[SLICE OF MIT THEME MUSIC]

ANNOUNCER: You're listening to the Slice of MIT Podcast, a production of the MIT Alumni Association.

When I set out to find MIT stories related to food, I was overwhelmed. Each interview led me to more people doing interesting things. Many food-related issues are calling for change, like food scarcity, sustainability, animal cruelty, genetically or chemically modified foods, and health concerns like obesity. And as it turns out, food innovation projects at MIT run the gamut.

In this Slice of MIT Podcast, you'll hear how to grow plants in thin air, how to know when your avocado is ready to become guacamole, and a Thanksgiving turkey tip. This podcast is being released a few days before Thanksgiving 2015. So I think it's important we talk about the Thanksgiving meal. And who better to talk to than Kenji Lopez-Alt, MIT class of 2002 and Culinary Director of *Serious Eats,* a well-renowned food blog. He's also a Thanksgiving feast expert. He'll be weighing in on the age-old question, to brine or not to brine.

KENJI LOPEZ-ALT: I had just changed majors from Course 7 to Course 4. And in the previous summer, I had worked in the biology lab. But I basically wanted to spend the summer of my sophomore year doing something non-academic, just because I was getting a little burned out. So I went around looking for a job as a waiter in Boston and Cambridge.

One of the restaurants I walked into had a prep cook that didn't show up that morning. And they basically told me, you know, if you can hold a knife and you can work this afternoon, then you can have a job this summer. By the time I graduated MIT, I started working with Barbara Lynch at No. 9 Park. And I helped her open B&G Oysters and The Butcher Shop. And then went and worked for Ken Oringer at Clio and Uni.

HOST: Kenji was on a roll. He felt at home in the kitchen, he was making a name for himself in Boston, and enjoying his work. But as someone who grew up around science, the question started to nag him.

LOPEZ-ALT: Yeah. I just had a lot of questions about why we were cooking things the way we were cooking them. But I never really had the opportunity to explore it just because restaurants are so busy all the time.

HOST: So he left the restaurant world and started cooking at *Cook's Illustrated Magazine,* where he became a test cook and eventually an editor for the magazine. After a few years, he combined his background in science and food to start *Food Lab,* a column on serious eats. Now the Managing Culinary Director for *Serious Eats,* Kenji is all about helping the everyday cook use food science to help make their food better. And we're not talking about crazy food experiments. We're talking basics, like steak and eggs, and yes, anyone can do it.

LOPEZ-ALT: I think it's the key tip for any food scienctist. Be skeptical of any conventional wisdom. And write things down if you're testing so that you can repeat them later on.

HOST: Like how people say that searing a steak before cooking it will lock in juices. It won't, says Kenji. Or that cooking pasta in a large quantity of water will help it return to a boil faster, and therefore cook faster. Also not true, he says. And he has the science to back it up.

LOPEZ-ALT: No matter what size the pot you have, when you add the pasta to it, it's not going to lose the boil. It's actually going to return to a boil at the exact same rate no matter what size the pot is. Because really the only energy that you need to add to that system to sort of regain that boil is the amount of energy it takes to take that pasta from room temperature up to 212 degrees, 100 degrees Celsius. Small pots can actually return to boil faster because they have a lower surface area. So they're losing energy to the atmosphere at a lower, at a slower rate.

HOST: Over the years, Kenji has become a guru on the whole Thanksgiving meal. And of course, Turkey is the key.

LOPEZ-ALT: Turkey. It's always, always turkey. Like what's the best way to roast turkey is, whether you should brine a turkey or not.

HOST: So here's the moment you've been waiting for, to brine or not to brine.

LOPEZ-ALT: I don't brine it. The main reason I don't brine it is because, you know, brining is when you soak a turkey in salted water. And essentially what happens is the salt will help dissolve some of the muscle proteins in the turkey so that it can then absorb some of the liquid that it's soaking in. And more importantly, it won't squeeze as tight once it's roasted, so that that liquid will stay inside. The problem with brining, though, is that the liquid that the turkey is absorbing is straight up water. So brined turkeys, they taste juicy but they also taste watery.

What I do instead is I'll dry brine it, which is you rub it with salt. So that initially what happens is that salt will draw out some moisture. And then eventually, that salt dissolves and that moisture

forms a really concentrated brine that then slowly works its way in to the turkey. So it has a lot of the sort of similar effects of regular brining in that it dissolves muscle protein so that they don't squeeze as tight once you're cooking. But it doesn't steal any of the turkey's flavor and it doesn't dilute any of the turkey's flavor. So you end up with a turkey that's really juicy, but also really nicely flavored.

HOST: Check out *Serious Eats* online for more ideas on cooking with science. MIT has a long history in food, from nutrition to the environmental cost. But MIT's newest food initiative, J-Wafs, as it has become known, is bringing together research across disciplines. The initiative was started last year and is officially named The Abdul Latif Jameel World Water and Food Security Lab. The lab was started thanks to a generous gift from Mohammed Jameel, a civil engineering graduate from the class of 1978, and is named after his father.

