



## Futures in Biotech, 39: Food, Genetically Modified

### Leo Laporte

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### Marc Pelletier

This is Futures in Biotech, Episode 39: Food, Genetically Modified.

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[Music]

### Marc Pelletier

Welcome back to Futures in Biotech. I'm Marc Pelletier. Today's episode is on genetically modified foods.

Now as a biotechnologist or someone who considers life to be a substrate for engineering I have a hard time seeing the controversy that surrounds genetically modifying foods. It's not that plants are sentient organisms; we don't consider them living in the same way that we would consider a mammal such as a cat, dog, primate, or human really. So to tinker with them, to add or remove a gene or to add a series of genes is really only an extension to what farmers and agriculturalists have been doing for thousands of years. But as I said, this is a very narrow-minded view.

So, today I've invited Dr. Lisa Weasel, who is an Associate Professor of Biology at Portland State University in Oregon, and a member of Governor Ted Kulongoski's taskforce on developing public policy for bio-pharmaceutical crops in Oregon. She has a new book out entitled *Food Fray: Inside the Controversy over Genetically Modified Foods*. So she is extremely qualified to help us with the pros and cons of GM foods. This is before we send out the blade runners to go neutralize our plant replicants that are out there. Anyhow, on to the interview.

So tell me, you are trained as a molecular biologist, but...

### Dr. Lisa Weasel

I am.

### Marc Pelletier

You escaped the lab.

### Dr. Lisa Weasel

Well, I escaped the lab or maybe I'm augmenting what we can do in a lab, I think as a scientist who's trained to do these kinds of experiments, as the more socially and ethically relevant research has moved forward, I think it's really important for someone like me to be able to answer those questions. So, that's really how I got into this research looking at global ethical debates around biotechnology and genetically modified food in particular was from my training as a scientist and feeling compelled to be able to answer these questions when people ask, you know, is this a good thing, is this really going to do what we say it's going to do or we hope it's going to do, so.

### Marc Pelletier

You know, everybody looks at genetically modified foods as a scary thing, right?

**Dr. Lisa Weasel**

Mmh.

**Marc Pelletier**

But how scary is it and how important is it that we worry about this or not worry about it, I mean, just changing a gene, it happens all the time out in the field, tomatoes mutate in the sun.

**Dr. Lisa Weasel**

[4:16] Sure. And I think it's really hard to provide a blanket answer about genetically modified foods. Are they safe, do we need to be worried about them? I think that more than being worried about them we all need to be informed and proactive about this issue. Because genetically modified foods, like all biotechnology, has so many different applications and different uses. Some of them, if not properly regulated or tested, could have potential negative outcomes that people should be concerned about. But of course, there's a huge amount of potential there too. So, I think, that it's an issue that really needs attention, but because there is such a diversity of applications and ways that the science can be used it's hard to provide a blanket statement about that.

**Marc Pelletier**

Can you give us a little bit about the history, I mean, you know, recombinant DNA work really got started in the '80s and then sort of plant transgenics started appearing in I suppose the late '80s, early '90s, I actually created the first transgenics at the university I did my masters at, it was kind of fun. But...

**Dr. Lisa Weasel**

Wow, what organism was it?

**Marc Pelletier**

It was Arabidopsis, it was just the standard...

**Dr. Lisa Weasel**

Yes.

**Marc Pelletier**

... fruit fly of the plant world and I was trying to introduce some single transduction genes that modulate the response to salt stress, so that we could understand them and then port them back to plants that could benefit. And you could imagine, I suppose growing them in a salt marsh, where the...

**Dr. Lisa Weasel**

Right.

**Marc Pelletier**

... or as productive biomass production, producing land in the world. So, maybe you could give us a little bit of the history of when...

**Dr. Lisa Weasel**

Sure.

**Marc Pelletier**

... plant transgenics came along, which organism, which plants and why they did those experiments and maybe how they got into food?

**Dr. Lisa Weasel**

Sure, I think the history of transgenic organisms really starts in the 1970s with whole recombinant DNA revolution. The recognition that enzymes – restriction enzymes from bacteria could be used to cut and paste DNA in a way that allowed moving genes from one organism to another across species lines, but even within organisms. So, those tools of recombinant DNA that were discovered and developed in the 1970s really have had a tremendous application and allowed us to move DNA around in ways that's really unprecedented. And today it's very simple techniques – there was just an article in the news about people doing this kind of work in garages hoping to come across something that's patentable. And of course, in high schools we teach students how to move genes around all the time within bacteria, because that's become a very, very mainstream application. So, those were the initial tools, then the movement into plants, as you said, occurred – the research began in the 1980s with the idea that there could be this tremendous potential as there was in the pharmaceutical world to produce proteins in plants, that wouldn't normally be expressed there and might confer properties to those plants that wouldn't be able to be developed otherwise. So...

