Vintage advertisement:

In your Frigidaire cold pantry, there's a place for all your food: fresh and frozen, canned, bottled, and wrapped, new bought and left over. They're all right there and they're all at your fingertips.

Let's start with the most ingenious store in any refrigerator. It has special places for bottles, spreadable butter, cheeses, even leftovers, and a big picture window hydrator for fruits and vegetables. But that's just the doors. Think of all you can store in here on these big firm shelves that roll all the way up to you so you can get at the food and back without moving anything in front. And how about your frozen things? Oh, yes, there's a place for them too in this big, big food freezer.

See all the wonderful ideas in this Frigidaire cold pantry at your own Frigidaire dealers. It's further proof you get the best when you buy Frigidaire, built and backed by General Motors.

Jerusha Klemperer:

When refrigerators became commonplace in our kitchens, they changed the way we shopped, cooked and ate. But home refrigerators are just the tip of the iceberg, as they say. The last step in a long, cold, technologically impressive supply chain of refrigerated warehouses, trucks, trains, boats, and yes, even planes that bring our meat, produce, milk and more from fields, factories, and slaughterhouses to our supermarkets and homes.

In the intro to her book, “Frostbite: How Refrigeration Changed our Food, our Planet and Ourselves,” author Nicola Twilley calls this so-called cold chain, the missing middle between farm and table. Most of us never even think about how all those bags of lettuce stay so crisp, and most of us certainly never think about what innovations were required to get us here and the impact of that system on our food itself, as well as on our bodies and our warming climate. Here at What You're Eating, I like to think we've done a good job of educating our listeners about the farm and about the table, but we have neglected to talk about that missing middle, the cold chain. And it's a blind spot that Twilley points out is actually dangerous to ignore.

Nicola Twilley:

Don't beat yourself up, everyone ignores it, including me. I wrote about food and thought about food and even taught classes on food for years without ever troubling my brain about the cold chain. So you are not alone.

Jerusha Klemperer:

I'm Jerusha Klemperer, and this is What You're Eating, a project of foodprint.org. We aim to help you understand how your food gets to your plate and to see the full impact of the food system on animals, planet and people. We uncover the problems with the industrial food system and offer examples of more sustainable practices as well as practical advice for how you can help support a better system through the food that you buy and the system changes you push for.

Nicola Twilley:

I'm Nicola Twilley, I go by Nikki and I co-host the podcast Gastropod, which looks at food through the lens of science and history. We're part of the Vox Media podcast network in partnership with Eater, and I also am a contributing writer at the New Yorker, and I also write books. So I co-authored a book on the history and future of quarantine with my husband Geoff Manaugh, which we sold long before COVID-19 came across the horizon. So we were ahead of the game in a sort of unfortunate way there. And most

recently “Frostbite,” which looks at how refrigeration has changed what we eat, how it tastes, where it's grown, how good it is for us, how good it is for the planet.

Jerusha Klemperer:

Well, you have learned about and then taught all of us about so many different foods, from ramen to breadfruit to Coca-Cola. You've been researching and writing about refrigeration in particular for it sounds like, well over a decade now. What made you curious about this topic and want to write a book, not about any particular food, but about this process that underpins all the foods?

Nicola Twilley:

Yeah, you really do have to cast your mind back, 'cause I have been working on this for a long time. But if you go back to sort of 2010 ish when farm to table was the hot new concept and no trendy restaurant worth its salt was opening up without a farm to table sort of message. And you had Alice Waters and Michael Pollan showing us what was going on on the feedlots and Eric Schlosser kind of peeking behind the curtain and Michelle Obama planting vegetables on the White House lawn. And farm to table was kind of the mantra of the day. And I was excited by all that coverage, jealous of the people who are writing these great books kind of revealing what was going on on the farm, and also intrigued by the word to, the preposition. I thought to myself, what happens between farm and table and maybe there's something for me there. Maybe I could go and look at that piece since other people have done such a great job of looking at the farm.

