Our Hen House Podcast: Transcript for Episode 669, Interview with Karthik Sekar

Mariann Sullivan: Welcome to Our Hen House, Karthik!

Karthik Sekar: Thank you, Mariann. I'm really happy to be here.

Mariann: Thrilled to have you. Really excited about your book *After Meat*. It was very enlightening for me and I feel like I know a lot about this stuff, but there was a lot in there that I didn't know about. But let's talk about something that I do know a lot about and actually listeners know a lot about, and that's the problem.

Our audience is pretty familiar with the arguments of animal suffering, which I know is also your primary motivation. And the environmental degradation arguments, but maybe some are not as familiar with the details of the argument that you primarily rely on in this book, that's efficiency. Why animals are so outdated as a production technology. And we're coming at that from two people who care very much about the animals. Because we're calling them "production technology" means that that's how the industry views them.

Can you explain why it's so inefficient? We know a little bit about it, but you really know a lot about it.

Karthik: Yes, the book *After Meat* takes this, I would say, third argument, separate from the environmental and the ethical arguments against animal agriculture. And that is just that animals are a really outdated means of ways of producing commodities that people like.

So this is our meat, our dairy, our clothing, our biologics, medicine, and so forth. And yes, Mariann, what makes animals particularly terrible in terms of a means to produce goods is a few things: So one is that animals take a long time to grow. We think about a cow and rearing her from adolescence to adulthood takes about a year, maybe a little bit less than that with all the breeding. And

from the standpoint of a producer, time is money, right? And so the time it takes for a cow to grow up into adulthood is an economic loss for them. And in addition to that, I think Our Hen House audience is very well aware, but animals don't convert what they eat into the commodities all that efficiently.

So I know for a cow, 95% of what they eat is quote unquote wasted. So it's not turned into any commodity. It's actually being used to fuel their breathing, their energy, their beating heart. And these aspects stem from a few biological features of cows. So one is that they grow big.

So they grow from a few feet into something the size of a car. That means that their bodies have to continually pervade nutrients around their body. And so this requires additional accessories or machinery within their bodies to actually circulate nutrients. And that's a cost. And in contrast, I think about something like microbial fermentation.

So microbes per their name are microscopic, so we can't see them just with our naked eye. And they're so small that they don't actually require these extensive circulation systems. So they can actually be way more efficient from turning input into output. So just to put this in perspective of the differences here, if we had a microbe that could produce meat, produce dairy, and we had a process to do this we could have a microbial bioreactor. So this is a vat where we're growing these microbes and making these goods and one vat the size of about a car or a bathtub can replace about 10,000 cows.

Mariann: Yeah, that's a mind blowing number.

And of course the efficiencies for chicken and pigs are conceitedly better, but they're still very poor. And compared to the argument you made for microbial based foods.

Is this the same thing as fermented foods? You use both terms in the book and I wasn't sure. And we talk all the time about the plant-based proteins and the cultured meat proteins, and then somebody always mentions, “Oh yeah, and then there's the fermented.” And I never know what exactly what that means.

And that's what we're going to find out in this interview. What that means and why it's such an important piece of this puzzle. So is it the same thing as fermented? Are those terms interchangeable?

Karthik: Yes. There's some nuance here. So I think of fermented as being like a bigger circle, and then there being specific technologies within that circle.

So fermented includes some very ancient food technologies such as beer, kimchi, wine. And when I think about replacing something like meat, I think about more modern microbial fermentation. I think maybe a term that might help here is biomass fermentation. So a useful example of this is Quorn. Q-U-O-R-N. So, much of your audience might be familiar.

Mariann: It is a food I'm very familiar with from having seen it in the grocery store, but I bet I and most of my listeners have not eaten it because…I think maybe recently it became vegan, but it was never vegan. So maybe you can explain that too. But I've certainly seen it many times and thought, "why don't they make it vegan?" And perhaps you could explain that.

Karthik: Yes. So I'll first explain what Quorn is. So it's a microscopic fungus, you can't see it with your naked eye, but what they did is they isolated this microbe. They grow it in these big vats, and so it feeds on the sugar solution. These microscopic fungi actually double themselves and they create this very protein rich matrix that's very akin to how we eat mushrooms that we buy in the grocery store.

