GMOs: Necessary in a Hot and Crowded World?

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Greg Dalton: Today on Climate One, we're biting into the controversy over GMOs, genetically modified organisms. Monsanto and other companies say GMOs are safe and can help feed a hot and crowded world in which more than a billion people are expected to move into urban and middle class lifestyles in the next 15 years. Food advocates say GMOs should be banned or labeled as a matter of public health and consumers' right to know.

Over the next hour, we will look at GMOs and related issues in our food system. Joining our live audience at the Commonwealth Club in San Francisco, we're pleased to have with us four guests on all sides of this lively debate. Robert Fraley is chief technology officer at Monsanto; Nate Johnson is food writer at Grist and author of All Natural: A Skeptic's Quest to Discover If the Natural Approach to Diet, Childbirth, Healing, and the Environment Really Keeps Us Healthier and Happier. There's an aerobic workout there, Nate.

Nathanael Johnson: It's a quest for the longest subtitle as well.

Greg Dalton: Longest subtitle ever. And Andrew Kimbrell, is founder and executive director for the Center for Food Safety. Jessica Lundberg is seed nursery manager at Lundberg Family Farms. Please welcome them to Climate One.

[Applause]

Greg Dalton: Robert Fraley, let's begin with you. You say that people have been genetically engineering foods since the beginning of time and yet GMOs and Monsanto evoke a real strong visceral reaction from people. Why do you think that is?

Robert Fraley: Let me start and just say thanks for the opportunity to be here this evening. It's always kind of special for me to come back to San Francisco and it's a special place for me and a lot of memories and really made a big impact on my career. So just as a little bit of background. I grew up in a farm in Central Illinois and always knew I wanted to be a scientist from the very beginning and did my schooling.

And then I had the opportunity to do my post-doc out at UCSF, just when the biotech industry was starting in the late 70s and early 80s and it gave me the tools and the skills to go to Monsanto and help develop the biotechnology techniques that have given rise to the GMO crops that we're going to talk about tonight, and I look forward to that discussion. So I've been doing this for about 32 years, and there's a lot of emotion and yet there's a lot of benefit. From a point of view of safety, the perspective as a scientist, perspective as a dad, I've got three children, safety for me is the most important thing to start with. I kind of drop my background as a scientist. I've watched and read and studied the evolution of crops, and man has been improving crops from the beginning of time, whether it's the tomato or the corn or all of our fresh fruits and vegetables, and I really think that they've done that almost randomly without really the insight of what's going on with the genes. And now with the tools we have, we can do what man has been doing for thousands of years really more

precisely and I think it's a powerful tool. It's not the only tool and if anything I'd be really clear on that, there's a whole set of tools that we're going to need to be able to meet the challenge of food production for the future.

Greg Dalton: Jessica Lundberg, your family is in food production. How do you think GMOs are different or similar to the kind of stewardship and hybridization and that sort of thing that's been going on in farming and agriculture for a very long time?

Jessica Lundberg: Well, like you mentioned, we've been selecting crops that suit our needs and our diets and our taste for the last 10,000 years - I think probably more actively in the last 2,000 to 3,000 years - and I think it has gotten more advanced since the 1700s, when we actually start developing breeding techniques and then we've seen quite a change. In the grand scheme, it's changed very quickly in the last 30 years, like you mentioned when you came into this with your career. In 30 years, we have been modifying these crops in a way that is different from what we've ever been able to do before. I think from the Monsanto website, modifying plants to the point that they're exhibiting traits that they wouldn't be able to exhibit in nature.

And I think that that's something that while it can be awesome from a science and technology perspective of what we can do, I think from a farming and a consumer perspective, that's not always something that we should be doing from both the food safety and an environmental impact. We should be thinking more in terms of the food system and what kind of a food system that we want to promote, especially when we talk about the topic tonight is really how are we going to feed people, and how are we going to have a healthy food system. And for us, for our family, we don't use GMOs. We don't support GMOs. In fact, we have been very outspoken as far as the need to label genetically modified organisms because we think that that's something that consumers should be able to choose. Because it is a new technology, it is something different and not to be afraid of the different, but we need to be aware of the difference and be able to make those choices. So that's really where we're coming from as farmers and as people who are selling products directly to the public.

Greg Dalton: We'll get into some of that food system issues in just a moment. Before we go to Nate Johnson, I want to play a collage we put together of some of the claims on both sides about franken-foods and about the good benefits of GMO. So let's listen to this piece that we put together about the voices on both sides.

Speaker 1: *Genetically modified organisms (GMOs) are touted as a boon to farmers and consumers.*

Speaker 2: *As a farmer, you believe. The farmer's role is to be the conduit for technology to exploit itself to feed the world.*

Speaker 3: *Biotechnology means a lot to me and my family. It takes much less worrying, and this way, we have a lot of peace.*

Speaker 1: *Detractors say GMOs are devil fruit.*

Speaker 4: *Hey, kid. Say hello to GMO - genetically modified organisms. You can eat them all day!*

Not only will mealtimes be extra delicious, they'll also contain oodles and oodles of insect genes and fish genes. Just think of all that extra yummy goodness.

Speaker 1: *People keep saying, "Oh, there are so many chemicals in my food. It's not even edible."*

Speaker 5: *I've been eating Monsanto products for years and it had no effects on my -- aaaahhh, why is everything covered with blood! Oh my, god!*

Speaker 1: *Supporters of GMO say they'll be necessary to end global hunger.*

Speaker 6: *By the year 2050, there will be nine billion people on earth who will want a higher standard of living and a need for the crops you provide.*

Speaker 7: *Hunger is one of the biggest problems in the world and drought in Africa is their number one problem.*

Speaker 1: *But food advocates see darker motivations.*

Speaker 8: *If we own the food, we will own life. So those naughty farmers better not save their seeds for next year's crop. If they do, we'll know.*

Greg Dalton: So lots of claims on both sides. Nate Johnson, tell us the story about how you came to write about this when you found what you found, hyperbole on both sides.

Nathanael Johnson: Well, I came to write about this somewhat unwillingly. I'd written this book looking critically at claims about what's natural and it would have fit very well to look at GMOs in that book. But it was such a technical issue, it was sort of so boring to me and I didn't want to deal with it and the claims were so, rhetoric was so high, I just sort of put it on the backburner. And then I came to work at Grist and my editor said, "I really want you to look into this." And so I figured I'd knock it out in a couple of weeks and it ended up taking me six months to kind of scratch the surface a little bit.