**Marc Pelletier**

What kind of proteins would that be? Are you talking, producing insulin in tobacco, so that we can just harvest tobacco and produce insulin?

**Dr. Lisa Weasel**

Well, right now there is actually a clinical trial, so move to the stages in the UK, where patients are undergoing clinical trials using insulin produced in safflower. That's a company called SemBiosys, that's come up with that technology being able to produce the insulin precursor, it's not actually the processed insulin itself. But it's the insulin precursor in safflower plants. That protein is then extracted, processed pharmaceutically to a form that is able to test on patients. So it's not yet commercially available, but it is very close. So, producing pharmaceuticals is one application, that's not where it started, it really started with more of the agricultural obviously tolerance to herbicides, that's the most prominent recombinant trait in plants right now. Resistance to herbicides like Glyphosate Roundups – Monsanto's Roundup, so, there's Roundup Ready plants, that's the majority of the commercially available biotech traits right now is the herbicide resistance. Then also, yes.

**Marc Pelletier**

May I ask you to unplug the power supply to your computer, you're getting some grounding issues?

**Dr. Lisa Weasel**

Okay.

**Marc Pelletier**

It's a Mac, right?

**Dr. Lisa Weasel**

It's a Mac, yeah.

**Marc Pelletier**

Sometimes.

**Dr. Lisa Weasel**

Is that better?

**Marc Pelletier**

It is?

**Dr. Lisa Weasel**

Shall I unplug it?

**Marc Pelletier**

Yeah. Unplug the – just the magnetic plug.

**Dr. Lisa Weasel**

Okay. Yeah. Is that better?

**Marc Pelletier**

Yeah. For the moment, when your battery goes low, we'll put it back on.

**Dr. Lisa Weasel**

Okay. Yeah. I'll watch that.

**Marc Pelletier**

So, you were saying that pesticides – is it – the companies that are just trying to reduce the costs of having to put pesticides or what is the determining factor here? I mean, economics is often a determining factor, but is there long-term reasons to go with a plant that can protect itself, rather than a pesticide?

**Dr. Lisa Weasel**

[9:33] Well, obviously if the plant is producing its own pesticide it reduces the external application of pesticides. But then there's some other issues, as recent research has found if the plant produces that pesticide, whereas it might degrade if it's exposed to sunlight when the plant is producing it in its roots and all of its stems and the entire plant, after harvest, the plant waste, the debris as well as pollen can get into the streams and then you've got that pesticide in the stream. So, while I think on the surface it is a very appealing idea and there's probably potential there, we really need to be looking at a more systemic approach to looking at environmental impacts, you know, potentially healthy impacts, because plants are very complex.

Plants are much more complex than bacteria and whereas most of the original recombinant DNA research originated in bacteria, they're much easier to control, to predict, they're simpler systems, but plants are much more complex. So, changing one aspect of a plant, programming it to produce huge amounts of a very large protein that's a pesticide might have other metabolic effects within the plant and then having that pesticide distributed throughout the environment in the ways that can potentially happen, also has some concern. So, I think that it's really important to take a very systemic ecological look at the application of particularly with pesticide properties.

**Marc Pelletier**

Would it be more important to look at the crops that are food or not food to evaluate – how do you go about starting this evaluation? I mean are you worried about jumping genes like an agrobacterium grabbing the gene and carrying it over to a different organism or are you more worried about the...

**Dr. Lisa Weasel**

Yeah, that could happen.

**Marc Pelletier**

... toxicity of the plant, which might be expressing some kind of now secondary metabolite making a poison. Turning on some...

**Dr. Lisa Weasel**

That's right.

**Marc Pelletier**

... historical toxin that the, you know plant used to have?

**Dr. Lisa Weasel**

Yeah, it could be a toxin; it could be even something as simple as increasing lignin content. Lignin is the structural, like woody type matter in a plant that gives it its rigidity and also defends it against pests. So, increased lignin content could, you know, make the plant tougher, but then it also makes it more difficult to use in terms of bio-fuel, those kinds of issues. So, those kind of internal metabolic conditions could occur in plants.

