see from consumers is they are trying to move more toward, away from factory farming and toward more local, sustainable agriculture. But to do that in their buying decisions, unless they're buying at farmers markets or other things, they do have to rely on labels. And that's why it's so important that these labels be truthful and meaningful.

We have a whole program on eco-labels where we talk about the various aspects of what makes a good, meaningful label and how they should be implemented. And we are seeing this plethora of eco-labels that are happening on all sorts of food, and the market is responding to consumer demand there. So that's something that does need to be watchdogged.

Finally I'll say that there is some work at the global level in the consumer movement in terms of trying to figure out how to move some of the same kinds of things that are happening in the United States and elsewhere – how to basically localize agriculture more and more. What we're seeing, particularly in developing countries in Southeast Asia, is more reaching out between the consumer organizations there and local farmer movements and folks working on alternative agriculture projects, too, because they do realize that all these issues surrounding agriculture and climate change are important ones.

I think one other role that needs to happen is consumers have to be educated to some of the larger issues, and what some of the hardest things is going to be to figure out how to create an enabling policy environment for a lot of these changes to move forward and come to fruition.

Thank you.

Hans Herren

Thank you, Michael. I'm glad you mentioned this issue of education just at the end, because I was about to sort of ask. You know, the consumer has to be more active in policy; for the policy; they also need to be educated.

But maybe just a quick one before we go to the floor, to Michael and Anita: So is it so that – we heard this yesterday – that quality foods are only for the rich? If we were to do all this, is it going to end up to be – grass-fed beef, as far as I know, it's quite a bit more expensive than your feedlot beef, and so are some of the organic foods, more expensive – so how do you see that also everybody can afford this food? With the labels it is more expensive, so you are adding all kinds of cost here, which actually makes what people should be eating more expensive – which means it's being eaten less. So in a few sentences, how do you see a way out of this bind?

Michael Hansen

I think there are two ways out. In the developed countries, what we see in New York City is farmers' markets now are in all parts of the city, including parts of the Bronx, in the very poor areas, and they're actually allowing the use of food stamps to purchase these foods. And sometimes when you're buying from the farmer and you cut out the middlemen, the prices can be cheaper.

And another ironic thing is – in Malaysia, if you look at the average middle-class person there, they have to pay a certain amount for chicken. It turns out the free-range chicken costs three to four times as much, and

so they can't afford it. But when you go out to the indigenous communities, like the Orang Asli, it turns out what they're eating is the chickens that are running around, the free-range chickens that the middle class in Malaysia can't buy. I was actually out in some of these communities, eating this food, and I just thought it was ironic – because the folks that were coming there with me were telling us how middle-class people can't afford these kinds of chickens because they cost three to four times as much; whereas the very poor and indigenous people, that's what they're eating. So it doesn't always have to be the case that the poor have the access to the lowest-quality food.

Hans Herren

Okay, thank you. Anita, what about the grass-fed beef? Do you see this like more extensive production, which would end up to be more expensive, or is there a way to compensate for this? Maybe the corn subsidies going to grass-fed beef producers?

Anita Idel

I think the problem is competition, price competition. And so this grass-fed beef, in small amounts, have to compete with other products produced by externalization of costs, huge amounts. And so there, I think, is the biggest problem.

Hans Herren

Helena, I think you mentioned something about ecosystem services, right? I mean, is there a way there you see where one can actually rectify the imbalance in the system of all this externalization of environmental costs? Can be they be corrected with ecosystem services – so that the people, farmers that do bad things get sort of taxed in some ways and the good guys get some benefit? Would there be a way to sort out the issue of price?

Helena Paul

I think it's possible. I mean, there's the whole business of how you monitor ecosystem services. But if you take some of it on trust, it might be possible. I think one of the things that I worry about is – if these things get used as fodder for offsets and just feed that market; but if it's a genuine attempt to try and reward good practice, then I think probably that's a way forward, yes.