To save you the six months of reading those pieces, although they're still up there and I stand by them, I think that I came to a kind of starting from the perspective of thinking this is something I know that people aren't dying from GMOs. They've been around long enough. It's not something that I'm worried about in a cute way, but we're fiddling with tomatoes or corn in such way that maybe we're changing something that we don't know about it that will impact our nutrition years down the road in a way that we don't understand. And so as I look into the claims about health and about the environment, I have softened, I suppose, I find much and much less to be worried about in every case. And once you're not so worried about the health claims, it's sort of domino effects to some of these other claims as well.

Greg Dalton: And how did people react? How did some Grist readers, et cetera, react to your changing your mind or softening your views on GMOs?

Nathanael Johnson: Right. Well, first of all, I want to say that there were a lot of people who were really happy to see what I have done. I think there's an issue where kind of the straight ahead journalism happened 30 years ago when these things were first coming out, and people were assessing in the kind of objective way. And then there's been 15 years where most of the news that we've had about this is sort of from an advocacy position and so from one side or the other. So there were a lot of people who really are like, "Finally. I've been looking all over for a way to get into this and find out what the facts are. It's nice to have this." But, that being said, I had lots of people who are very upset with me. I had my face photoshopped and people yelling at me when I appeared on radio programs and that sort of thing. I was called all sorts of nasty names.

Greg Dalton: Nate Johnson is a food writer for Grist. Andrew Kimbrell, is there scientific evidence about human health from directly eating GMO foods?

Andrew Kimbrell: That is a difficult question to answer to as science in both sides. I think the burden should be on the industry to prove that the food is safe. If you're putting new products patented - and let me remind everybody here - that everything that Monsanto has put into these novel crops and that means novel DNA, that means viral DNA, that means bacterial DNA, that means antibiotic markers. All those things are patented is completely novel. They're never been in food before. So we can get rid of the beer and yeast argument. Our patent officers said they're completely novel and Monsanto has accepted those patents.

So we haven't really done the work. Monsanto hasn't done it, or government hasn't really done the work to say, "Are they safe?" And that seems to me is not the burden of the NGO or the other communities, that's the burden of if you're putting a new product on a market with novel, novel proteins that have never been before in that food will seem to me that it is your burden, not the burden of others to prove it safe, and that they have not done. Having said that, that's exactly the one question, if I can say, Greg. Because the real problem that we have here is that 85% of all the genetically-engineered crops out there and that Monsanto sells are genetically engineered with some bacterial DNA that makes them tolerate huge amounts of pesticide, herbicide spraying.

Last year, Monsanto made $14 billion selling its Roundup and the seeds that can tolerate this huge amount of Roundup. So this is about chemical companies selling chemicals. It's not about feeding the earth in 30 years, in 30 years of research, private and public. We have yet to see a GMO crop that has greater yield, that does anything about malnutrition. There's not a single commercialized crop that there's anything about a better taste, a lower cost. It has really been about finding a trick that they found in the early 80s - quite by chance actually - I think you probably told the story, Rob - that allows them to use a heck of a lot more of their chemicals.

For those that have fought for years, I know there's many people in the audience that are like this, to get the organic food production that pass and make sure that we have organic standards in their integrity. I know the Lundberg family is devoted to this. We have been able to save 30 million to 40 million pounds of pesticide each that would have been used, if not for organic. And here we come with the technology with whatever the green washing, they are selling chemicals about 140 million more pounds of Roundup, about in total about 150 more million pounds of chemicals each year being used on our crops so that actually dwarfs all that we've saved during organic.

So if you wonder why people that fight for organic or pretty pissed about this, that's why. Because we have spent all that time trying to save us, having less toxic, more sustainable culture and here's a technology 85% that you wouldn't even hear talking about it if it wasn't for that 85% that is specifically designed so that more toxic chemicals can be used. That's the right question I think.

Greg Dalton: Robert Fraley, is it about more application of herbicides and pesticides?

Robert Fraley: No. I think you have to take it back one step further. It's about the challenges that farmers face. So I grew up on farm, I could remember what my dad farming the challenges that occur when you have weeds, when you have insects that devouring your crops. Farmers around the world face tremendous challenges to grow the crops in the face of this kind of pest, and as kind of as I look into the future, those challenges are actually going to get worse because climate change, I think one of the big implications of climate change is small temperature changes are going to start to affect literally when insects hatch, when you have disease outbreaks, when weed seeds germinate. My view is we're going to need all of the tools that we can have. So the advances in breeding are important, the advances in biotech that have given farmers new tools to help control weeds and insects are critical. I think there's a lot of things that Jessica does in her practices that make an awful lot of sense, the crop rotation, the cover crops, microbes are a new tool that plays in this.

My view on this is, with the challenge that's in front of us, we need all the tools and I hope there's folks in this room who will help invent a few new ones. I mentioned earlier that I had a very special experience of being out here in San Francisco when the innovation around biotech really started. I mean the GMO industry really started here with the ability to create human insulin as a product that I took that knowledge to figure out how to create new crops with features. It's kind of interesting to me right now what's happening is another very powerful tool is being developed right here in the city, within a few blocks up here and that's the precision ag tools. That's the ability to use the advances and information technology to be even more precise in terms of how and where we farm and how we use crop chemicals and how we plant our seeds.

And so it's kind of interesting to have the conversation here tonight in really the part of the world that has really given us these two innovations which I think will look back at some point in time and say that the advances in biology and the advances in information technology are going to create a wonderful opportunity for us to not only meet the challenges for food production, but I think exceed it and ultimately give us the ability to be smart enough where we can start to take actually farmland out of production. I really believe we're pretty much are getting to that point and I think it's really exciting.

Greg Dalton: Rob Fraley is chief technology officer at Monsanto. Rob Fraley, there's another approach to this which is concerned that 95% of crop varieties have disappeared in the last century and it's the monoculture that makes crops vulnerable that if there is more diverse crops that that would achieve the resilience in the face of climate change and pests and other things, so that fertilizers and technology are one way, but another way is to have more diversity of seeds and more diversity of crops, and that's kind of the way it has been a nature in the past. I'd like to hear your response to that and then we'll get Jessica Lundberg on that.