With a pesticide though it's really the issue, if you've got a plant that's producing a pesticide, you kind of want to know where that plant material is going after you harvest it, where that pollen is blowing, if it's blowing into streams where caddis fly larvae can feed on it and die that's sort of an outcome that has recently been identified that could be a potential problem. Because that – then that in turn will affect the entire aquatic ecosystem, since caddis fly larvae are food for amphibians and fish. So, that's kind of...

**Marc Pelletier**

I never thought of that...

**Dr. Lisa Weasel**

Yeah.

**Marc Pelletier**

I thought it was a no-brainer, you're eliminating billions of barrels of pesticide across the prairies, but then again all the essential critters.

**Dr. Lisa Weasel**

Yeah, I think you have to look at all sides of it and that's where it's important as we push ahead with our enthusiasm and the real true power of these kinds of technologies I think there is growing concern to take a big picture view on some these things. There's huge potential I think if we can get more open source biotechnology and more access to the public sector and especially in developing countries using some biotechnology. Not necessarily focused only on transgenics and GM traits, I think that the debate has gotten very polarized and very focused just on this issue of transgenics, but there is a huge realm of biotechnologies and ways to use genetics towards agricultural improvement and sustainable food security as well.

**Marc Pelletier**

I am thinking that some of those issues, for example the plant pollen that goes out and caddis flies eating the pollen, that could happen if you decided to do a monoculture of a plant that the caddis flies shouldn't be eating, right? And that – is that necessarily – should we raise that, if there are issues being raised for transgenic plants, should it be raised for all crops now, and should we be concerned?

**Dr. Lisa Weasel**

[14:08] I think that, you know, ecosystems have evolved so that – in this case what you're doing is you're taking a protein that's intentionally – we know it's toxic to lepidopteran larvae, to insects – certain class of insects' larvae, and caddis flies happen to be in that same group. So that it would be the same thing as if we took that pesticide and just sprayed it into the stream, you know, it's having an effect on it, that its target organism or one of its target organism. It's an unintentional target. So it's a little bit different than saying just any plants – any pollen that blows into the stream the caddis fly shouldn't be eating, most organisms have evolved avoidance strategies for food that they shouldn't be eating. And I think the issue there is that really, you're putting a pesticide, putting a protein that has a very specific intentional effect so...

**Marc Pelletier**

I suppose genetic engineers don't pick proteins that are, you know, smile, they go right after the pest.

### **Dr. Lisa Weasel**

Right. The goal is to kill off the pest in the crop plant and the caddis fly doesn't – it just happens to be a sort of innocent bystander that is also susceptible. So I think, that's where the problem comes in, but I'm sure that there are solutions to that as well as long as from the start that's looked at. It's a shame if we're finding these things out once all of these crops are out there. I think it's important that that there is enough sort of upfront approach to the bigger picture.

### **Marc Pelletier**

I'd like to take a minute to thank audible.com for sponsoring Futures in Biotech. They have over 51,000 titles now. It's an absolutely great way to catch up on literature when you're commuting or you're traveling. I always listen to audio books while I'm traveling.

Now the book I've picked for the week is a fairly controversial book, it was written 150 years ago by Charles Darwin, it's *On the Origin of Species*, it's narrated by Richard Dawkins. Regardless of whether your understanding of life is based on faith or on science, this is a really interesting book. So here is a clip.

### **Richard Dawkins**

... plant to the mistletoe, and that these had been produced perfect as we now see them; but this assumption seems to me to be no explanation, for it leaves the case of the co-adaptations of organic beings to each other and to their physical conditions of life, untouched and unexplained.

It is, therefore, of the highest importance to gain a clear insight into the means of modification and co-adaptation. At the commencement of my observations it seemed to me probable that a careful study of domesticated animals and of cultivated plants would offer the best chance of making out this obscure problem. Nor have I been disappointed; in this and in all other perplexing cases I have invariably found that our knowledge, imperfect though it be, of variation under domestication, afforded the best and safest clue. I may venture to express my conviction of the high value of such studies, although they have been very commonly neglected by naturalists.

From these considerations, I shall devote the first chapter of this Abstract to Variation under Domestication. We shall thus see that a large amount of hereditary modification is at least possible, and, what is equally or more important, we shall see how great is the power of man in accumulating by his selection successive slight variations. I will then pass on to the variability of species in a state of nature; but I shall, unfortunately, be compelled to treat this subject far too briefly, as it can be treated properly only by giving long catalogues of facts. We shall, however, be enabled to discuss what circumstances are most favorable to variation.