So that's how it really started was this sense of like, huh, this phrase is everywhere and it has a preposition in the middle that actually sort of conceals, as it turned out, this vast mechanical winter that we had built for our food to live in. And at first I just wanted to see these spaces. It was sort of a curiosity of like, well, wow, here is this world where our food lives on its way from farm to table, I should go see it. And then it turned into, oh wow, that has really reshaped a lot of things about our food system, about our health, about the economics of global trade, all kinds of, everything. From the invention of the hoodie to Irish independence, you could sort of end up tracing refrigeration's impact everywhere. And that is really where I realized, oh, I have a book here, not an article or a podcast episode or whatever.

Jerusha Klemperer:

I was surprised to learn that I understand so little about even the most basic facts about the cold. Namely that cold and refrigeration are really just the absence of heat. Can you just explain that a little bit?

Nicola Twilley:

I know. It's sort of embarrassing, but I was quite a long way into researching the book before I realized that too. I thought to myself, I should really figure out how refrigeration actually works. I'm not a person who loves physics. I was relieved to give it up in high school, but it does come back down to some thermodynamics that you probably did learn in high school. And just to give myself some credit, for most of human history, cold has been a huge mystery. No one has known what it is. People have speculated that there was something called frigorific atoms or maybe it was sort of a property of the North Pole and it sort of flowed down from there. Or maybe it came from the ground or the air, people really didn't know. And all of the great minds, Galileo, Robert Boyle, Isaac Newton, they all speculated on this subject and they all found it very annoying 'cause they couldn't figure it out. Francis Bacon actually died trying to figure it out. Of catching a cold while he was trying to figure it out.

So cut yourself a break if you don't know what it means. But yes, fundamentally we are not making cold. We are just, when you look at whether it's a fridge or a refrigerated warehouse, all we're doing is pulling heat out of a box. That's literally what's happening. We're using the property of a class of chemicals that are called refrigerants, because we use them in refrigerators, but just basically have the ability to evaporate in particular conditions, and when they evaporate, they turn from liquid to gas. That's a reaction that takes energy. And so what happens is that pulls the heat energy out of the box that is your fridge, that heat energy gets used to turn the liquid into a gas and your fridge feels cold. Boom.

Jerusha Klemperer:

Easy peasy.

Nicola Twilley:

I know. It's really, I've done a few interviews about this book now and whenever anyone is like, "Oh, so how does a fridge work?" I'm like, oh crap.

Jerusha Klemperer:

But you built a fridge.

Nicola Twilley:

I did build a fridge and for the hour that I was building the fridge, I understood it extremely well. But there's some science there. There's low pressures, there's high pressures, there's thermodynamics. If that's your jam, I respect you. And for me, it was important to understand because I wanted to understand really why it took us so long. Humans have had control of fire since before we were modern humans, but we have really only been able to make cold at will for about 150 years. It's really, we only domesticated it a century ago. And I wanted to understand, I think the purpose of that, of building a fridge, was really to understand why was this so complicated? Why did it take us so long?

Jerusha Klemperer:

What does heat do to food and why is fighting that process so important for how we feed ourselves?

Nicola Twilley:

Yeah, so I mean it's all very poetic, just the same way that cold is just the absence of heat, well, a refrigerator is just a time machine for slowing down death's inevitable march. So obviously for most of human history, we have had to deal with a problem that food rots. And there's a couple of different things going on. With meat, with dairy, those kinds of things, they're already dead, if you will. The thing that's living on them is the microbes and fungi, bacteria that want to eat it and they want to eat it before we can. And so much of human history has been our attempt to sort of stop that from happening. Think about cheese. Cheese is delicious. That's not why we made it. We made it because if you reduce the water availability of milk and you add salt, and sometimes you even recruit friendly fungi to keep out the bad fungi, you make it very inhospitable to the things that want to eat the milk before we can. There's an amazing quote that's like cheese is milk's bid for immortality, but that's what it is. We are, it is essentially the byproduct of our inter-species warfare with microbes and fungi.

Cold does that job for us by slowing down how fast microbes and fungi metabolize. And that is primarily how cold works, by slowing things down. One of the things I found amazing is that sharks and orcas and

things like that, they love to hunt in the coldest parts of the ocean. It's not because they love the cold, it's because their prey there is slower. Mountaineers have a phrase for this in humans, "Cold-stupid." When you are cold, you think more slowly, you move more slowly. Cold just has this slowing effect. And so what it does on microbes and fungi that want to eat our milk is it slows them down so they don't reproduce as fast and they can't make us sick.