Hans Herren

Okay. Any questions from the floor, please. And maybe you can also mention to whom you want to address them? Go ahead.

Question

In general, any of the panelists could respond to this. What we've heard this afternoon is a lot of discussions about perceived or hypothesized carbon credit, offset, carbon sequestration – properties of a lot of different agricultural techniques and practices.

What is not so clear to me is, where are we going to look for scientifically based methodologies for both monitoring and verifying these values? I don't find much sort of information in the literature where there really are good, scientific studies that are being done and adopted by global institutions that could really give us some verification of this.

And furthermore, in addition to this is – for application in the developing world and for small farmers, you've got the issue of very high transaction costs to verify and monitor versus the implementer, who would be getting some kind of benefit. And I'm really interested in seeing where do we need to go, and what do we need to advocate, to get these kinds of protocols in place? They're not going to be accepted in a year or two, but hopefully after Copenhagen there would be some substantial investment in doing these procedures.

Hans Herren

Okay. We'll take these three questions that we answer; four.

Question

Thank you. This has been an excellent session, and I appreciate it very much and have been waiting for this session. And thank you for holding it.

And now I wish to make a small comment to the paper, great paper, great presentation by John Reganold. And that is simply to point out that it perhaps needs to be emphasized that in any given set of circumstances the capacity of the soil to sequester carbon is finite – it's limited. It can be augmented up to a given point, depending on the continuation of the particular mode of treatment. And finally, there is great difficulty in monitoring the carbon content of the soil continuously. And this is necessary if we're going to institute a system of rewards for carbon sequestration. The monitoring of it is a great, practical problem. Thank you.

Question

Thank you for the encouragement on management-intensive raising, which is my game. The animal sciences department, Ohio State University – I'm David Zartman. I teach a class on the topic of ecological farming. It's paraphrased "ecological farming" because we are harvesting sunshine, it's what it's about. I'm a little bit lonely in this domain in animal-sciences departments. And I'm wondering what you might say to encourage this avenue of agriculture in our traditional animal sciences departments and agricultural programs. And where might the grant money come from that would encourage professors to go this direction?

Question

Thank you. I would like to make perhaps – regarding the question people have been raising bordering the high costs attached to organic agricultural produce. One of the presenters presenting went back to some of the experience in Africa, whereby some of these crops produced locally have been found to be cheap – I'm talking about raised organically. So this issue of organic agricultural produce being costly, I think, has to be studied more pragmatically, rather than just being said casually.

Today our farm is propagating the PGS – the Participatory Guarantee System – trying to look at the ultimate goal of, perhaps, reducing the cost attached to certification, which increases cost of organic agricultural produce. I think these areas also have to be studied by socio-scientists. And again, vis-à-vis the cost that could been attached to health issues. Someone like me, I'm organic-agriculture person, and what drew me there was the health issue in my country, whereby people don't so much attach importance to standard. You know, people have problems. So I think all these areas, socio-economics will have to be encouraged to help us look deep into these so that we don't just make just straight point – "It doesn't work," "it works," or "it's costly," "it isn't costly." Several other hidden costs, I think, will have to be studied.

Hans Herren

Okay. I think we got the question. All right, so let's start with Anita – there was a question about the animal issue. We have about four minutes, so we can share the time among the panelists, please.

Anita Idel

I'll be short. There was a question of international organizations and the question about carbon sequestration and grazing management. So actually the FAO did a study and we will get it in the next weeks, and it's about all the literature which is available actually regarding grazing management.

And only one point regarding the lonely person we had. So it's even bad – I can talk about my country, Germany, and, well, most of the institutes are locked now; they are closed. There's no more grassland research.

Hans Herren

But what we need is an industry, right? I guess that maybe that's what people think in some places. Just before… Some people seem to be leaving. There's a number of books here and material also from the Ag Assessment, so before you walk out, see these, make sure that you pick up the material if you would like to. John.