Renee Robins, Executive Director for the lab and a graduate from the class of 1983, sat down with me to tell me more about their work.

RENEE ROBINS: Population growth, development, urbanization, and climate change pose an unprecedented threat to the world's supply of food and water. And MIT's perspective, research, and innovation can help.

HOST: As Renee explains, when you're talking about food, the link to water is unavoidable.

ROBINS: 70% of fresh water withdrawal worldwide is for agriculture. So the two issues are inextricably linked. I was born in '61. The population was about 3 billion then. Today, I think it's 7. And by 2050, we expect it to hit 9 billion people. There was the Green Revolution in the '70s and substantially increased the productivity of agriculture across many parts of the world. We feed many more people now than then, but we still have something like 800,000 to 900,000 people who go to bed hungry every night, on the planet.

HOST: The issues are varied, Renee keeps reminding me. Of course, you also have to understand local geography, climate, and cultures to understand food and water issues worldwide.

ROBINS: Many of these issues are contextual. You've got sort of overfeeding problem in some parts of the world, while elsewhere people are going hungry. You have to understand the local geography, the climate, the political structure, the local organizations, and even local customs. And they all affect both the nature of the problems and how potential solutions might emerge.

People are becoming increasingly aware of where their food comes from and potential problems related both to what's in their food, like what we've been learning lately about the effort to shift towards low fat or no fat has actually resulted in a great increase in the amount of sugar that's in a lot of the food products we eat. I think more and more attention will be paid to where food is sourced from, how it's grown, how livestock are treated. We also have a big problem with food waste.

HOST: This is something we'll get into shortly.

ROBINS: So some statistics have indicated that we could feed all of those 800 million hungry people today if we did not waste the amount of food that we do. And the waste happens along the entire food supply chain, from food that goes bad in farmers' silos to transport, supermarkets, and at home on people's tables.

HOST: J-Wafs is working with departments, labs, and centers across MIT, as well as domestic and international industry partners, to help cultivate ideas, fund projects, and ensure that the technologies can be brought to market.

ROBINS: There's just a huge human drive to develop technology. And I think we're seeing a lot of really interesting things. And some of these technologies coming out of MIT will address a lot of the different kinds of problems around our food and water supply.

HOST: So now let's hear about a couple of ways that MIT people are using data, technology, and research to address some of these problems.

CALEB HARPER: This used to be just where people eat lunch.

HOST: Before sitting down with Caleb Harper, Principal Investigator at the Open Agriculture Initiative, he takes me on a tour of the Open Ag Lab in MIT's Media Lab. Caleb earned his Master's in Architecture at MIT in 2014. We first check out what he calls the Food Server, a greenhouse-looking case built against a three-story, all-windowed wall in Building E-15, that used to be lunch tables and is now home to the first of several of his controlled agriculture experiments. He also shows me smaller versions called Food Computers, which look kind of like hollowed out TV sets from the '90s, with plants inside.

HARPER: We create and control climate in here to produce very specific expressions in the plants.

HOST: Inside the Food Server, there are hundreds of plants growing. Once I get a better look, I see

why this isn't your typical greenhouse. The plants aren't being grown in dirt. They're being grown using alternate methods, including aeroponics and hydroponics. They are LED lights of various colors and sizes. And they are containers filled with nutrient-dense water that feeds the plants. And it is all controlled by what he calls the Brain, a computer with a set of actuators all built off open source technology.

HARPER: We've developed a few interesting components, like this is called aeroponics. So aero is no standing water, no soil, just misted water that's nutrient dense. So in this method of growing, you're basically building in like two hearts for that plant. Like the more root material you have that's alive, the faster the plant is going to grow. That's one additional thing that makes these plants grow so much faster.

Of course, the supplemental light, exactly in the wavelength that the plant needs, that's photosynthetically active, is part of it. The fact that this environment has an increased humidity and increased temperature to outside is part of it. And we increase the CO2 in this environment. So there's a lot that we do to create a perfect world for these plants to express that make them grow up to like five times faster than they can in the field.

HOST: Caleb's research projects include dozens of small food computers throughout the state of Massachusetts, which are used for STEM education at local high schools, two of the larger food servers, including the one I toured, and most recently, a food data center that is being built in Middleton, that will allow him the space and resources to perform more rigorous testing.

HARPER: Our research has two fundamental components, which is agriculture technology platforms-- and you saw the small one, the medium one, and we're building the large one-- and then the datasets that come out of them. We call that the Open Phenome Project. So the small platform is called the Food Computer, the medium one is called the Food Server, big one is called the Food Data Center. All those run on climate recipes. That's the Open Phenome part. We're just trying to build that, like a Wikipedia of climates.

HOST: By figuring out the best way to optimize this system, Caleb hopes it can become a widely used method of agricultural production to help provide individuals with access to food that can be eaten closer to the point of growing, and the ability to grow anything, anywhere in the world, with similar technology and the right climate recipe.