For fruit and vegetables, it's a little different because they weirdly are sort of still alive in a way when they're harvested, they're still breathing. It's called “respiring” in plants to make it seem less creepy, I think. But they are still breathing and like us, they have a certain number of breaths they can take before they die. And the way cold works is to just slow down how fast they're breathing. So it extends how long they have to live before they consume all their internal resources and shrivel up and call it quits.

Jerusha Klemperer:

And it would be tempting for us to just think when you talk about refrigeration or refrigerators, to just think about what we each know, which is that thing in our house that keeps our food cold. But obviously there's, you mentioned moving it around. There's everything that comes before that. I was wondering if you could describe those various steps in a typical cold chain, and obviously it looks different for each product. In the book, we learn quite a bit about bananas and apples. Apples to me are interesting because I'm always amazed at people's ignorance about how old an apple is that they're eating, if it's not right now. If it's not September basically from January onward.

Nicola Twilley:

Yeah, so the cold chain is sort of the industry term for all of the interconnected cold spaces that get our food to us. So the fridge I like to say it's just the tip of the iceberg, and it literally is. When a fruit or vegetable is harvested, it has to be what's called pre-cooled. So that's pulling out the field heat. This is a weird concept, but if you've ever picked a tomato in your back garden, you will know it's kind of warm to the touch. It's been on the plant, living, breathing, metabolizing, and it has what's called field heat. Well, that will accelerate how fast it consumes its resources, basically. It's warm, it's breathing at the normal rate, but you've taken it off the parent plant, and so then it goes into shock and starts breathing really fast. And breathing really fast, as we know, accelerates its death.

So what you want to do is pre-cooling straight away. So pick the apple. Usually this is done with apples by kind of vacuum cooling them. So you pull cold air really fast through the apples and all the heat that's in the apples moves into air and they cool down. You can add to colds sort of time machine effects by also tweaking the atmosphere. So it turns out that if you give apples very, very low levels of oxygen, you can sort of get them to breathe almost hardly at all. They're just breathing at the bare minimum not to die and ferment and turn into mush. And that oxygen level varies between species. And what's nuts is the most advanced apple warehouses these days actually let the apples kind of set their own atmosphere. They'll have a little plastic tub of kind of canary apples, like a canary in a cold mine.

Anyway, they'll have a little plastic tub of canary apples that are wired up to sensors and whatever those apples say they want to be breathing, however fast they're breathing, that kind of determines the atmospheric composition of the entire warehouse. So what's nuts about that is, and I think as you say, what most people don't realize is that it preserves apples so well that you can happily pick up an apple in June that says it's an American apple and eat it, and that apple is nearing its first birthday. And I have been surprised at how shocked people are by that information. Because just if you think about it for a few seconds, we do all know that apples are harvested in the fall. So how on earth would you have an apple in May, an American apple in May if it hadn't been harvested in the fall and stored somehow?

But it's really the only way that... For example, Washington state has such a huge apple crop, it couldn't sell it all. It couldn't possibly sell it all if it didn't have these controlled atmospheres, refrigerated warehouses that allowed the apple to be stored and extended its life for so long that we can happily have a quote unquote fresh apple in June. And then of course, you get the whole other set of things from moving it around the country. So refrigerated shipping containers, refrigerated trucks, those pieces, and there's an entire kind of logistical geography of getting the apples from their controlled atmosphere warehouse in Washington where they're being stored to the distribution center for your local Walmart, which then brings it to the actual store. A lot of that has gone on and you've never even seen it, but that is what is happening to make sure that your Honeycrisp is in fact crispy and sweet tasting in June, May when it hasn't seen a tree for months.

Jerusha Klemperer:

It's wild. And I will just say that the book does, you do such a wonderful job of really explaining all the different ways that food gets around, whether it's by truck, train, boat, airplane, and kind of the development of technology on each of those modes of transportation.