In the next chapter, the struggle for existence amongst all organic beings throughout the world, which inevitably follows from their high geometrical powers of increase, will be treated of. This is the doctrine of Malthus, applied to the whole animal and vegetable kingdoms. As many more individuals of each species are born than can possibly survive; and as, consequently, there is a frequently recurring struggle for existence, it follows that any being, if it vary however slightly in any manner profitable to itself, under the complex and sometimes varying conditions of life, will have a better chance of surviving, and thus be naturally selected. From the strong principle of inheritance, any selected variety will tend to propagate its new and modified form.

Although much remains obscure, and will long remain obscure, I can entertain no doubt, after the most deliberate study and dispassionate judgment of which I am capable, that the view which most naturalists entertain, and which I formerly entertained – namely, that each species has been independently created – is erroneous. I am fully convinced that species are not immutable; but that those belonging to what are called the same genera are lineal descendants of some other and generally extinct species, in the same manner as the acknowledged varieties of any one species are the descendants of that species. Furthermore, I am convinced that Natural Selection has been the main but not exclusive means of modification.

**Marc Pelletier**

So if you'd like a free copy of *On the Origin of Species* by Charles Darwin, you can sign up for the AudibleListener Gold Monthly plan, which includes a free audio book. It's a 14-day free trial, if you like it, you continue with the subscription, and if you don't well you still get keep the free book. So you go to [audible.com/biotech](http://audible.com/biotech) to get the free book. Now, back to the interview.

Are these decisions being made properly? Is the infrastructure there right now to make sure the, you know, there is no dramatic environmental changes as result?

**Dr. Lisa Weasel**

Yeah.

**Marc Pelletier**

Are we moving forward correctly or is there – are people just doing it, is this the Wild West of farming right now?

**Dr. Lisa Weasel**

[20:26] I think one of the issues is that our regulatory systems the USDA, the EPA, the FDA which regulates biotech to some extent, all of those regulatory systems and policies were put in place at a time before we ever foresaw that we would, for example, be intentionally producing pharmaceuticals in food crops. So all of our policies around testing and food safety and regulation never imagined that, you know, if drugs got into food, pharmaceuticals got into food, it would be some kind of accident, it wasn't something that we would intentionally be doing. And the same thing with pesticides, that pesticides would be something that would be applied from the outside and wouldn't be something engineered into the food itself.

So that our regulatory agencies have really had to adjust and juggle this issue at a time of great deregulation. I think we're seeing the impacts of that on many different levels reverberating throughout society and you know with the recent inauguration we're seeing a time of change and increased scrutiny to government regulation and the need for some government oversight. And so I think that that has been the case as well with biotechnology through, you know, various means, obviously the enthusiasm over the potential of the science and this technology and then also the significant private interest effect that has been pretty lopsided in terms of private versus public development of these technologies, has lead to a regulatory climate that probably isn't addressing all of the needs.

And the USDA themselves, the Inspector General from the USDA has issued a report saying we need better oversight now testing foreign foods coming – imported foods for the potential that they're produced using biotechnologies that aren't approved in this country. And the government accountability office has also issued some warning signs that our regulatory system for transgenic plants isn't as well coordinated as it needs to be. And that there have been these accidental contaminations that slipped through the regulatory system.

**Marc Pelletier**

I think it will be very, very hard to control. I mean, if you think about it the Great Lakes are full of Goby, right, from the Black Sea...

**Dr. Lisa Weasel**

Right. yeah.

**Marc Pelletier**

The world is one small beaker.

**Dr. Lisa Weasel**

Yep. Yeah, I mean, we're really seeing that with food. I think this is a new era in food when we see like the melamine contamination. People have figured out how to get around intentionally or

unintentionally, these kinds of issues. So it is definitely a new era and probably requires us to spend some time thinking about new tools and new technologies to help secure our food safety and our environmental sustainability. And there is the potential, I think for that.

**Marc Pelletier**

Just in pesticides alone, I mean, you know, I think the world has the capacity to produce enough food for this population plus 20%.

**Dr. Lisa Weasel**

Right, yeah. That's right.

**Marc Pelletier**

I think our distribution and that's another issue where genetically modified foods can potentially help by preventing foods from spoiling during travel that normally couldn't, maybe can enhance our efficacy of bringing food to the world. But I think in the long term sustainability isn't it, there's so much promise with respect to being able to limit the amount of chemical pesticides?