So you think about your portabella, it's that very textured kind of smooth protein surface. And so these microbes produce these in these vats. And yes, the process economics of this are just amazing. It's thousands of times more efficient than what we could be doing with a cow.

The history of it is interesting in that Quorn, typically they add egg to kind of help it bind a little bit better, which is tragic. But I do know that they're starting to have more offerings where they omit the egg and have a fully vegan product.

Mariann: Well, that's exciting to hear and it's exciting to see that the eggs aren't a necessary part of the process.

I have long said, without knowing really much about it, it's just my basic instinct that fungi are going to save the world. That the answer is in fungi, I love mushrooms, but I just love the whole thing. When I first started learning about fungi and how they connect everything in the world and all of the forests. It's just such a fascinating topic.

So you have this biomass fermented…bio reactor, whatever that is. And you just put sugar and microbes and I'll use the term microbes, but clearly that's a term that needs to die in this area because you know, we're not gonna sell microbial food to people. *laughs*

That's my marketing opinion. But we'll use it now. Alright, so you have this bioreactor, which we can talk about how big a deal is it to make a bioreactor, and you just put sugar…like just regular sugar in it and microbes, and all of a sudden you've got enough food to feed the village?

Karthik: Yes. You formulate a media broth with all the essential nutrients that the microbes need. And you make the conditions right and yes.

Mariann: So what is there besides sugar?

Karthik: You know, there might be some amino acids, there'll be some salts. There'll be some things to help balance the pH. Make sure the salt levels are the right level. It's just all about creating the right environment for them to thrive.

Mariann: Those materials, they're vegan and they're relatively easy to obtain? I know with cultured meat, which we can talk a little bit about the comparison. The actual serum in which the cells grow has been a big problem. I think it's a problem that they claim to have solved, but that's a huge problem. We don't have any such problem here?

Karthik: That's right. So microbes by default do not require any of these growth factors to actually replicate themselves as you would (need) in cultured meat. So yes, you can have truly vegan sources for all the inputs that go into the process.

Mariann: So are there any other differences between cultured meat and fermented foods in the process of making them? I know you're a big fan of the fermented, the biomass fermented, that's what we're calling it? *laughs*

Karthik: Yes. Biomass fermented.

Mariann: Are there other relevant differences?

Karthik: Yeah, so like you said, Mariann, I think biomass fermentation is the future. I think actually cultivated meat is honestly a distraction, and the key differences I see is, one, that the deficiencies are just going to be even better than we can do with cultivated meat.

I think it's also just going to be easier. So I think…the analogy I give with cultivated meat is, it's like we're going back to the 19th century and trying to replace horses with robotic horses. We don't do technological progress by

replacing things one to one. And so, in my view, that's exactly how this transition's going to occur.

It's not going to occur by us trying to make steak exactly like our grandparents ate steak. It's going to be by creating these wondrous new foods that are more nutritious, that are healthier and cheaper than anything we could ever do with an animal.

Biomass fermentation, I think it's going to be easier to innovate. I think it's going to be more potent in the long run in terms of taste, nutrition, and efficiency. Yeah, I think the other key differences are like, you have like a really big variety of microbes. So just the diversity of microbes that are out there is just incredible. Of course, we need to do our diligence to make sure that they're fit for human consumption.

And I can totally expect some weariness from the audience that these foods seem completely foreign, alien, and how do we know that they're safe? And if it's any solace, Quorn is actually probably our most safety-tested food to date. So there were over 15 years of studies to understand how toxic or healthy it could be for people.

Mariann: So let's get off of health, because I'll take your word for that, but you kind of glided over the word taste. Are we just going to all be eating mushrooms for the rest of eternity? How many different foods can you make with this and how do you control how they taste?

Karthik: Actually in my day job, I work a lot on flavor science.

And so taste or flavor comes down to how chemical molecules interact with our tongue and in the back of our nose. So there's the taste aspect. So that's your sweet, salty, umami, sour. Those are like the acetic acid that's in our tomatoes. For the more complex aromas, as we eat and chew food, we release odors. The odors get to the back of our nose, and then that's where we get like the complex aromas.

And so, when people talk about losing their sense of smell and taste with COVID, that's what they're referring to. And thankfully these taste molecules, they're not monopolized to certain parts of biological life or kingdoms, right? So the molecules that we associate with, for example, animal products, so things like buteric acid.