Nicola Twilley:

Right. The connection, for example, between being able to kind of ship things by air and the rise of sushi and then bluefin tuna becoming an endangered species. These things, I think that's what I love in the end about these refrigerated stories is the implications are so weird and not what you... You invent a machine that allows you to truck refrigerated food around the country. I'm sure the guy who did that whose story, personal story is kind of amazing, a self-taught, African-American engineer orphaned, kind of figured out everything himself. He, I'm sure, did not foresee that his invention would lead to the end of unionized meatpacking. And the fact that now in slaughterhouses, you know labor is such a huge issue, that's because the refrigerated truck means that those slaughterhouses can be out in the middle of nowhere. Previously they had to be in cities because you needed refrigerated rail cars to ship the meat around, and in cities, you had enough kind of a mass of people to get labor organized and unionized and fight for better conditions. So these kinds of implications just sort of spiral outwards, and I think that's why I had... I mean, I had a lot of fun writing this book because you look at the technology and you could never predict the outcomes.

What amazed me with this story is how uncelebrated these people are. Okay, so I mean, you have Gustavus Swift, an astonishing guy. He sounds like a royal pain in the ass in real life. But anyway, you take someone like Gustavus Swift who invented the, well, really, lots of people tried to invent a refrigerated rail car, but he is the guy who made it work and allowed us... I mean, transformed the production and consumption of meat. And he is so much less of a well-known name than say Henry Ford, who looked at what Gustavus Swift was doing with a production line for meat slaughtering and was like, "Hey, that's what I'm going to use to make a model T Ford." The modern assembly line came from that. He gets all the credit for that. Henry Ford, everyone knows Henry Ford. Gustavus Swift, not so much.

So I really felt like a lot of these people that I wrote about, they had done incredible work. It changed what we all eat. And no one has heard of them. I mean, perhaps my favorite example is Barbara Pratt who spent her twenties living in a refrigerated shipping container to understand what was going wrong. She redesigned the ventilation systems. She's the reason we have Peruvian asparagus all year round, Chilean grapes. For good and for bad. I mean, we can talk about the impact of that, but we just wouldn't have those things all year round if it wasn't for her work. And who has ever heard of Barbara Pratt? No one.

The guy who invented the salad bag. You can stop me at any moment, I'm sorry, but-

Jerusha Klemperer:

No, I love all of these stories. I was riveted by them.

Nicola Twilley:

Jim Lugg is the guy who invented this astonishing technology that most of us think is a plastic bag that our salad leaves in. The salad leaves are in a plastic bag. You buy them at the supermarket, you give it zero thought, you open it to squish it into your crisper drawer. That salad bag is actually a multi-layer, semi-permeable membrane. It's a high-tech respiratory apparatus that is delivering exactly the right blend of gases to those leaves to help them live as long as possible through this very sophisticated set of layers. So there'll be a layer of the plastic that's regulating carbon dioxide and a layer that's regulating oxygen and a layer that's working on humidity levels. And all of that is the equivalent of taking that controlled atmosphere technology I was talking about for apple warehouses and shrinking it down to the size of a plastic bag that you can buy at the store.

And I had literally always assumed it was just a plastic bag. No one has ever heard of Jim Lugg. No one even knows their salad bag is this high-tech device that's extending the life of their salad leaves. I find it astonishing/ when he retired, the company that bought his company just kind of threw out all his initial prototypes. It's amazing. We would not have that kind of salad blend without him, and yet he is the opposite of a household name.

Part of why we don't know these people's names is because the food industry doesn't really want us to think about how old our fresh food is. It's disconcerting. It troubles. I've heard people say that they enjoyed my book, but they don't feel better for knowing how old their food is. And it's true. There's a limit to how much people want to know about their food often. And so part of the reason we haven't heard of Barbara Pratt and Jim Lugg is that those stories are not the ones we get told.

Jerusha Klemperer:

I want to come back to what you were saying about meatpacking and meat distribution. You detail in the book that the cold chain really helped fuel this system and bring it to the kind of scale that we're at today. So how did refrigeration and refrigerated transport enable the expansion of this industrial meat system and the birth of factory farming as we know it today?