Robert Fraley: I think those are all important considerations. So as a company, one of the things that I think has hurt us a lot is we've been so closely identified with GMOs that a lot of the other tools that we work in and collaborate with small companies, and startups here, and universities. Yesterday, I was at UC Davis talking to folks that we collaborate. Today, I spent some time with scientists from Berkeley. Everyone looks at us as GMOs and bug control and weed control traits, but I got here some of the cool things that we're developing.

So just outside of Davis is our second largest research site in the country where we do a lot of fresh fruits and vegetables. It's a combination of the biotech products, the breeding advances, the

information technology, there are so many tools that are being developed that I think will allow us along with smart policies and good regulations to achieve what we are want to achieve. I think there's a real common ground in terms of what we all want. I mean everybody wants food security. Everybody wants to improve the environment and I hope tonight we get a chance to not only talk about what our differences are, but what we can do and how we can achieve this.

Greg Dalton: Jessica Lundberg, let's get you on the diversity of types of crops and seeds, and how that is sort of nature's own way to have food resilience?

Jessica Lundberg: Sure. Well, I think that that is one of the big issues that we're talking about and with some of the potential in the technology I think that has caused the consolidation of some of our seed and genetic resources. One of the issues that we know gets brought up with this is farmers not being able to save their seed because of the patent technology, but then also the development of some of the terminator technologies so that it forces farmers to not be able to save their seed. But I also see it from the other side, the research side of it, that consolidation of seed and genetic resources. We do need more diversity. We need to have more tools, not less tools available, and that consolidation means that there is less for farmers to choose from, less to be selected from. And some of the technology that I think that is allowing the genetic modification can have tremendous benefit to our food systems.

Genetic-assisted or marker-assisted breeding can actually take a traditional breeding system and provide us with some of the same advancements that we see that are touted by GMOs in a very short amount of time to allow us to see that adaptation in crops through traditional breeding methods, and give public institutions the ability to move those out to farmers that have more diversity. Because like you say, it's going to take more resources, more diversity, more tools for us to be able to be successful as the climate changes, as the types of agricultural areas that we're producing in changes, as our water supply and those challenges that provide different scenarios that we're having to farm and to feed more people. It's going to take more, not less, so the consolidation issues and the lack of, or decrease in, genetic resources are disturbing in some of these technology developments.

Greg Dalton: And how about seed savers and open-source seeds or some things? Seed savers are not new but open-source seeds et cetera to try to get at a more diverse, I guess, ownership base of seeds. Andrew Kimbrell, do you have some thoughts on that?

Andrew Kimbrell: Yes. Actually, one of the things that we're doing, which is very exciting right now, is we're developing a program to unite the seed savers internationally. There are so many people now that see the loss of diversity. We have lost 90% of our fruit and vegetable diversity just in my lifetime. But there are seed savers out there that are preserving that, that are preserving that diversity but they don't have a way to talk to each other and exchange seeds because there are certain laws and certain things. So we're developing an international seed savers exchange, the first ever, and I'm very excited about that program because it'll let people talk to each other, no best practices and exchange seeds across the world so that's absolutely critical. It is critical for us here in the United States because we have food and security in the United States, even though we're a net export food nation.

And here, we have 53% of all our cropland devoted to corn and soy. I wish that was the worst news, most of that being genetically engineered and being pushed by the companies, of course, but I wish that was the worst news. That's not the worst news about it. The worst news is about 90% of that corn and soy is going into cars, and to cattle, and in animal factories. And another percentage is going to high fructose corn syrup and soy lecithin. It's only a tiny percentage is actually sweet corn

and anything that anybody eats. So for talking about hunger, what a terrible model we're setting here in the United States, over half of our agricultural land is used for these two monocultured crops, genetically-engineered, sprayed with these herbicides and they're not even being fed to people, they're being fed to cars and to cattle. That is not a model to feed the earth. That is not a model to feed the earth. That is not a model that's going to do anything about climate change and that's where we are.

I want to quickly mention one other thing which is that because we mentioned a couple of times. We need to be very careful not to get involved in outdated biology. In the early 80s, what was cutting edge biology? With you and Rob Porch at the Monsanto and it was cutting edge. It's not cutting edge anymore. We now know that the idea that a single trait, let's say drought resistance, let's say nitrogen fixation, let's say the ability to produce more of a certain vitamin, that is not linked to one piece of DNA, it's not a single gene, it's not even polygenetic. So it's not like I can go and play with a couple of genes. We now know that the cell is an ecosystem and relational, so it's the DNA, it's the RNA, it's the epigenetic markers, it's the relationship of all those dynamically to each other in the cellular environment. So one of the reasons why the only thing we have right now, 99% of all genetically-engineered crops, are herbicide tolerant or BT isn't just because Monsanto is greedy, it's because the biology doesn't allow it to happen.

We are in no position yet to even begin to understand if we're using this technology on how to have serious phenotypic trait alterations by simply manipulating a couple of genes. Just, for example, wheat has 80,000 genes, we have 20,000. So if you add the genes of four Nobel Prize winners, let's say, Watson and Crick, Borlaug and Berg, you wouldn't quite have the number of genes in one cell of wheat. So we are in a very complex, mysterious place right now and we don't want to play to the system we don't understand, so we're not. This idea of one gene, one trait is no biologist believes that anymore. It's a much more complex system and that's one of the major reasons why the biotech industry, including some of the better intentions in the early days of Monsanto are not able to do that and we just have these two traits, HT and BT, which aren’t doing much for anybody except the company is selling chemicals.

Greg Dalton: Andrew Kimbrell is founder and executive director of the Center for Food Safety. I'm Greg Dalton. Our other guests today here at Climate One are Robert Fraley is chief technology officer at Monsanto; and Jessica Lundberg from Lundberg Family Farms; and Nate Johnson from Grist. Robert Fraley, I want to go back to something that Andrew Kimbrell said about the amount of crops that go into cars and cattle. There's a recent cover story of National Geographic that had a plan for feeding the world going forward nine billion people. It called for less meat consumption and actually changing the thing that Andrew Kimbrell was just talking about. I'd like to know if you actually agree with him with the way that crops into cattle and cars is bad policy in America.

