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Matt Eastland [00:00:03] Agriculture is at the heart of our food system as our population grows, so too does our dependence on it to feed and nourish us. And farming sustainably will be crucial to people and the planet. But sustainable approaches like regenerative agriculture require planning and patience. So is there a way of using technology to speed up and support the process?

[00:00:28] I'm Matt Eastland and welcome to The Food Fight podcast from EIT Food exploring the greatest challenges facing the food system and the innovations and entrepreneurs looking to solve them.

[00:00:40] So there's a sense that industrial agriculture and innovation has gone too far at the expense of our land. So in a way, you can understand why some farmers might have some reservations about using new technology, but surely we can use technology to farm better and in a more natural way? Well, to help us understand this area better, we're joined by two sustainability heroes with a taste for tech. First of all, I'd like to welcome the founder of Hummingbird Technologies, Will Wells. Hummingbird Technologies is an imagery analytics provider optimising satellites, drones, robots and planes to help pharmacy complex problems within their fields and work towards becoming more regenerative. Thanks for joining us today Will.

Will Wells [00:01:21] It's great to be here, Matt. Thanks for having me.

Matt Eastland [00:01:24] Thanks Will. And joining us from Switzerland is our second guest, Marina Martin Curran, who's the sustainability manager for one of our Rising Food Stars at EIT Food, Vivent. Vivent develop technology for applications in agriculture and medicine, helping improve health outcomes of people and plants! Thanks for joining us today, Marina.

Marina Martin Curran [00:01:45] Thank you for having me.

Matt Eastland [00:01:47] Great stuff. So in a previous episode, we were talking to Patrick Holden, who's someone who's really seen as a pioneer of the regenerative and sustainability movement, and he, while he was on the podcast, he kind of had this great phrase where he said, "we're at the threshold of a whole new chapter in the global history of farming right now". And I just wanted to kind of get your top line thoughts, is that something you agree with and if so, why? And maybe, Will, we can start with you. Do we think we're at a threshold?

Will Wells [00:02:19] I would have to wholeheartedly agree with Patrick there. Look at what's happened in the last five years. It was unthinkable at the time to imagine that we would now be in a world in 2021 where climate innovation is out on farm. Novel farming systems are being scaled up, including cellular, protein controlled environment, agriculture, drones, satellites, robots. These are all things that are not commonplace but are being used. And it's an incredibly exciting time both for us in technology, but also at the biological end where we're seeing as much innovation.

Matt Eastland [00:02:59] Amazing. And Marina, is that something you agree with?

Marina Martin Curran [00:03:02] Absolutely. I think that we're at the threshold also because young people are getting interested again in farming, and that's really key because they've got the skills they're hopefully digital natives they understand about robotics and AI. They're excited to apply this tech in the field and get their hands dirty.

Matt Eastland [00:03:25] And do you kind of get the sense that previously there might have been a resistance towards technology in the agriculture sector and maybe now that's opened up?

Marina Martin Curran [00:03:35] I don't even know that there was a resistance per se. I mean, maybe with an old guard of farmers, then yes, it's like we need to just farm the way we've always farmed and the way my father taught me and that sort of thing. But I think also because the technology just wasn't there. So now that it is, I would say, even the older generation have a chance to get on board with it.

Matt Eastland [00:03:58] And Will, do you think the older generation are starting to adopt this?

Will Wells [00:04:03] I think so. And what's interesting is that lots of people talk about a stereotypical Ol' McDonald version of farm adoption, as if there's some older generation that are blocking technology being rolled out. I would disagree there, because as Marina said, a lot of the times the technology didn't really work. And if it did, that was this question hanging in the background - well, who pays? And so a lot of the adoption that we're seeing now is consumer led, as Marina said, or it's government inspired or government subsidised. And the technology, quite frankly, is now giving that ROI on a sort of unit hectare basis that it perhaps didn't do five years ago. So we're seeing the right ingredients in the mix, public, consumer and technological to kind of really leapfrog us forward.

Matt Eastland [00:04:58] It's great to know this space is really developing. That's really encouraging. And Will, you know, can just tell our listeners a little bit about Hummingbird and how your technology or technologies actually work?

Will Wells [00:05:10] Sure. So Hummingbird is a remote sensing and artificial intelligence platform for agri food. And what that means is that we use satellite data predominantly to measure and monitor sustainability across very large agricultural areas and in an algorithm and model level what we're really interested in is in looking and picking up changes in soil practises. So, for example, a switch to conservation tillage, improved biodiversity at a crop rotational level, so we can tell what's in what fields and over time. So if we get given the land parcel, we can see what's been planted every year for the last few years. The introduction of cover cropping and other metrics that is sort of globally acknowledged to be regenerative by switching practise and our job, rather like an audit, is to pinpoint when they happened and to give independent, objective evidence from space in a very cheap way that certain actions took place. And this is super important for governments, for consumers or any large corporates that want to monitor their supply chain.