Butyric acid gives the experience of butteriness that's perceived in dairy. But butyric acid actually naturally occurs in many microbes. And so we can imagine that if we do our innovations in a very intelligent way and know where to look, we can reproduce flavors, we can reproduce taste, and we can even do better. And that's where I'm really excited.

Mariann: Yeah, no, I definitely want to get into that.

But before I do that, you mentioned that butyric acid imitates butter. Are we talking also about texture? Because texture has turned out to be such an important factor in plant-based meats, trying to get that texture right. It's really important to people, not just that it tastes like a burger, but that it feel like a burger.

Is that something that can also be replicated? And I know you're not only interested in replicating, but we'll get to that in a minute.

Karthik: Yeah. I agree. So texture is definitely not decomposable to just molecules. It's just a much more complex phenomenon. So, admittedly, it's been a struggle in the alternate food movement.

This is actually why cheese has been so difficult. Mariann, I'm not sure how much vegan cheese that you eat and how much you can recall dairy cheese, but it's definitely the biggest gap.

Mariann: It's been a while, but I do recall it and I've eaten really, really a lot of terrible vegan cheese because I've been vegan that long.

And so now the vegan cheese is fabulous, as far as I'm concerned, because I went through that experience.

Karthik: Yes, It’s certainly come a long way. You know, we just used to have like the Follow Your Heart and the Daiya and now we have like the Miyokos and the Violife. And yes, it's certainly come a long way, but you'll notice, especially like with the nutritional label, that the vegan cheeses, one, they tend to be very starch based.

So they tend to have a lot of potato starch. And this is to basically give it that stretchiness and melt-ability that's missing (when compared to) dairy cheese. And the dairy cheese is able to have that stretch and melt due to casein protein. So casein protein, is an incredibly idiosyncratic, unique protein in that it's able to provide these textural properties to dairy cheese. And there's no obvious plant

analog to casein. So you can't just go out there and say, “Hey, this protein can directly substitute for casein.” And so, yes, it's been a huge challenge to find a protein that can provide that stretchiness and melt-ability that casein can.

So I will not say we'll find this, that we've already found this, or we'll find it tomorrow. But it's a tractable problem. I know from working with people, conversations, working on the problem firsthand, that there is evidence that you can find such functionalities in plant proteins and so I'm fairly confident that we'll be able to reproduce it, if not do better.

Mariann: So now we get to the point that I think you're the most excited about, is that you don't just plan to replicate, you plan to improve, you plan to reinvent food. Can you talk about that a bit?

Karthik: Yes. One of the reasons I wrote *After Meat* is I want people to understand that the way to look at the replacement of animal products with alternatives is not akin to someone getting a knee replacement. So like someone getting a knee replacement is something that is understood as you try to put it off as long as possible, and when you do get a knee replacement, it's never as good as the original, right?

In my view, the better model is to understand that we're actually going to be replacing animal based foods with things that are just better in every single way that we care about. So for purely selfish reasons. So for the taste, cost, and nutrition. And so I think a better model to understand the replacement of animal based foods is going from donkey carts to electrical vehicles.

In many ways, it's just going to be all around better and everyone's going to wanna do it for purely selfish reasons. And so along with that model of thinking about this transition, I think it's important to stop thinking about trying to do things one to one.

Why do we need to do molecularly exact milk? Why do we need to do molecularly exact steak? I think we can do better. And at the end of the day, better is ultimately what's going to win.

Mariann: Yeah. And it's very exciting. Is this just limited to animal products or are we talking about like the *Starship Enterprise* and you press the button and that makes your food? Anything that you could possibly want, it makes. Is that where you're headed or is it just animal products?

Karthik: So I think the future of food is very exciting. To your vision of a *Starship Enterprise* and exploring foods, I could imagine, you know, we have our own 3D printers at home for making our very personalized meals. So, let's say that it's learned the types of foods and tastes and moods that we have, and then we push a button and it's able to just produce the perfect meal for us at that exact moment.