Robert Fraley: I don’t know if any of you had a chance to see it. This was my prop, the National Geographic, the May issue. I read it and I read it and reread it several times, because I loved it. I love the simplicity of the plan. I liked the fact that I think it really reflects what a common ground approach needs to be. There's so much of the dialog and discussion gets focused on the extremes that I think we forget that there's so much in the middle to achieve. So the beauty of this plan is we laid out five simple steps. The first thing it said was freeze agriculture's footprint. We are really close to being able to do that. The efficiency gains that are occurring in agriculture, not only in the United States but around the world are incredible, so I think that's possible.

The second thing is use the technology we have and use all the techniques. I mean, I believe we should be using organic, we should be using conventional, we should be using biotech, we should be using all our tools and raise yields. The third thing it says is really improve efficiency and that's

really the beauty I think with the precision ag tools. I mean we're literally at the point now where we can map every single field of crops. We can study them, we can make recommendations to farmers. I will just talking to sciences today from Berkeley who are doing a lot of this really exciting work in terms of studying the weather and the cool things that they are doing. I mean water is the big issue in agriculture and now having monitors and devices that you water really specifically and you don't over water the crop, I mean that's got to be so important in some of the things that you're doing. Obviously, this year in California, it really points to the importance of water and the other things that they recommended were change the diets. I mean we all know to your point and I think Andrew that a lot of what we raise as a grain goes in to feed animals and it's less efficient. Diet modification for health purposes and other reasons make sense.

And then the other piece that I thought was really cool was the emphasis on reduction of waste. It's been estimated that about 25% of the food that gets produced around the planet gets wasted, and that's a combination of everything from helping to support refrigeration in some countries, to portion control, to rethink packaging. The beauty of this was it laid it all out and that's what excites me. I think we can actually go one step further than what they put in here. If we do these things, by 2050, when population reaches 9.6 billion, I was doing the math on the way here and so close your ears Jessica but I'll be 97 years old by 2050. So I'm not talking about me but I'm talking about my three kids, that's what gets me up in the morning thinking about them. I think if we do these things, we'll produce more than enough food to feed the world but we'll produce enough food that we can really start to think about how we start taking land out of agriculture and production. For me, that's the win. That's really what's worth going after. So to answer your question --

Greg Dalton: And are you willing to --

Robert Fraley: I like it.

Greg Dalton: And are you willing to go to Iowa and say that? Is Monsanto, as a company, willing to go say, "We need to have less animal, change the Farm bill, change ag policy."

Robert Fraley: Absolutely. I mean I give this kind of talks all the time and I think growing up on a farm, my experience has been farmers are more focused on sustainability, more focused. I mean they are the ones who are working the land, they are the ones who are thinking about how they pass that land on to generations. I mean you guys wrestle with that all the time in terms of how do we preserve our environment. I mean the people who live on the land I think are the real conservationists.

Greg Dalton: Nate Johnson, I would like to get your thoughts on that plan on shifting diets away from animal protein which has a big carbon consequences, what we eat is perhaps more consequential than what we drive. Let's have your comment on that.

Nathanael Johnson: Yes. I mean I know Jonathan Foley who wrote that piece and I thought he did a great job with it.

Greg Dalton: He's the new director of the California Academy of Sciences and will be here at Climate One later this year. All right, go ahead.

Nathanael Johnson: Yes. I think the question is I think we all have pretty similar goals. My goal would be to have humans be able to feed themselves in a way that's equitable and sustainable and make the earth a more beautiful and delicious place in doing it. If we start from there and say, "Okay, what are the tools that we want to use to do this?" I don't think we'd go through and say,

"are GMOs necessary?" I think we'd go through all these things and we'd be looking at politics and food waste. And then we'd be looking at individual GMOs, and we'll be saying, "That disease-resistant banana is going to be really useful. I want that." This herbicide-resistant soy, I do think that there is some nuances that Andy glossed over that there has been some benefits of introducing the herbicide resistant soy and I think there absolutely are some problems with the consolidation that has resulted just for making money but I think that that's one of the things that we would say no, I don't know if we need this so much for our grand plan here.

Greg Dalton: Who really benefits from GMOs? Is it farmers? Is it consumers? Is it just the company, the fertilizer companies? Who benefits, Nate Johnson?

Nathanael Johnson: Well, there's economists that have done the research on this and whose captured the benefits of this new technology and the seed industries have gotten the lion share of the benefits, the people who made the innovations and farmers have gotten a big chunk of the benefits and then there's a -- consumers have seen a very small decrease in price but small enough that most of us wouldn't notice it.

Greg Dalton: We glossed over earlier that the human health impacts which I do want to come back to briefly. Nate Johnson, I learned from your writing of a report from the American Association for the Advancement of Science that said some things - I don't know if you can recite what that is - what they found about the human health impacts of GMOs.

Nathanael Johnson: Well I don't know exactly what they said but there's -- what I was really surprised to see when I went through and looked at this is if you look at all of the big scientific organizations, Advancement of Science, National Academies of Science, the European Union, nobody has proved that this is safe but nobody has proved that walking down the street is safe either. As close as any new technology can be proved safe, what you do is you go and you bring together the smartest heads in the room and you bring together many different fields, toxicologists and ecologists and plant biologists and you have them assess the science that is out there. When you do that, I guess there are some studies that you probably heard about because they are the ones that get reported on that suggest there's some health hazards. But you have to weigh that against the hundreds of independently funded studies that suggest just the opposite. When you do that, they really start to look pretty safe.

Greg Dalton: The actual AAAS actually looked at 25 years of research, 130 research projects and they said that science is quite clear, crop improvement by molecular techniques of biotechnology is safe. They said that was backed up by the World Health Organization, the American Medical Association, the National Academy of Sciences, et cetera. So Andrew Kimbrell, is there something of an ideology on the left that says, "Nuclear power is bad. GMOs are bad." Similarly, as there is on the right, when people are chided for saying, "I don't believe climate scientists. Climate change isn't happening." There's ideology towards science on both sides.

Andrew Kimbrell: Yes, except I mean in the late 80s, when we not only said in the 90s, we didn't say we also litigated saying, "If you keep using this amount of Roundup, Darwin is going to show up." We're talking about fourth grade science here, right? Darwin will just show up because the weeds are going to develop resistance to this, and I hate to say it, but several people at Monsanto, literally in court and elsewhere, said, "No, that ain't going to happen that glyphosate is a natural plant hormone and there will be no additional resistance." That happened. I was there.