**Dr. Lisa Weasel**

You know, I think we're going to be driven away from heavy chemical use just because in the developing world where food is needed the most, they really can't afford those kind of inputs. So, I think that we are going to be forced to find alternatives and that biotechnology and again not just transgenic single gene moving from one organism to another but the whole range of biotechnologies of harnessing microorganisms to help fix nitrogen, to help mobilize potassium these kinds of things. There is a lot of potential there that tends to get overlooked sometimes I think.

**Marc Pelletier**

What's your favorite application, where you think is the most promising?

**Dr. Lisa Weasel**

[24:23] Yeah. I think that some of the viral resistance GM work is potentially very important because viruses are simpler to understand. The issue of genetically modified papaya, modified to resist the ringspot virus is an interesting example, because when people expressed concern, well, GM food it has these foreign genes in it. So, when the Papaya plant is infected by the ringspot virus, there's actually quite a lot of foreign DNA in there, right? Because it's the ringspot viral DNA, it's not – that's not part of any Papaya plant. So you've got all this viral DNA. The resistant variety that's genetically modified, it's got a DNA sequence put into the papaya plant, it's a piece of the virus itself. So, the plant produces that RNA transcript, doesn't even translate it into a protein and that prevents infection with the ringspot virus. So, that's an interesting case where the GM variety has less foreign DNA in it than the virally infected non-transgenic papaya.

**Marc Pelletier**

Not to mention the – we talked about secondary metabolism, so plants' primary metabolism of course is the housekeeping biology that a plant has, but the secondary is where you have a response to herbivory, right?

**Dr. Lisa Weasel**

Right.

**Marc Pelletier**

Or an animal starts nibbling on the plant, and the plant starts to produce toxins. So I suppose if there is a viral infection or some insects that are feeding on the plant, the plant's starting to make all kind of compounds, good and bad, I suppose sometimes plants will taste better once they've been nibbled on.

**Dr. Lisa Weasel**

Yeah. That's true. But I think the biggest thing there is just in terms of food use too. You know, virally infected plants produce much less edible food and ringspot infected papayas, you know, they can't really be sold or...

**Marc Pelletier**

Right.

**Dr. Lisa Weasel**

They're not as useful as food. So I think that because viruses are simpler, smaller, easier to understand and have less variables, there is still a lot of variables – I don't want any virologists to jump on me and say – but I think that that some of this viral resistance work in terms of genetic modification could be a very fruitful area. As long as, of course again appropriate safety and regulatory controls need to be in place and looking at the potential adverse effects that might come from inserting genes in random locations. But all of those things – our science is to the point where those things can be controlled if enough time and energy is devoted to it.

**Marc Pelletier**

Well, the technologies for genomics and, you know, there was this lag, I suppose when recombinant DNA came out, we'd get a Ph.D. thesis out of just sequencing a gene.

**Dr. Lisa Weasel**

Oh, I know. Yes.

**Marc Pelletier**

And then there was this plateau where the technology hadn't caught up and we had – geneticists were isolating new genes, but not able to really determine function, but nowadays especially with extreme sequencing – you can sequence a genome of a bacterium in an afternoon.

**Dr. Lisa Weasel**

Right.

**Marc Pelletier**

And within a couple of days, I suppose with enough resources perhaps from some of the Monsanto or whatnot, those kind of resources you could do a genome of a new crop in perhaps a month and then study gene profiling and effects of that single. And get some really accurate feedback on that organism I suppose, but not within its environment, but you could find out...

**Dr. Lisa Weasel**

Absolutely. Yeah. And marker-assisted breeding – so marker-assisted selection where you can use genomics, quantitative trait loci and looking at markers in the chromosome that correlate with traits that you like, can really speed up conventional agriculture, as well conventional breeding where you're taking two plants that have traits that you want and you want to get those traits together, a certain trait into a plant that you want. And that's especially important for multi-genic traits, traits that you can't just find a single pesticidal protein. And the kinds of environmental stresses that we're seeing, drought tolerance, tolerance to salt, salinity, those kinds of things can often have more than one gene be involved. So, marker-assisted breeding is a way of really grasping our knowledge of looking at the entire genome of a plant as you're moving genes around in big pieces on chromosomes.

**Marc Pelletier**

[29:25] Now, we're slowly getting into the area of genetically modified foods, right, not just crops that might be used as materials I suppose or the pesticide use of genetically modified food. With respect to food; one, what is the biggest concern and what would be the biggest benefit?