And my point about the place of animal-based foods is that it just has no room in this future because it's so inefficient. It's so limited. Yeah. So it's basically like the *Starship Enterprise* flying into vast regions of space and we're just leaving it behind

Mariann: It does seem very exciting. I'm sure it's at odds with a lot of people… Well, in the vegan movement and outside the vegan movement, the whole recent, well relatively recent, local foods movement. Everything is natural. Some vegans embrace it, some do not. I'm not really that into it, not that I'm offended by it, but naturalism and anti-GO-ism are really problems for you.

Can you just talk a little bit, particularly the anti-GMO-ism, which I'm sure some people listening ascribe to, and some don't, but can you just talk about… you really feel that it's standing in the way of transitioning to get out of animal agriculture, don't you?

Karthik: I do. Yes. So I'll first start with naturalism because I think it segues pretty well into the anti-GMO-ism. So naturalism or quote unquote how natural a food is or really anything. I just see it as being very, very imprecise. So the first issue is that what is natural? So all food that we eat today that we buy in a grocery store is unnatural in some way. So it's been crossbred or cultivated to have certain features in a way that it's just not really comparable to its ancestors.

And so I have an example of the banana. An ancestral banana had these very big seeds. The pith or the part that we eat of the banana was just very, very minuscule compared to the seeds themselves. And then only through a lot of breeding did we get it to the point where bananas are today, where the seeds are small, where you could just eat it as it is and it's sweeter. And so, yeah, I just don't see naturalism as a helpful adjective to couch what's good and what's what's bad.

I think we have to be more precise. I think we have to say ethical, I think we have to say nutritious, and so forth. And then getting into anti-GMO-ism. So the first point I emphasize about GMOs is that there are inherent limits with GMOs. I worked in a GMO lab during my PhD and I can tell you, one, it's like you

don't get the intended outcome that you want. Like it's a lot of trial and error, and that's because they're just inherent limits to GMOs. You can't create some sort of monster that gobbles people up, you can't create a pathogen that just wipes out half of the population of the earth. Like that's, in my view, that's impossible and I write about the details as to why.

Instead, I think it's useful to think about GMOs as a tool to actually get ourselves past animal products. So I see it as a way to hasten that transition. I don't think it's absolutely necessary. I think we'll still make the transition without GMOs, but let's think about the fact that there are 70 billion animals slaughtered every year for farmed animal agriculture and then the trillions of fish on top of that, right?

So if we can get to a world where we've replaced animal agriculture half a year sooner and that might entail the use, the safe use I should say, of GMOs, it seems to me that that is very much worthy of our consideration and we should look at it with more nuance.

Mariann: So let's talk a little bit about regulation, because obviously, regulation is, at least in this country, and least in every country other than Singapore, is keeping cultured meat off the market. And though I am told it, all of the companies, or a bunch of companies, are ready to get it on, but we still haven't gotten a pass.

What kind of regulatory issues would you anticipate for biomass fermented foods?

Karthik: Yes, so there's first getting it certified for GRAS or generally regarded as safe. So all microbes have to go through this process before a consumer can actually purchase anything produced with a microbe. So I think just making that process more streamlined and easier will go a long way.

For cultivated meat, I will admit that's a little bit outside my wheelhouse, but yes, I think obviously we want to do whatever we can to ensure safety, but it seems very worthy of putting a lot of money into the problem, right?

So making sure that we have the resources to do the validations quickly and not having issues, such as with the FDA, where there's just a lot of short staffing and not enough bandwidth to assess everything in a timely fashion.

Mariann: I didn't really want to force you to talk about the cultured meat movement, because I know it's not your thing, but now I'm going to ask you about it. *laughs*

What do you think about the cultured meat movement and all of the other approaches that are being taken? Do you think they're wrong-headed? Do you think they're steps on the way to a bright and better future? It sounds like biomass fermented foods are not getting the same attention. So how would you change the way that the food movement, the alternative, animal-friendly food movement is working?

Karthik: So I would not eliminate cultured meat and cultured meat research or funding entirely. But I would love to flip around the emphasis. So the same emphasis that cultivated meat is getting, I would actually love to put onto biomass fermentation. And the little that biomass fermentation is getting, I think we should give to cultivating meat.

I see it as, this is such an important problem. So transitioning from animal agriculture is just one of the most important efforts of our generation. It like we have to do this. It is going to be one of the best things that humanity accomplishes. And in my view, we should be trying as many things as possible.