HARPER: There are many places in the world that can't grow food, right, ever, and never will be able to

grow food. But with technology like this, they could, right? Because you're basically making climate stable.

HOST: Caleb started his research in the Media Lab under Kent Larsen's Changing Places Group. His work has now become a separate group, the Open Agriculture Initiative, where he is Principal Investigator.

HARPER: It's amazing that we farm the world right now. But I think with stuff like this, we're going to get more de-centralized and start to mitigate what is local, what is global, what's best to be grown local because it's healthier for you or it's more sustainable. Everyone wants to know everything about their food. And that's a big shift, a big cultural shift from 20 years ago where we just wanted more food and cheaper food.

And so everybody wants to know everything about it. So I think any technology that's hiding behind kind of intellectual property opacity is going to have a pretty hard time in the future of food. So, and I want this to spread like a virus. And there's only one way to do that, give it back to society.

HOST: Caleb's angle is not to create a product, but to create a platform to transform agriculture for the good of the world.

HARPER: I've come into this and I say, look, this is a system of components that needs to be smarter to be more efficient. I'd like to think that I'm building the platforms now, the tools to allow the real brainpower of MIT plus the real brain power of other people to come together and make better solutions than these kind of one-off proprietary ones.

HOST: Visit the MIT Media Lab's website to learn more about Caleb's work and the Open Ag Lab's mission to create more farmers for the future of food production. Now let's get back to that food waste problem we were talking about earlier.

ROBINS: We also have a big problem with food waste.

HOST: At both small and large scales, it's a huge problem. I spoke with Jan Schnorr, CEO of C2Sense, about the sensors they're working on and how they can help cut food waste. C2Sense came out of Tim Swagger's lab in the chemistry department, where they've been working on various sensors for the last 20 years. Jan, who completed his PhD in 2012, was working in Swagger's lab when they decided to start the company.

JAN SCHNORR: Every household throws out about $2,500 worth of food per year. And a good portion of that is avoidable. Towards the end of my PhD, we had a project around ethylene detection, which is very relevant for fruit freshness. There, we decided that we want to launch a startup. So what we're trying to do with these sensors is to give a sense of smell to the digital world. The same as what cameras have brought to your smartphone, the sense of vision, we want to do with gas sensing with a sense of smell.

HOST: Often, we can actually smell when a fruit is ripe, or in many cases, overripe. So the sensors actually detect whether your food is ripe, not yet ripe, or on the verge of going bad, and do a much better job than we could do with just our basic sniffing abilities.

SCHNORR: It's multiple types of sensors.

HOST: The key, says Jan, is finding ways that specifically interact with each particular compound so that once it's used in the real world, it will only react to the relevant smells. So how does it work?

SCHNORR: For fruit, for example, one option could be that an employee in the supermarket has a handheld device. They use it to check a shipment of produce that's coming in to make sure it's fresh. It can be a consumer who uses the sensor at home to test if the avocado is now finally ripe enough to make a guacamole.

And it can be used further up the supply chain. For meat, for example, on the other hand, there you could even imagine a sensor being integrated in packaging. So you'll buy a packaged steak that has a sensing tag in the package. You just read it with your smartphone and it tells you, OK, the steak is good for roughly three days. Or maybe that's something you have to eat today.

We wanted to create something very simple. So you have the material that's between two electrodes. And when a compound, let's say a biogenic amine or ethylene comes in contact with that material, the electrical resistance of the material changes. So you have this network of nanotubes. You have our custom designed selectors. You have a matrix material, maybe some additives. And all these combined give something that responds specifically to that compound and then lead to that natural resistance change.

HOST: What C2Sense is working on is capturing this information. Then that information could be presented in a variety of ways, depending on if it's for consumers or someone in the supply

chain shipping produce.

SCHNORR: Helping consumers, helping people in retail, in the supply chain, at all steps were waste is generated, to reduce that waste. I think that can have a huge impact in terms of feeding people, saving money. At the same time, just being more efficient about the resources we need when producing that food.

HOST: So far they've done two successful field tests with the sensors, in the supply chain and food storage stages. Next, they expect to have a product out in the pilot phase by Fall 2016, and the first commercial product in 2017. So after exploring a couple of MIT'S food initiatives, we certainly have a lot to digest. Pardon the pun. There are countless projects happening at MIT that address improving food. And thanks to the work of J-Wafs, an effort to bring people together and turn research into revolutionary technologies.

What questions do you have about the future of food technology? Care to weigh in on the great turkey brining debate? We'd love to hear from you. Tweet us your thoughts on this episode too @MIT_alumni. And a special thanks to Kenji, Renee, Jan, and Caleb for sharing their work. If you want to hear more surprising, insightful, and quirky stories from the MIT community, subscribe to the Slice of MIT Podcast on iTunes. Let us know what you think. Please rate the podcast and leave us a review. We'll be back next month with another episode of the Slice of MIT Podcast. In the meantime, check out our website at slice.mit.edu. Thanks for listening.

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