**Dr. Lisa Weasel**

Well, I think one of the problems is perhaps, you know, rushing products to market without looking at being able to look at long-term impacts; food crops have a huge environmental impact as well, which feeds back to human health in some level. So, and I think that one of the issues that has been consistently pointed out in terms of regulation is that there aren't many independent safety tests done. The companies are doing their own safety testing, submitting that to the government and the government is then approving these generically modified crops. And because now the predominant traits, 75% to 80% of GM food out there is herbicide tolerant and the remainder, 25%, expresses the BT pesticide. And these have been around for a while.

And as a scientist it is not that – I don't find it that stringent an argument to say we have been eating it for all this time and nothing has happened; that's not a very scientific argument. But you know there is some truth to that, these have also been largely in soy, corn, cotton that comes into the food system in terms of cottonseed and canola. But they've largely been food products for animal feed. Or in highly, highly processed form in human food, you know, you hear that two thirds of the products in the grocery store contain genetically modified food, but not really in a very raw form, as some byproduct of corn or soy.

So, in terms of safety as newer products come on the markets it feels a bit like we find this complacency where we say, oh, yeah GM food is safe, we haven't seen any health problems come up. But as I mentioned in the beginning of the interview, genetic modification of foods can encompass a huge range of different kinds of proteins being put in. So, in terms of concerns, there's concerns – environmental concerns need to be addressed and then of course human health concerns as well.

**Marc Pelletier**

Such as – what would be the primary concern for a tomato that has been modified for – I don't know for what reason for making the stem fall off easier when it's harvested?

**Dr. Lisa Weasel**

Sure. Well, I think any time that you put protein from a non-food organism, an organism that we don't – we haven't – don't have a history of ingesting into a food crop then there is potential for allergenicity to take place, it's a protein that if it doesn't break down, digest fully in the digestive tract, then the body could mount an immune response to it. So obviously allergenicity, shifting the plants metabolism, so that perhaps there's elevated levels of natural toxins where that gene integrates into the plant genome – if it integrates into a gene that disrupts the plant's metabolism. So, I think some of those issues and then obviously of course the protein of interest being put into the food as we look towards biopharmaceutical crops where we're putting drug compounds into food crops. The implications are obvious, you know, drugs have intended human metabolic impact, that's why they are pharmaceuticals.

**Marc Pelletier**

Have we been able to use GM foods to bring certain quality foods to areas that haven't been able to get those foods? I am kind of thinking rice, and I don't know the story very well, golden rice or is it....

**Dr. Lisa Weasel**

Okay. So the story of golden rice is – they were able to engineer beta-carotene, enzymes to produce beta-carotene into rice in a way that it would be expressed in the starchy part of rice, the endosperm, where it's not normally produced. So, even though the rice plant expresses beta-carotene, the rice kernel that people eat when white rice is polished to preserve it for in storage, so it doesn't rot and the oil doesn't become rancid, that part does not express beta-carotene. So, they were able to engineer the enzymatic machinery into that part of the rice to produce beta-carotene, that vitamin A precursor. And the idea was that since there's such significant consumption of rice in the world especially in areas where vitamin A deficiency is such a big problem that by providing rice that has beta-carotene, that vitamin A precursor, in there, vitamin A

deficiency could be treated in that way. So golden rice got quite a lot of attention and I cover this story in my book about how it was developed. But it is still not commercially available.

**Marc Pelletier**

Really?

**Dr. Lisa Weasel**

[34:38] And there is a few reasons for that. There's two main reasons, well, I guess there's three main reasons. First reason is there have been a lot of regulatory and patent intellectual property hurdles along the way, because a lot of these technologies that were used to make golden rice are patented and golden rice of course had a humanitarian intent, so that it would be available freely without a patent. But because there were so many steps of recombinant DNA technology involved that had intellectual property patents, that took some time. I think most of the companies that hold those patents and organizations that holds those patents have released their rights as long as golden rice is given only in a humanitarian sense to poor farmers earning under \$10,000 a year. But it took some time to resolve that.

So that I think that points to one really big issue that is often off to the side, we hear all kinds of things about is it right to patent life, is it ethical, but there's actual practical implications that have ethical implications about access to these technologies. So that was the one of the issues.

Another problem of course is consumer acceptance with golden rice that there's been a lot of rejection of the idea of golden rice and the technology. And it took a while to get a golden rice strain that produced enough vitamin A that people wouldn't be having to eat six pounds of rice per day. But they've really got those strains available. So it's largely a regulatory issue right now with consumer acceptance and then the patenting issue as well.