Nicola Twilley:

Yeah, this is where I feel like I have to preface this by saying you can't say, oh, refrigeration is to blame for factory farming. Refrigeration is an enabling technology. What it enabled was for us to be able to slaughter huge amounts of meat and store it and ship it to cities to feed people there. Previously without that, I mean getting meat to cities was a huge problem. There were a variety of solutions. People would literally try and walk meat into the city. There are accounts of people herding turkeys along country lanes to try and get them into the city for slaughter. They had to be slaughtered in the city, which was another huge problem, and put a constraint on how much meat people could eat. All of this made meat more expensive too, because as it walks into the city, it's losing weight, it's becoming more expensive, then it has to be slaughtered in the city. That's urban labor, which is more expensive. Also because it's not being slaughtered in bulk, you don't monetize the byproducts, and that's a big part of how meat became so cheap too.

Gustavus Swift, who I mentioned earlier, is credited with being the man who said, "We now use every part of the animal, the pig, but the squeal." So refrigeration is the reason. By enabling us to slaughter at scale and outside of the city near... First in Chicago, which had the benefit at the time of being sort of this American, it was the portal to the Great Plains and Texas and all of these spaces that European settlers saw as quote unquote empty and ready for exploitation. Cattle could be raised there much more cheaply than on expensive land outside of New York City or Philadelphia, but you couldn't get it to the people who wanted to eat it in New York City or Philadelphia without refrigeration. It just couldn't walk all that way.

So refrigeration opened up all of that vast expanse of land where suddenly you could raise cattle at scale, you could slaughter them at scale, you could monetize the byproducts, you could ship the cattle. Also, much cheaper to ship under refrigeration because actually you're only eating about half a cow. The rest is bone and hoof and stuff you're not eating, horns, organs, its skin. So you're paying to ship all of that and you're not eating it. That adds to the price of meat. So it really, refrigeration enabled this kind of revolution in how where meat was raised, the scale at which it made sense to raise it and slaughter it, and then the price of it could be sold for. And that led to an enormous boom in meat consumption.

And so all of that together, it adds up to a world in which we have industrial feedlots and slaughterhouses in the middle of nowhere. Most of us don't think about how our meat gets so cheap and how it gets to us. There's an amazing quote by a geographer called William Cronin who says forgetfulness was among its most significant impacts. Because refrigeration made meat production and meat slaughter take place out of sight. And once you have that, then the forces governing it are economic and you lose a lot of the concern you might have from consumers otherwise, if they were looking at this and saying, "Wow, this is cruel, this is disgusting that I don't like how the people are being treated. I don't like how the animals are being treated." If it's happening thousands of miles away, it's very easy not to worry about that. And that is what refrigeration made possible.

Jerusha Klemperer:

You do an excellent job of making that connection between the expansion of our cold chain and biodiversity loss. Also connected to that, which I always think is such an important part of the biodiversity conversation, a kind of deliciousness loss, a loss of flavor and deliciousness. How has the cold chain, even as it has brought new and interesting flavors to palates who may never have tasted them before, how has it also diminished really what we have in terms of variety and also in terms of flavor?

Nicola Twilley:

That's such a good way of putting it. And yes, you have to go back and think, wow, most Americans had never tasted a banana hundred years ago. So the refrigeration has brought us the banana. It's made the banana the most popular fruit in the world. Here's this slightly obscure tropical fruit that seems very unlikely to take over the world, and now you can find that in the most remote and unpromising gas station is a banana. So it has in some ways greatly expanded what we're able to eat and also when we're able to eat it. I mean the food writer, Joanna Blythman calls our supermarket sort of produce shelves permanent global summertime, and I think that's right. Everything is there all year round, and that is thanks to refrigeration.

Now, what it has also done, and if we go back to the apple, this is a great example because as undoubtedly your listeners know, there are thousands of varieties of apples. We have amazing names, Winter Moon and Opal Beauty and things like that. And you think, Ooh, what does that taste like? You

don't find those in the supermarket, and there's a reason for that, which is only certain varieties of apple really stand up to that controlled atmosphere storage that I was talking about. A lot of apples just don't do well in that situation. And guess what happened to those apples? They are no longer commercial apples. So yes, you might find them at the farmer's market, and I seek them out. I mean, my favorite apple in the world is the Ashmeads Kernel. That is never on a supermarket shelf, and you can only buy it in the fall, and it has to be grown locally. Because it just doesn't do well in refrigerated storage and shipping. So I just happen to think it tastes a hundred percent better than anything in the store, and most people haven't tasted those flavors. That's a reality.