Now we know that 50% of American farms in America do have weeds that are resistant to Roundup. And so right now, we have at USDA Dow Chemical saying it wants to sort of replace Monsanto with

its 2,4-D which was an element of Agent Orange, 2,4-D tolerant corn, soy, and cotton. That's up for approval right now. It could be approved as soon as September. And according to Dave Mortensen at Penn State, right now we have about 46 million pounds of 2,4-D which is a more toxic herbicide than the Roundup certainly. About 46 million pounds and they are saying it should be up to 350 more million pounds that will have to be used. But there's already a resistance to 2,4-D so Monsanto, not to be outdone, has now come back and this is where most of their research is, not in vegetables, this is where if you look at their field trials and you look at all of them.

They have now come back with Dicamba-resistant. Dicamba is a very toxic herbicide that volatilizes and can have non-targeted crops miles away that are destroyed by it, organic or conventional. So what we're seeing is a chemical arms race, after Roundup and where peak herbicides there's going to be new ones, that's why they're going back to 2,4-D and back to Dicamba. We're talking about 800 million or more extra pounds of this herbicides, many of them are more toxic than Roundup, 2,4-D and Dicamba, poured on our crops the next 10 to 15 years and has planned obsolescence, Greg. Because sooner or later, Darwin is going to show up again and we now have these weeds that are resistant to these unless you believe miraculously you can come up with another Roundup and I haven't heard anyone at Monsanto say they are.

Broad based and all the other aspects of that, we are going to have millions and millions and millions of acres of American cropland that are choked. Talk about feeling for the farmers and their problems. I mean there are already cotton farmers, they can't knock over that pigweed with a Combine, and you're going to be talking about a really semi-catastrophic situation with weeds that we don't know how to get rid of. That was planned obsolescence. That's a very, very, very bad plan for the future. Cover crops which is really absolutely important, crop rotation. You have seen good science coming out of Iowa. It says you can reduce up to 70% to 85% of weeds using the sustainable methods.

Going down this track, yes, it profits the chemical companies and it makes it easier for large farmers to apply the herbicides. But with this science, so it's not that we're against science, so it's not that we're against science, I'm talking about this is like fourth grade science that adaption was going to happen and the same thing with BT. We now have rootworm which is the big problem. Everybody knows it's important. Root is a billion dollar problem they call it. Well, guess what? When as organic gardeners, when we spray our BT, that doesn't cause that much resistance, but when that BT is in the plant 24/7, guess what? Darwin showed up. The rootworm has now and you're seeing this all over studies over the place, peer-reviewed studies, that say that the rootworm is now resistant to BT.

So not only is this bad because we have to spray all those pesticides again, but it means a very important tool for organic farming which is BT is being undermined. So we're not on scientific at all. I'm talking like fourth grade science is the other side of this and been denying this all the time that this isn't going to happen this terrible scenario, this domino spin of more and more and more herbicides. They were the ones that I think that didn't really look at adaption seriously and that is a serious, serious situation for American agriculture because we decided to go down this path, and there is another wonderful path. I'm going to say we have some agreement, by the way, I don't want to say that we don't. Food waste is an extraordinarily difficult problem and that's a problem that we all have to address built in to our commodity system. We also completely believe that we've got to reduce our animals. I don't think we should get industrial meat at all. I think it's a moral crime as well as an environmental problem, but we know that even just the water, 2,500 gallons for just one pound of beef. So I think we agree on a lot of those steps, but I think we disagree on the direction that biotechnology is going.

Greg Dalton: Andrew Kimbrell is founder and executive director --

Robert Fraley: And we agree on one more thing.

Greg Dalton: -- of the Center for Food Safety. I'd like to hear from Rob Fraley.

Robert Fraley: We agree on one more thing that Darwin is alive and well [Laughter]. That's an important thing to maybe start is the basis for common ground. So, as I said, farmers have been battling bugs and weeds from the beginning of time. They're going to continue to battle those weeds and bugs. I think our choice, as society, is do we arm farmers with newer tools and I absolutely believe that the role of science has got a big place here. So you're right, I mean weeds have become resistant.

Greg Dalton: But is Monsanto making it worse by accelerating this chemical arms race?

Robert Fraley: I don't think so at all. I mean we're working with new generation genes but the beauty of science is that we're in such a rich period where this is the heart of innovation and these new tools can help. They add to the tools and practices and can give us those opportunities to meet these challenges. New bug control traits, new weed control technologies, to meet the challenges of the future. And as I said earlier, these challenges aren't going to get better, they're going to get worse with climate change and we need to arm ourselves with all the tools that are possible, and that's what we believe in and all the practices. I mean there is clearly room for all these methods. We sell lots of seed for organic production. We sell lots of seed for conventional production. We sell biotechnology seeds around the world and farmers, I think, are really smart in terms of how they use these tools, how they integrate the tools, how they bring them in with their best practices, and as a scientist, I really believe in that.

Greg Dalton: Rob Fraley is chief technology officer at Monsanto. We're talking about GMOs and food production at Climate One. I'm Greg Dalton. Our other guests are Nate Johnson, a writer for Grist; Andrew Kimbrell from the Center for Food Safety; and Jessica Lundberg from Lundberg Family Farms. Nate Johnson, do you want to jump in there? We're going to talk about labeling and disclosure and then go to audience questions, so quick, Nate Johnson.

Nathanael Johnson: On this issue?

Greg Dalton: Yes.

Nathanael Johnson: Well, I think the point is that it's not the tool, it's how you use it. It's the social structure that you put around it. And so if the resistance was there before we had these GMOs, I think that the companies and the governments who structured this in such a way that there's an incentive to use these all the time, do bear the blame for this resistance that we're seeing, an acceleration of resistance. We get resistance no matter what, of course. But I think the people with the power to set the structures and set the incentives really have to help prevent this tragedy of the commons with the farmers so that everybody is not competing against each other to use the weed killer first before it becomes unusable.

Greg Dalton: Let's talk about labeling. There's a big move in states around the country in California and other state capitals there's been ballot initiatives. Rob Fraley, don't consumers have a right to know what's in their food and shouldn't the GMO labeling be a matter of transparency and consumers' right to know?