**Marc Pelletier**

I suppose too you can bring a horse to water, but you can't make him drink.

**Dr. Lisa Weasel**

Yes.

**Marc Pelletier**

Maybe that's a really horrible example but, sorry I might edit that one out...

**Dr. Lisa Weasel**

But I think – but that's relevant in terms of Europe, Europeans, right, we have this big WTO lawsuit and Europe lost the case and said you've got to accept these genetically modified foods, you can't say you don't want them, you can't say – so Europe has instituted a labeling law, but if you go to European supermarkets and you look for those GM labels you can't find them. Because they don't have GM food on the shelves. So this is sort of the flipside, you know, you can bring the horse to the water, but you can't make it drink. Well, here you can throw the water at the horse, but it still – if the horse isn't going to take it. So European consumers have really continued to say no to GM even though the law says you guys have to take it, but that doesn't mean they have to purchase it at the store and supermarkets know that if they put those products on the shelves there is going to be some consumer backlash. So it is very interesting when I was doing this research I was hoping to get a good lot of photos of these labels to use in my presentations and my PowerPoints of what those labels look like in Europe and it was very hard to find any.

**Marc Pelletier**

Well – I guess sort of public consumerism gets swayed and it doesn't take much, right? I think here there was a – in the US there was a big – it became an issue to drink bottled water, because the amount of oil that was used to produce the bottle of water and to carry the water and the amount of energy was a huge waste. So people – it became more elegant to eat or to drink tap water, right, and bring your own tap water bottle.

**Dr. Lisa Weasel**

Right.

**Marc Pelletier**

And I suppose if one were to think that in the situation where there was a crop that now doesn't require tons and tons and tons of pesticides. Or completely a new rotation of pesticides because, it's just not one pesticide, eventually the pests become resistant to that pesticide, then you have to come and introduce a new a pesticide. And this rotation of tonnage, which happens faster than you can evaluate the environmental impact of these various pesticides.

**Dr. Lisa Weasel**

That's right.

**Marc Pelletier**

One could say well, we'll eliminate all of that and I suppose it could change overnight – it could – one public leader could say, "Oh, by the way, you know, our environment is going to benefit in a huge way" and then all of a sudden the product gets accepted. Coming back to the golden rice...

**Dr. Lisa Weasel**

Yeah.

**Marc Pelletier**

... wouldn't it be fantastic if you reduced blindness from occurring in 10 out of 1,000 people to a 1 in 1,000, 9 out of those 1,000 people would no longer become blind, because of deficiencies in vitamin A. I mean the potential is fantastic, but I suppose if the culture is that the whiter the rice the better it is.

**Dr. Lisa Weasel**

Absolutely.

**Marc Pelletier**

Because people in high society eat white rice and we don't want to eat the brown rice even though the brown rice is more nutritional or like brown bread or whatnot, or whole wheat – the same thing with a rice of a different color that's off in color I suppose. And the numbers, how high do the numbers of cases of blindness have to happen, to have to be visible in a community to see, oh that person became blind because they had a deficiency. There's so many cans of worms here, it's...

**Dr. Lisa Weasel**

There are. And consumer acceptance is a really tricky, tricky issue as well, especially when you're dealing with significant power imbalances. You know scientists from the US come in and tell me I should eat this rice and people are of course suspect that there might be contraceptives in that and all kinds of things. But I think that there are again there are ways around that and it's probably embracing a multiplicity of approaches to introducing golden rice, not just as a miracle cure that's developed by scientists in the West. But to really looking at how many different approaches to vitamin A deficiency can be treated. So golden rice might be part of a solution, but encouraging, you know, more fresh vegetable consumption, fresh greens; encouraging, you know, biodiversity in agriculture in developing countries, might also be part of it. So I think that the polarized nature of some of these debates can be off putting and as you say can shift things really rapidly in one direction or another. And again involving stakeholders in these technologies I think is really crucial. So working together with communities on food security issues, agricultural issues and having their input and participation in the development and testing of new products I think can – could really help consumer acceptance.

**Marc Pelletier**

I would like to take a minute I thank our second sponsor. Futures in Biotech is also brought to you by GoToMyPC. GoToMyPC gives you remote access to your PC and all your files on it; your email, your programs, your applications, your entire desktop. GoToMyPC is great for people who work from home and need to access their office PC and it's also great for people who travel for their jobs and need to access their files back in the office. GoToMyPC enables you to work from wherever you are as if you were sitting at your desk. That's mean you can spend less time at the office. Let me repeat that: less time at the office. GoToMyPC is easy, it's secure, and it's an award-winning service; PC World's World Class award for best remote access software. Setup is automatic; it takes about 2 minutes. Try GoToMyPC for free today. Visit [gotomypc.com/twit](http://gotomypc.com/twit). Now back to the interview.