Even if I don't fully agree that cultivated meat is necessarily a great solution, I still think it warrants some amount of interest and investment. And the way technological progress works is, often things kind of occur in ways we don't foresee. So I could see a solution where biomass fermentation does end up being the winner, but maybe we learn some things from the way we did cultivated meat. Or cultivated meat is able to produce some key ingredients. I know a lot of companies are focusing on fat with cultivated meat because fat is actually really hard to produce in a way that's similar to animal products using plants or microbes.

It's actually easier with cultivated meat technology. And so that might be the ultimate end for cultivated meat technology. But at the end of the day, I wouldn't want to stop any effort that helps us tackle this problem.

Mariann: So, who is working on biomass fermentation? Is it a very small world or are there companies who are trying to get there?

It's not all happening in your garage, right?

Karthik: *laughs* No, thankfully. So there are a lot of companies, and as I understand it, it's actually one of the fastest growing markets in the alternate food space. So, Quorn is of course like the most canonically known, but there's also newer companies such as Meati.

I know Paul Shapiro's company. I feel really bad, but I'm forgetting the name of this company, but they do microbial biomass fermentation. So, investors seem to be kind of clueing in onto it. So there is definitely a lot of industrial interest in microbial biomass fermentation.

But of course, I would love to see more academic interest too. Like I would love to see some government programs actually funding labs like the one that I worked in for my PhD to be able to tackle these sorts of issues.

Mariann: We just don't have nearly the amount of funding for academia that the meat industry does.

I think it's one of the great tragedies that the research the meat industry does is idiotic, for the most part, and deceptive. There needs to be much more funding. I'm going to take this quote out of the book because I just thought it was such an interesting idea, but it brings up a lot of questions.

"We could gift bioreactors with such production organisms," (i.e. the biomass fermentation) "to starving villages in Niger and Afghanistan, and farmers could reap sufficient food in a trivial amount of time." It intrigues me because I just wonder what that looks like.

All right, you take a bioreactor, which I assume is…I'm picturing it like a huge Xerox machine, I don't know why. And you ship it over to a village in Niger. Do farmers still farm? Or do they just get, I don't know, some kind of ingredients that they feed into this bioreactor? Like what does the world look like? Are there still farmers?

Alright, I don't even know what the question is! Like, it seems like you're changing the way the entire world creates food. So take me to that starving village in Niger and tell me what it would look like when the bioreactor arrives.

Karthik: It could look like many, many things.

So all bioreactors still need some sort of input. So there's laws of physics, you know, that mandate that. But yeah, it could be as simple as, let's say, that there

are these crops that are able to be grown in Niger that are not directly consumable for humans. But you could throw them into a bioreactor.

The microbes have enzymes that digest those crops into something that they can consume, say, releasing the sugars that are in those crops, and then the microbes produce the meat or food and then the farmers can harvest it. So it could be something like that. It could also be that we put bioreactors in key points throughout the world and then we have drones that fly food from these points to different parts all around.

And yeah, it's just going to be way easier with technology such as biomass fermentation.

Mariann: So a bioreactor…how complicated a piece of machinery would that be? How expensive would it be? I know we're talking about the future, so it's a little hard to predict because I assume the price will come down once we start using them.

It's all a little out there in the ether. But how big a deal is a bioreactor? Is it a relatively…you talked about having, and I've seen talk before about having a 3D printer in your kitchen. Would it be that simple? Could everybody have their own bioreactor?

Karthik: Yeah, absolutely. Actually, in fact, many of us already do. If you do any sort of beer brewing, you have a bioreactor. So I know bioreactor evokes this image of this very sophisticated piece of equipment. But really all a bioreactor is, is a bucket. So it's a bucket and then it might just have additional bells and whistles depending on the needs.

So, you know, typically it has an impeller to stir, to create good mixing and ways to control it's environment, so the oxygen and the pH. And so all that visibly adds a level of intricacy, but when you understand what it's doing there's still a simple, big picture to it. And yes, you bring up a really good point, Mariann, about the cost of bioreactors and what the outlook looks like for food.

And this is something that the alternative food movement is kind of grappling with. So, classically bioreactors have been sort of catered to the pharmaceutical industry. So they're expensive, they have lots of bells and whistles, they have all these high standards when it comes to sterility and making sure it operates very cleanly because that's imperative for a pharmaceutical context.