Robert Fraley: Yes, I absolutely believe in that. It always surprises a lot of people when they talk about the labeling discussion. The first place I started is that, as a company, we support voluntary labeling of these products and believe that that's really the right way to meet consumer demand and consumer choice and there's all kinds of voluntary labeling options. Some of the most popular ones are The Organic Standard. So when The Organic Standard was created over 20 years ago. It contained specifically the exemption of GMOs that are in organic production. So anything that's organic or certified as organic is GMO-free. Recently, the GMO-free foods have really taken off and I think the last time I looked on the website - I don't know if you know this - but I think there was over 20,000 foods that have now been labeled as GMO-free.

In fact, I was coming in from our Davis site and we stopped at a Safeway store about halfway through here and I was checking out the, as I always do, what's in the grocery store shelf and what's going on. And about half of the store was GMO-free and half of the store was conventional, and I think that's really the way it should work. The beauty of the voluntary labeling and why we support it so much, I really celebrate when Cheerios decides that they want to create a GMO-free brand or Whole Food says, "We are going to source ingredients and we're going to sell a premium product in that they think consumers will benefit."

Greg Dalton: Really?

Robert Fraley: Yes, absolutely.

Greg Dalton: You celebrated when Cheerios --

Robert Fraley: Yes, I actually. If you check my tweets and stuff, I've done that so.

Greg Dalton: Somebody get --

Robert Fraley: And the reason is because that's the way the system should work. The companies that are going to the trouble, like you do, to create an organic product, and sell it a premium to a consumer who wants to purchase it, that's the way the system should work.

Greg Dalton: Andrew Kimbrell, are voluntary disclosure enough or there's a need to be mandatory disclosure of GMO labeling?

Andrew Kimbrell: It needs to be mandatory disclosure. There's several problems with voluntary. One is you are telling people that have not changed anything they've done, that they have the burden of labeling, right? I haven't changed anything I'm doing. I've got my Andy's Tacos that you're saying. To let the consumer know, you got to put the labeling on. You got to do it. I'm putting something new in the market which is genetic-engineered. I don't have to do anything but you have done the same thing so it puts the burden on the wrong producer, you should put the burden on the producer who is putting the new proteins in the food, "Hey, you should label." You shouldn't tell somebody who hasn't changed whatever. For people to know, you're going to have to label. So that's one problem, putting the burden on the wrong producer who hasn't done anything different instead of putting the brand.

Greg Dalton: And there's cost to labeling and can give you --

Andrew Kimbrell: And there is cost. They're not huge but there is cost. The second thing is, as you pointed correctly out, they didn't say, "Okay, all Cheerios is now going to be." We have one honey nut, not the different kinds of honey nut so it's not consistent. So the consumer has no

knowledge, no consistency on knowing, "Hey, that is, that isn't. It's very catch-as-catch-can. It seems to me if a company is going to, as Monsanto and not just Monsanto, Dow and DuPont and many other companies, have gone to the patent office and said, "We want to patent because we're putting completely novel material, DNA that's going to produce novel proteins in foods and they get those patents." They do then label it and say, "Hey, this food is novel," or give up your patents because you can't have it both ways. You cannot put something novel in food and then not say there's nothing new here in the labeling.

One other quick thing which is they often say, "Well, we shouldn't label because it hasn't been proven dangerous." But if you look at all the labels that you see on your food, all the labels that you see on the back of your Cheerios, all of the food dyes. If you seen a radiation which is labeled. If you see from concentrated or not this. That's not there because if the FDA thinks it's dangerous. I actually disagree that you have to allow this but they think it's completely safe. It's just a change in the food, novel material in the food that they think the consumer has the right to know because it's not obvious visually looking at the food. So we don't say you should mandatory label GMOs because they are dangerous, if the danger is we shouldn't label them, we should take them off the market. But they are novel, they're patented novel material that consumers have the right to know that. And if it's not novel new material, I hope Monsanto companies will voluntary resend all of their patents and say, "They aren't new." The kind of both ways.

Greg Dalton: If you're just listening and if you're just joining us on the radio, we're talking about GMOs at the Commonwealth Club. I'm Greg Dalton. We are going to take a pause here to invite your participation at that microphone over there, where our producer Alyssa is. Then if you're on this side of the audience, please go through that door over there, and the line will form outside there. We invite you to join us with on one-part comment or question. I'll tell you the more succinct, the more likely it gets included on the radio show if it goes on. That's the first one we snip, and we'll try to get as many as we can in here in the next 18 minutes. And while we're doing that, I just want to give a shout out to the fantastic Climate One crew who is here today. I want to give them a big round of applause. They do a lot of fun things.

[Applause]

Greg Dalton: we're talking about GMOs at the Commonwealth Club. I'm Greg Dalton and my guests are Rob Fraley, chief technology officer at Monsanto; Nate Johnson a food writer for Grist; Andrew Kimbrell is an executive director of the Center for Food Safety; and Jessica Lundberg is a farmer with Lundberg Family Farms. Let's have our first audience question. Welcome.

Female Participant: Hi. For whoever who wants to tackle this question. With the monocultures that are being grown and the pesticides in the ground, what is the quality of the soil and with whatever the quality is, is it possible to go back to growing the way we used, or do we then become totally dependent on GMOs in that area, in that soil?

Greg Dalton: Jessica Lundberg, you're closest to this, would you tackle that one.

Jessica Lundberg: Well, I can't talk to the quality of the soil but when you say "can you go back?" of course, you can go back. I think if you look at some of the research that's been done by the Rodale Institute, they provide an excellent example of that. That was a family farm that had been heavily chemically intensive area in Pennsylvania, and they had a complete change of how the family farmed and they actually went organic, and they went to crop rotation and they have shown measurable changes in the health of the soil. So, of course, we can go back and I think that that's something that we need to be aware of as farming progresses is that it has to be a continuous

improvement process. We need to be constantly aware of the soil and its health and be effective of growing food on the environment.

Greg Dalton: Let's have our next question. Welcome.