Then tell me a little bit about the book and why you wrote it.

**Dr. Lisa Weasel**

[42:34] Sure, so I think the research for my book when I began the research I thought it was – I structured it as a straightforward academic research project looking at what are the ethical debates, why do we see this inconsistency Europe, US, developing countries in terms of acceptance and rejection of biotechnology, and particularly genetically modified food, became much more clear that this was sort of the focal issue globally were we saw these significant differences. And academically that of course is a very interesting question; why do some people in some locations – geographic locations and cultures reject a new technology and why do some embrace it, accept it.

But as I did the research and the interviews for the book two things became very clear. One was that Americans in particular had very strong significant feelings and beliefs about genetically modified food, but they were completely uninformed about it, both the science and some of what I'd call the ethical and social concerns about it.

And then the second thing that became clear, was that this was not just a straightforward ethical cognitive question, but that there is so much politics involved and as I think Heidi Cullen from the Weather Channel has said, scientists tend not to be advocates, but advocates never hesitate to be scientists. So as a scientist you're kind of trained to say, well, let's just look at the science, let's not look at all these politics, but in this case it's really so integrally involved in shifting what kind of science gets done what kind of technologies get promoted out there. So that was very interesting and I felt that it was pretty much my responsibility as a scientist, if I was uncovering both the finding that people are not very well informed and that this is a really complex issue that is not just science, but has political, social, ethical ramifications as well that I should probably present those findings in a format that's accessible to the public.

So, that's how I came to write the book in the way that I did, and sort of try to tell the story that unfolds these more complex issues and helps people, you know, come to terms with what's a stereotype, what an unfounded fear and what are maybe some potentially legitimate concerns about the technology.

**Marc Pelletier**

What this kind of brings to me, I tend to always I suppose I'm trying to think of the big picture here, not necessarily a big picture necessarily of just genetically modified food, but life as a substrate for engineering, right. We can't deny the fact that biotechnology is going to allow us to do pretty much anything we need to do. And that doesn't – it's not restricted to – DNA is not restricted to plants.

**Dr. Lisa Weasel**

Right, yeah.

**Marc Pelletier**

So, this, I think what's fun about, well, fun about this book – what is thoughtful about this book is the way you raise questions and you look at both sides and it's the first example as a when looking at the big picture of life as a substrate for engineering and how that impacts, you know, our community and...

**Dr. Lisa Weasel**

Right.

**Marc Pelletier**

... and even on an individual basis for example when a person goes blind

**Dr. Lisa Weasel**

Yeah.

**Marc Pelletier**

And there is potentially something out there that could help that person. So in the big scheme of things this is a first – plants are a great – in terms of recombinant DNA work, a great entry into that life is a substrate for engineering.

**Dr. Lisa Weasel**

Yeah. Absolutely.

**Marc Pelletier**

So I will put a link in the show notes to the book, so that people can find out where it is, has it been made an audible book yet?

**Dr. Lisa Weasel**

No, it just came out recently, it came out last month, so.

**Marc Pelletier**

Have you thought about that, maybe you can do – record it.

**Dr. Lisa Weasel**

That's an idea, I can talk to my publisher about that, that's a...

**Marc Pelletier**

It would be fun. You've got a great radio voice, that would be fine.

**Dr. Lisa Weasel**

Great. Well, thanks.

**Marc Pelletier**

All right. I want to thank you very much for coming on.

**Dr. Lisa Weasel**

Sure. And I'll look forward to logging on and listening to it.

**Marc Pelletier**

That was Dr. Lisa Weasel, she's an Associate Professor of Biology at Portland State University in Oregon, and the author of Food Fray: Inside the Controversy over Genetically Modified Foods.

If you'd like transcripts to the show, they're available at [futuresinbiotech.com](http://futuresinbiotech.com), you just have to scroll down a little bit, and they're kindly provided by the team at Pods in Print. If you have transcripts that you need to get done they will assign an expert in the field to handle them. You can visit them at [podsinprint.com](http://podsinprint.com).

I'd also like to thank Phil Pelletier and Will Hall for the opening and closing themes. And Leo Laporte and Dane Golden for co-producing the show.

For Futures in Biotech, I'm Marc Pelletier.

[Music]