So I think all the people who are not really bothered about apples because they've had a Red Delicious or a Golden Delicious and been like, it's not that delicious, which it's not. There's a world of apples out there. There's one for you, you just might not ever taste it if you don't go seek it out outside of the supermarket. So it's definitely reduced the variety available to us. The other thing is, in order to be stored in this way, an apple has to be harvested a little bit early because that extends its storage life. If you get it a little bit too late, basically it won't last long at all. Once it's really fully mature and ripe, bad idea. What you want to do is hit the sweet spot where it's sort of physiologically ripe, but not as in its done all its development, but it's not fully ripe yet.

That's a very narrow window. And what growers do is they err on the side of too early because too early is much better than too late. Too late, your warehouse full of apples will rot. Too early what'll happen is what does happen, which is it never ever develops its full flavor. And so, but guess what? Growers and supermarkets don't get paid for flavor. That's not how we shop. We shop, we look at it, it looks like a shiny green apple. We buy it, we take it home. Then it disappoints us much later. So after the transaction. A lot of people just want something sweet and crunchy, they're not that bothered about the nuances of flavors they're missing, but some fruits really suffer. The tomato is the poster child for this because it has to be harvested while it's green, before it's ripe, then it gets artificially ripened off the vine. And if you refrigerate it after that, just so people know, if it goes below 50 degrees for more than three days, the machinery that makes flavor will switch off forever. So don't refrigerate your tomato.

But also in breeding a tomato that was capable of being harvested while green and shipped around the country and ripened on demand using plant hormones near the place where it was going to be sold, breeders actually accidentally bred out the machinery, the genes that are responsible for flavor. As it happens, those genes are also connected to nutrient levels. And this is a really interesting thing that many people are not aware of, which is that nutrient levels in our fruit and vegetables are dropping. It's sort of this mystery that the USDA has observed but doesn't really understand why it's happening. And my unproven theory is that I really believe, and the tomato gives us compelling evidence that this is the case, that in breeding for shipability and that kind of sturdiness and ability to refrigerate, we've bred out not only deliciousness but the associated characteristic of making the nutrients we want.

So yeah, it's a weird thing, refrigeration. It's brought us blueberries on Christmas day and bananas all year round. And there's no doubt that before it came along, people in the Northern Hemisphere in February, March, they were suffering from a lack of fresh fruit and vegetables. People used to call it spring sickness. And the way to treat it was get yourself round a salad as soon as you could. It wasn't scurvy, but it was what people were in a pre- sclerotic state is what the doctors say.

So it's not as though the past was this ideal place where we were eating much better. But refrigeration has diminished, I would say, the deliciousness and variety of our fruits and vegetables while sort of increasing the availability of those select few that kind of can function in a refrigerated system.

Jerusha Klemperer:

What you're getting at is something that I think the book does a really wonderful job of is doing a real sober look at the cost benefit-analysis of refrigeration and all that we have gained, and then the things that we lose as well. You describe a few what I would call sliding doors moments when we could have built things better or built a world that was less environmentally disastrous. And I do want to talk about those environmental impacts. Of refrigeration in particular, not just the world that it enabled. You mentioned that we could have nutritionally focused on beans instead of meat as our major protein source, and that kind of blew my mind that if nutritionists had come down at that time in favor of beans instead of meat, that really could have been a game changer. But also that we could have instead of sticking with electric refrigerators that we could have gone with gas and then maybe even powered our home refrigerators with household level food waste. And then I just felt like crying. 'Cause I thought that is so beautiful and could be such an amazing thing on so many levels.

But it was just interesting to me because it seems like we think of things as an inevitable forward march of progress and things can only happen in one direction, but actually these are choices that are made all along the way. And then you really set us up for looking at places that have not developed their cold chain yet. Or that are a few steps behind us, and that actually looking at these inflection points where we maybe made some bad decisions becomes an opportunity for how we'll develop the cold chain in other places, like in the developing world. What are some of those things that we got wrong that we could maybe get right in places like Rwanda, which you visited and focus on in the book?