Miguel Robles: Hi. My name is Miguel Robles. I'm from Mexico. In last year, the government tried to release permits to grow GMO corn in Mexico.
We have 59 races of corn in countless varieties and then relay all our food. We need several different kind of corn for each meal in different states. We have a huge gastronomy. So I wonder -- we believe that's going to happen what happened in India with the cotton seed that we're going to lose all our seeds if they allow Monsanto to grow GMO corn. Now, since October last year, there is a moratorium on any kind of pilot commercial or experimental GMO corn crop in Mexico. So what happened also is that in Yucatán they were growing soy and Monsanto was saying that the bees, because Yucatán is the sixth major exporter of honey to the European Union, and Monsanto was saying that there was no problem because these bees won't visit the soy flowers or the soy crops. What happened is that now they also banned GMO soy because they found out that was contaminated all the honey with soy. Why Monsanto lies once and again is my only question? Why they are lying all the time?

Greg Dalton: Rob Fraley?

[Laughter]

[Applause]

Robert Fraley: I was just in Mexico a few months ago, working and meeting with officials. There's a lot of interest in biotechnology in Mexico and a lot of interest. Mexico is one of the importers of corn. What we're working with the government on is a staged-introduction that commercial production of corn is in the northern part of Mexico, the center of origin is in the southern part and we're working. The commercial production is yellow corn largely for chicken and animal feed. Domestic corn that's used for tacos is white corn and so we're working with the government on how we get the best of both worlds. The preservation of the native races and the benefit to the farmers to use the technology to control some of the same challenges that farmers here in the U.S. have.

Greg Dalton: Andrew Kimbrell, I remember a big part of Food Inc. touched on this issue. What's your response to that?

Andrew Kimbrell: Well I mean, first of all, when we talked about soil before, and this is about climate, let's not forget the enormous role that soil plays in sequestering carbon - absolutely huge. When carbon is released, it mixes with the air, we get CO2. So it's absolutly essential if we're going to deal with climate change that we not think of our boundary with food is the supermarket, but remember, as the Lundberg Family said beautifully, that it is the soil. From 2006 to 2011 alone, about 1.25 million acres were cleared of forestation, of forests, for more soy and more corn.

Now, that means that all of that carbon was released into the atmosphere. We have to stop doing that. We have to understand that we cannot continue with this ludicrous push towards biofuels. We now know that first generation biofuels actually add 7% to greenhouse gases. It's a useless technology. Billions of dollars are going into this technology from the government and is destroying our soils. So we have to think of our soil and we're using our top soil at 13 times greater the level than we can replace it. That is a dead paradigm walking and that's a zombie paradigm on our soil and we need to make sure that that changes.

We know from Ignacio Chapela right here at Berkeley that genetically-engineered corn has contaminated heritage corn in Mexico, and it is a scandal that happened. It was a scandal that was covered up and it was a scandal that the Nature Magazine and others did not publish it. They did but they were forced to rescind it and I do think that it is important to note and the Miguel would know this, but many people around this audience notice that so many scientists, independent scientists, and I can give you a number of their names, including Ignacio Chapela, that we're also talking about Cornell scientists, Pennsylvania, any scientists out that can tell you, when they published an independent science review on contamination or another problem with genetically-engineered crops, they are hounded, they are persecuted, they are often denied tenure, so that is a serious issue we have of scientific with corporate pressure and scientific independence. It is something that I found very disturbing over the last many years, including what happened to Ignacio Chapela right here in Berkeley when he did talk about the contamination of Monsanto's corn with the Mexican corn.

Greg Dalton: let's have our next audience question.

Male Participant: This comes right from what you were just saying. I just wanted to point out that as I understand it, Genentech around here do not come up with genetically-engineered insulin, genetically-engineered insulin was from City of Hope Medical Center, two biochemists, 25 years ago. Just like that they did that and 25 years later, those two guys actually were awarded damages, and in fact, triple damages. So that's who we're dealing with. Thanks.

Andrew Kimbrell: That's a long story.

Greg Dalton: Okay. Thank you.

Andrew Kimbrell: That's correct but it's a very long story on how the particular -- anyway it's a long story.

Greg Dalton: Let's have our next question. Welcome to the Commonwealth Club.

Male Participant: Thank you. I have a question about a comment you made, sir. You said that if organics are labeled that they're guaranteed not to have GMOs.

Robert Fraley: That's the part I started.

Male Participant: And do you seriously believe that? Because we both know that with pollen drift you guys invade organic farms, sometimes thousands of miles away. In Mexico, a thousand miles away corn was infected. You can't control your own product. You can't guarantee that organic is organic. Do you have a comment?

Greg Dalton: Robert Fraley, response?

Robert Fraley: Yes. So let me respond to that. I actually had another point of common ground in that and alignment that I wanted to embellish. So the organic standard was actually developed to exclude the GMO technology and it was actually designed 20 years ago that as long as an organic farmer his intent was to grow an organic crop, if there was accidental drift from a neighbor's chemical pesticide or if there is accidental drift from pollen that did not interfere with the ability to market that crop as organic. In fact, just two years ago, the USDA did a large study to confirm the opportunity for coexistence.

And for me, one of the real strengths of U.S. agriculture is the ability for all of these practices to co-exist. When I grew up on the farm and we were growing field corn and everybody thinks corn is corn, there's white corn, there's yellow corn, there's field corn, there's blue corn, there's high-amylose corn, there's high-lysine corn, and the pollen is flowing for all of these products in agriculture but farmers talk. There is databases, there's maps and I think a real beauty of the U.S. agriculture system is how we can co-exist and use multiple practices.

People talk about monoculture. For me, the U.S. is a bread basket of agricultural production for the world and farmers have the flexibility. They are making a decision every year, whether they're going to grow a corn, whether they're going to grow a soybean, whether they're going to grow wheat, whether they're going to grow alfalfa, all of these crops that have the flexibility to meet market demands. That's a strength not a weakness of the U.S. system.

Greg Dalton: And there's lots of subsidies that distort that system but let's go to our next --

Robert Fraley: Just a quick note on this. I mean coexistence is often treated by Tom Vilsack - I know he was here - USDA secretary as a political question. It is not a political question, as the questioner points out. The idea of coexistence is a scientific question and it's a fairly easy one to ask but a very difficult one to answer, which is, are there any scientific way to control genetic contamination, pollution from genetically-engineered crops? And the answer to that right now is, except from massive geographic operation, growing a crop in Vermont not wanting to go to Montana, the answer that is no. We do not have any peer-reviewed scientific evidence saying this is the way we can ensure that this organic crop is not going to be contaminated.