John Reganold

Dr. Hillel brought up a great point, and I appreciate that. The sink for carbon sequestration in the soil is finite. Basically that one gigaton that we can sequester in the soil per year – let's say we actually can sequester that much, and that's at the high end – that basically equals about 5-15 percent of our fossil-fuel emissions. So what that does is it buys us some time. That's all it does. In other words, we still have to make other corrections. And maybe that buys us 50-60 years where we can continue to sequester the carbon in the soil.

However, irrespective of this climate-change debate, we should be doing this anyway. It's so important for soil productivity and increases our yields, our water-holding capacity. The benefits are incredible. So even if there were not climate change, I would be arguing the same points.

Hans Herren

Peg, do you have something, too, one quick one?

Peg Armstrong-Gustafson

Just to the question about measuring and monitoring – you're absolutely right. We must be very vigilant to make sure that we really can measure and monitor that we are reducing the greenhouse gases and that they are permanent.

In our instance of our specific project, the measuring and monitoring, and the indicator, is actually done by the plant. The nodules actually show you, if you cut them open, that – if there's an exogenous source, they're a pale gray to a white; and if they are actually fixing their own nitrogen, they're a pink to a bright pink.

And so we need to look for the simplest, yet the most effective way to measure and monitor, but we have to have rigor in our measuring and monitoring to make sure we really do what we intend to do by reducing greenhouse gases.

Hans Herren

Michael, the issue of organic and health – is that something where we need more numbers, I guess, right?

Michael Hansen

Well, actually there have been a number of large-scale studies that have been done recently, and I'm not talking about the one from the United Kingdom. There has been one that has come out of France and then also out of the Organic Center in the United States that does show the superiority of organic agriculture in terms of health for polyphenols and a few other compounds.

Very quickly, what I'd like to say about the high cost attached to organic agriculture – I was particularly talking about in the developed countries. When you start talking about Africa and Asia or Southeast Asia, it's a very different question there, because when you're talking about more traditional systems, there are local groups. There's all these ecological agricultural or Pelham groups throughout Africa who are doing a lot of good work. I know in Bangladesh, there is the Nayakrishi Andalon, the new agricultural movement; everything they do is organic, but they don't go through any certification process. It's just the superior quality of their stuff is recognized in the local marketplaces. So yes, you have to take into account, particularly when you're talking about developing countries, that this move towards more traditional foods and more ecologically rational foods doesn't necessarily have to cost more.

And I should also say, finally, that there is work showing that a lot of these traditional, supposedly lower-yielding, crops actually have higher nutrient density. People are realizing that there's actually an inverse correlation between yield and nutrient density. So sometimes the things that yield a little less actually have more nutrients in them when you look at them carefully compared to just the complete, high-yielding varieties.

Hans Herren

Thank you. Good point. So since, Helena, you had the first talk, so you have the last sentence.

Helena Paul

Very, very briefly, I think the main thing is that we have to realize that there must be policy changes to enable all these things to happen. If grassland research has practically ceased in universities, let's have it – let's have proper extension work. And don't let's imagine that we can trade our way out of all these issues. Because I do worry very much, particularly with the climate issue, that this is one of the things that's going on – that it's being reduced to a trading arena. We must be courageous and take policy decisions.

Hans Herren

Thank you, thank you, and to the panel, a great panel today. Thank you. And I think we just sort of kicked off the whole issue, so as we discuss what's going to happen next year, maybe we'll take some hints here on the unresolved, unanswered questions, that will carry forward. Thank you very much, and don't forget to pick up some material here.

Kenneth Quinn

I have no voice left; I've been worn out by everything here. But Hans has done an enormous amount of work to pull all this together; we began talking about it months ago. And I want to thank him for his ideas and his leadership and all his effort – and also for his wine. He had ideas about wine as well – organic wine – that we served Wednesday night at the dedicated of Norm's building. And thanks to all of you on the panel for doing this, it was wonderful. The World Food Prize is all about ideas and conversation and exchange and getting the facts and looking out, so you've added an awful lot to this. Thank you so much.