Nicola Twilley:

Yeah, I mean, this is what I hoped to do with the book. 'Cause I feel like refrigeration hasn't been questioned. And it's funny, people within the industry, and I think a lot of people outside of the industry have asked would be like, "Oh yeah, it's been a blessing." It prevents a ton of food waste. It gets us a huge variety of fruits and vegetables, lifts farmers out of poverty because now they can export their products. It seems great. What could you possibly have against it? And I think the purpose of writing my book was not to be like, gosh, refrigeration is dreadful and we should all immediately get rid of our fridges. Absolutely not. You can pry my fridge out of my cold dead hands. But it was more to say, listen, it has had these costs. Some of them are sort of inherent to the technology. Some of them, like you say, are choices that we've made.

One of the things that refrigeration tends to do, for example, is it tends to scale. And there's a few reasons for that. It's expensive. And so as I saw in Rwanda, for example, even companies that are founded with a sort of a non-profit mission to spread the wonders of refrigeration among these small holders cannot actually work at the smallholder level. The cost of running refrigeration and the price, the level of infrastructure required just doesn't work at the smallest level. They find themselves having to work with bigger farmers and farmers who are growing crops for export, and that's not the point. Those are not the people. Do we want a system like the U.S. where I think it's less than 4% of Americans are farmers anymore, and these are huge farms, and there isn't really an economic way to make it work at a smaller scale other than by doing experiential things like pumpkin patches and pick your own or specialty crops. It's very hard.

Refrigeration doesn't have to mean that. I mean, Polly Pennington, who is another of those unsung heroes of refrigeration, that pioneering kind of female chemist who made Americans trust refrigeration, she saw that tendency and tried to set up community refrigerated warehouses so that farmers didn't have to scale up their production and essentially the scale of their farms and could still benefit from refrigeration and the ability to store meat and sell it later when it would get a higher price, and ship it

across the country where it would get a higher price, all of that. That was something she saw coming and tried to avoid.

It's the same thing with shopping. I mean refrigeration, once you have a fridge in your home, you can store things from multiple days, means you can buy things for multiple days, means you can do a bigger shopping trip, leads to the invention of the shopping trolley, leads to the out-of-town supermarket, which then puts those high street shops that you would've gone to every day out of business. That's not an inevitable chain reaction if you put in place things to make it not inevitable. So for example, in several European countries, there's legislation around the size of grocery stores and not allowing them to be these suburban out-of-town kind of places that destroy down towns.

So that's a long-winded way of saying what I hope to do by flagging some of these issues was say, "Hey, in the parts of the world that haven't built a cold chain yet, can we do better?" The famous thing that people always say is like, oh, look at Sub-Saharan Africa. They didn't have to build a landline network, they went straight to cell phones/ and they didn't have to worry about checkbooks, they've gone straight to digital banking. Large chunks of the world do not have a refrigerated food system. They are building it right now. And so this is our chance to say, hey, what doesn't work about ours? Where have we sort of allowed this technology to enable results that are not good for the environment, for the planet, for our social equity, any of the measures you might want to look at, and can we do something about it?

The other thing that makes it more pressing right now, as you pointed out, is that cooling food has a huge climate change impact. I mean, cooling anything has a huge climate change impact. We're seeing that right now with all the data centers for AI. But cooling, and this is again, just sort of basic thermodynamics, you're pulling heat out of something. It takes a lot of energy to do that. That's a huge part of cooling's impact. Cooling is currently responsible for 10% of global emissions. That's only growing. It takes more energy to cool things as the planet gets warmer. That's a huge problem that is coming down the line. The other issue is that the chemicals we use, those refrigerants I talked about earlier, those often have extremely high global warming potential. There are gases that have many hundreds or even thousands of times the global warming potential of a ton of carbon dioxide, say. And so that's a huge problem too.

So the climate change impact of refrigeration had sort of flown under the radar for quite a while. When I wrote my first story for the New York Times magazine about a frozen dumpling billionaire in China and how China was building a cold chain and being China, they had basically done it overnight. I talked about this impact, and the fact-checker at the time was like, "Yeah, this seems right, but why is no one talking about it if it's right?" And it's true. No one really was talking about it. And it's really, I mean, the first meeting of the UN panel on sustainable cooling was in 2017, I was the keynote. It's a very sort of recent like, oh wait. This is a problem. And so figuring out how to do either cooling or maybe food preservation, 'cause this is the other thing I always point out is you want your ice cream to be cold. You want your beer to be cold. Your apple doesn't actually have to be cold, it just has to be fresh.