But in a food context, those things are less important. You don't need things to be nearly as sterile, you don't need things to be nearly as clean. And so there is no reason we can't make bioreactors that are cheaper, and I think even a fraction of the price of what they're sold (for) in the pharmaceutical industry.

Mariann: That is really interesting. Yeah, that makes total sense that though you want food to be clean, it doesn't have to be as refined as producing drugs. Alright, I'm just gonna get to…I keep coming back to the food. Because I keep wondering what's coming out of that bioreactor and whether I would want to eat it.

And according to you, I would be dying to eat it! It would be just delicious. But the thing that of course always comes up and what you discuss in the book is when talking about changing people's food habits, which I think is a lot easier than most people think. I think you think it is too. I mean, once you've gone vegan, you realize it's not that big a deal. But it's the tradition people always bring up, "Well what about traditional foods?" But you make the point that tradition is a lot more malleable than people think it is, so can you just talk about that? And how food coming out of the bioreactor might be able to scratch that itch?

Karthik: Yes. So the first point I make about this is, if you actually look at most of our food, most of our food today only came about in the last hundreds of years. So, great example is the tomato. Tomatoes are a quote/unquote new world food. So that means they weren't quote/unquote discovered until the Europeans, I guess, found them in either Mexico or Peru.

And I know the exact origin is contentious. And so what that means is every food that we eat today that uses a tomato only came about in the last 200 years or so. In fact, tomatoes were regarded very rarely because they look a lot like belladonna and other night shades. So people actually thought they were just poisonous and they liked how they look, but they didn't actually consume them.

And so that means Italian food, Indian food…So anything that you can imagine that's very tomato heavy, didn't actually exist until about the 19th century. And that extends to many other foods. So, milk chocolate is an invention of the 19th century. Even a lot of vegetables that we eat today, I bring up the example of brussels sprouts.

We didn't actually eat that many brussels sprouts until about the nineties and two thousands because they were just way too bitter. And farmers figured out

how to breed them to be less bitter. And so any cuisine is just very different than when it was hundreds of years ago.

So all to say, our food traditions are constantly evolving. It's not like if I'm eating a Christmas meal that I'm eating the same thing that one of my ancestors ate from 20 generations ago. And so to me it's just something we do organically, as better and newer foods come out, we tend to adopt newer traditions and I seen the same effect happening here.

Mariann: Well, I know you don't want to replicate current foods, but let's face it, people have a really hard time imagining not eating meat, like just classic meat. And there are some people who eat it at every meal, most people seem to eat it at every meal.

So arguing to people that tradition doesn't mean anything, or the traditions are not as traditional as they think they are. It's probably not gonna change their minds. It's hard to imagine what's going to change their minds, nothing seems to change their minds. But you think you think this is going to do it? That biomass fermented foods are going to be the key?

Karthik: Yeah, and let me just say, I don't think it's going to be that we eliminate our traditions. I think we just kind of adapt them, we evolve them, we refine them. And actually, like the Thanksgiving turkey, I think is actually a really good example. So the Thanksgiving turkey became commonplace, didn't really come about until probably like after World War 2, when we had better refrigeration technology and we started, unfortunately, to develop concentrated animal feeding operations. So everyone having a turkey for Thanksgiving dinner, that just wasn't a thing. Even as early as the turn of the 19th, of the 20th century. So I think we're going to see a similar progression where, instead of turkey, we might just switch to something like a better turkey replacement. So like the Impossible or Beyond Meat of a turkey. And then that might give way to something else. Gradually by gradually we'll be in a completely different place than we were say, 10 years ago.

Mariann: It all sounds so exciting and it sounds like it could make a difference in the world that is just astronomical. I can't wait. I hope I make it to see this brave new world, and I don't use that term pejoratively.

It's really been exciting to hear about it. Thanks so much for joining us, Karthik.

Karthik: Thank you, Mariann. And thank you so much for all the work you and Jasmin do. You know, love your podcast! And it's just been a joy and you've

done so much for the movement. And I look forward to seeing more of the great content that you both put out.

Mariann: That's so nice to hear! Thank you so much.

Karthik: Take care.