So coexistence isn't a political sash, let's just get along. It's all the tools and toolbox. That's the tool that contaminates all the other tools in the toolbox, and the question is how can we stop that and the answer is we don't know. USDA doesn't even know how the rice contamination which is one small unit, this research plot in the south contaminated over a billion and half of conventional rice that couldn't be sold overseas to Japan or Europe. Farmers had a successful class action suit. If you ask the USDA today, how did that happened? How could one small little field lead to that massive contamination throughout the south and that huge loss for farmers, USDA will give you this answer because they have given it to me, "We don't know."

Greg Dalton: we have about seven minutes left. We're going to try to get through as many questions as possible, so quick questions, quick answers. Let's have the next question. Welcome to Climate One.

Male Participant: Great. Hopefully a fun one. Question about as each of you come from very deep industry perspective, I'd love to know some paradigm shifts that you may think of that might be coming be it for managing, you mentioned the dramatic amount of water use in both agricultural as well as with cattle. Do we see things as well as some of the contamination issues? Do you see coming up in the horizon for the billions of more people maybe large scale greenhouses that can create isolation? Do you think maybe commercially viable or unconventional sources of protein such as some of the cricket flower things and eating grasshoppers? In terms of speculation and paradigm shifts you might see coming here.

Greg Dalton: Who would like to take a brief tackle at that one? Rob Fraley?

Robert Fraley: I was tackling that. It was a great question on the paradigm shift because yesterday I was doing Bloomberg's Next Big Thing and I told you the talk before me was colonization

of Mars, so I don't know whether we want to produce protein on Mars and export it but that would be a pretty big seismic shift in terms of what I see. Now I really think a lot of it is going to be diet modification. I think it's going to be health driven and I think that's going to be a really important factor. You mentioned water, water is the big deal and it's going to take a lot of different approaches.

We do a lot of breeding for drought tolerance, and a lot of people don't think about it this way, but when I left my dad's farm in 1970, the average corn yields were 70 bushels an acre. Today, corn yields are 150, they've doubled. The rainfall is the same. So we actually been able to capture more and more of that water and produce a bushel of corn for half the water that we did 30 or 40 years ago. Those are important gains where there's biotech traits that are impacting drought, there's irrigation technologies, there's such an acute sensitization around water. It is, I think, really the issue. I mean we'll talk about water for the next 30, 40 years, often like we talk about energy and fuels today. It's just going to determine where and how we grow crops. And so for me, it's really top of mind.

Greg Dalton: Rob Fraley is a --

Robert Fraley: I couldn't get more on the water issue. I think we'll hit peak water before we hit peak oil. I would note that USDA when they analyzed Drought Gard, the Monsanto product, did say that it is no better than conventional varieties, so that's an environmental assessment so I want to just get that out.

Robert Fraley: Let's build on that because it was launched last year and Drought Gard is already been sold on a half million acres.

Andrew Kimbrell: I'm not saying they're selling it, I'm telling you what the environmental assessment said, which is that it is not better than conventional varieties, and that's in the environmental assessment, you know that.

Greg Dalton: Jessica Lundberg?

Jessica Lundberg: All I was going to say is that the corn yields that you made mention to that most of the improvements in that corn yield was actually through traditional breeding and through the genetic diversity through public institutions.

Greg Dalton: Let's have our next question.

Female Participant: Thank you. My question is for Nate Johnson, as well as Rob Fraley. Specifically, Nate Johnson, you declare yourself in a recent article on the Next Generation of Genetic Engineer, namely synthetic biology, as a skeptic of corporations, and your writing actually appears to be more skeptical of environmentalists more than the corporate-based science. In fact, you say that activists are obstructionists, Utopian and blocking solutions. I'm wondering if you can explain - and for both you and Rob - if you can explain where the burden of proof should be the public or the patent holders and why?

Greg Dalton: We got about two minutes to do that, so Nate Johnson.

Nathanael Johnson: Well, I absolutely am more skeptical of corporations than activists. I'm skeptical of anybody who is making money off of the claims that they're presenting to me. I'm interested in figuring out what can we do to move the ball forward, what can we do so that we don't

have the wool pulled over our eyes and so I'm interested in forcing people to show me the burden of proof.

Greg Dalton: Rob Fraley?

Robert Fraley: I think probably in my mind that one of the biggest issues with the intense focus that's occurred on GMOs is it's really a distraction from what the real challenge is. And here we are, we know that the world is going to reach 9.6 billion people. When you do the math, we have to produce twice as much food as we do today in the next 36 years. Where I put my attention on is, how in the heck are we going to do that? That's why we need the breeding tools, we need the biotech tools, we need the precision ag tools and that's where we should put our focus. I'm an optimist. I actually believe that we can do it. I think for me, that's the reason we should have the real discussion on what are the plans, what are the steps, how do we move this forward. We spent almost all of our time talking about history in the past and that's not going to solve the challenges for my kids.

Andrew Kimbrell: Well Michigan State --

Greg Dalton: Andrew Kimbrell?

Andrew Kimbrell: -- in 2006 has a major. Everyone please look at this great Michigan State study, Catherine Badgley and the group they did. It's a huge study and their answer is that organic not only can feed the world, it will feed the world with less land. This is University of Michigan, Catherine Badgley, and the FAO and the World Bank got together, as most of us know, in 2009 with the famous IAASTD report - IAASTD 2009, where they have a huge program for how to feed the world, they deal with this and with the climate in mind, I recommend everyone read it. They talk about a more holistic approach in agriculture and not growing commodities but growing food, concentrating on the 2.1 billion people, the poorest in the world who are living in rural areas, how to strengthen their farm communities and their farms. And at the end say that biotechnology offers at best a meagre opportunity. So there's people who have done the research, I recommend you look it up.

Greg Dalton: We have to end it there. That's the last word. Andrew Kimbrell is founder and executive director of the Center for Food Safety. We've also been listening to Jessica Lundberg from Lundberg Family Farms; Nate Johnson a writer for Grist; and Rob Fraley, chief technology officer at Monsanto. I'm Greg Dalton. Thank you for coming to the Commonwealth Club to Climate One today.

[Applause]

[END]