So if there's another way of doing that that doesn't require refrigeration, that surely is worth looking at. And so yeah, I think part of why this book is sort of important right now is that we are at this inflection point where if the rest of the world builds a U.S. style cold chain, there will be no harvest to put in it because climate change will have taken care of that. So we really do have to do cooling better. And I think, I hope, when I'm feeling optimistic, I think, well, if a place like Rwanda can figure out a better system, maybe we could learn and fix some of the problems with our own food system.

Jerusha Klemperer:

Well, you took me right to what I thought would be my final question, which was I'm a downer. So I felt at the end of the book nervous, a little scared about what lay ahead in terms of the possibility for replicating our mistakes and this sort of hotter and hotter world, and us cooling it more and more and more. But it sounds like you maybe feel hopeful.

Nicola Twilley:

I mean, it really varies depending what headlines I've read that morning. Listen, will we do as thoughtful a job of building a better food system as I want us to? No, of course we won't. And frankly, realistically, any technologies we develop are always going to be implemented in pursuit of profit. We can hope that and we can ask our governments to also consider their environmental impact and their health impact. And I hope by writing the book, I can flag some of the things, the questions we should be asking and the things we should be saying to our elected officials that we are not happy about and that we would like them to do some regulation here. I mean, the government has regulated the cold chain in as far as it ensures food safety. They haven't regulated it in the U.S., at least, in as far as it affects the scale of grocery stores, the scale of farms. Those things are seen as kind of being individual liberties here, but they have impacts. So we can think about those. I'm European originally. I'm not as afraid of regulation as many Americans find themselves.

But leaving that aside, I do think that there are some really promising technologies out there. For a long time, cooling had just been left the same. It worked. We tweaked around the edges. We replaced CFCs when they turned out to be causing a hole in the ozone layer. We made things moderately more efficient. We did not fundamentally wholesale rethink how we were doing this. And that's weird. When I went to the library, when I first started thinking about writing this book, I wanted to check: had anyone else written about this? And so I went to the library and the only book that wasn't sort of a textbook for refrigeration engineers had been written in the '50s.

And the guy at the end of the book was like, "Yeah, this refrigeration thing is awesome. It's been revolutionary, but it's only the latest in a long series of improvements and innovations and breakthroughs in the way we preserve food. So I'm sure coming down the line, there'll be something else." And there I was like, huh, coming down the line.

Jerusha Klemperer:

Any minute now.

Nicola Twilley:

Exactly. But actually, yes, any minute now. I mean, it sort of blows your mind 'cause you're so conditioned to think about refrigeration as being the way that keeps food fresh. But there is technology out there that is able to give fruit and vegetables the same shelf life as refrigeration at ambient temperature. There is technology out there that can frozen french fries that are normally frozen, keep them at ambient for months. That can be applied to meat, that could be applied to all kinds of products that currently have to travel in the cold chain could be pulled out of the cold chain, and that would have huge impacts. The same way the cold chain has had huge impacts, pulling things out of the cold chain would have equally transformative impacts.

And so I am excited in the past couple of years to have seen these new technologies emerge. It has been a very kind of under-researched field, but now people are working on both alternate food preservation methods and completely new ways of cooling. So not using this traditional vapor compression system we

have using materials that, I mean, they will have almost zero, not zero, because nothing is zero, but almost zero climate change impact. And so it's exciting. None of these things are totally ready for primetime yet, but they're in pilot phases, they're in production. Some of them are in the grocery store. So we have some really good tools. Now, if we can implement them in a considered and thoughtful way, that's great. If not, it will at least improve the climate change impact.

Jerusha Klemperer:

That was fantastic. Thank you so much.

Nicola Twilley:

Well, those were great questions and also really nuanced questions.

I think people are conditioned now to be like, is it bad? I'm like.

Jerusha Klemperer:

It's both.

Nicola Twilley:

It's both.

Jerusha Klemperer:

What you're eating is produced by Nathan Dalton and Foodprint.org, which is a project of the Grace Communications Foundation. Special thanks to Nikki Twilley. You can find us at www.foodprint.org where we have this podcast, as well as articles, reports, a food label guide and more.