Matt Eastland [00:06:25] Wow, OK. And I know as well that you're sort of working with lots of scientists remotely across the globe. I mean, what's the reasoning behind that and how are you all working together?

Will Wells [00:06:35] Well, there's a lot of science under the hood in farming and whether you're developing a deep learning based classification model. I mean that in layman's terms just tells you what signature each crop is giving off so that you can look at Germany

and pinpoint what's in what field everywhere. That's an A.I. science endeavour that gets turned into code that gets turned into software. But if you're embedding agronomy or bioinformatics insights into the software as well, you really need to know the farming, know how the agronomists know how and possibly some plant pathology as well. So we have to work really closely with academics, research scientists to get that knowhow into our system.

Matt Eastland [00:07:21] Got it. OK, that's super clear. Thanks very much, Will. And Marina, over to you. So can you tell us a bit about Vivent and the role that you play in the company?

Marina Martin Curran [00:07:31] Sure. So Vivent was started back in 2012. The research and development has taken a long time to get to where we are, and it's really only in the last year that we've been able to commercialise. And what we have been focussing on is the plants rather than the human side. We have a device which the easiest way to explain what it is is like an ECG for plants. So it's a box with electrodes that you can then poke into the plants and you have two electrodes in the stem top and bottom of the stem. The bottom one is essentially the Earth. And what you're measuring in milli volts is the electrophysiological signals of plants. So, for example, when a caterpillar chews on the leaf of a plant, then a signal is moving from where the caterpillar is all the way along the nerves (nerves in quotes) all the way along the leaves through the stems so that very quickly, literally within a matter of seconds, the whole plant knows that it's being attacked by a caterpillar.

Matt Eastland [00:08:40] Wow. OK, so how do farmers work with that? What's the real benefit for them?

Marina Martin Curran [00:08:44] What's the use? So we have these signals, like Will, we're able to then apply machine learning and build algorithms for different types of signals for different types of crops. So we have what we call crop stress pairings. So, for example, tomatoes and a drought stress signal. So each type of signal will be slightly different if the plant is under stress because it needs water or because it's deficient in a particular nutrient, or because it's being attacked by a fungus or a nematode or an aphid. All those signals will be different.

Matt Eastland [00:09:22] So does that then mean that you can use resources more efficiently effectively?

Marina Martin Curran [00:09:27] Exactly. So we then are able to provide a grower, whether it's an outdoor farmer or indoor horticulture controlled environment growing with this information for the farmer to then be able to make decisions. So it's like an early warning system because we can actually see the stress in the signal before you see it appear on the leaves. So we know well before the leaves are turning brown or spotty or whatever it is that there's a problem. And so the grower is made aware of that, and they can then make a decision as to what they need to do - more water, a particular nutrient in the fertiliser, rather than applying the whole array of fertiliser, using pest control in a much more efficient manner, especially in light of obviously, this whole conversation is going to be about regenerative agriculture, but especially in that light of trying to be much more efficient and reducing use of pest control.

Matt Eastland [00:10:31] Got it, just amazing. I love this space, there's so much amazing technology coming out here, just it's incredible to even be speaking to you about all of this

and question to both of you then. So where do farmers start using this technology on their journey? So whether or not they're sort of conventional farmers looking to move to say, for example, regenerative, already regenerative farmers, where do you kind of start with this tech? And I was just thinking about one of the things you said as well, where you're talking about some of the bigger players is this sort of technology just for big players? Or can this kind of go slightly for smaller farmers as well? So, Will, what do you think? Where would a farmer sort of say, you know what, I want to start using Hummingbird Technologies.

Will Wells [00:11:14] So we work with many farmers, but not necessarily directly. We tend to work with governments, water companies, ag input companies, big businesses that are farmer facing and even carbon trading platforms where farmers or big businesses can register a project and Hummingbirds job is to independently verify what was going on. We did actually start at the beginning of our journey working with farmers. It's quite difficult when you're measuring sustainability to navigate the whole who pays thing. And what we found was that we had better traction working with very big businesses and then through them farmers, but trying to influence some B2B value rather than, you know, dumping loads of technology on the farmers and saying, hey guys, can you pay? So but there tends to be benefits that flow in all directions. It's just that's our channel and it seems to be working so far.

Matt Eastland [00:12:12] OK, got it. So maybe going through other people to then influence the farmers is obviously yielding better results for you and Marina, I could see you sort of nodding away while Will was talking. Has that been your experience?

Marina Martin Curran [00:12:25] Yeah, it sounds very familiar. It's really difficult. You know, new technology has a cost inevitably, and farmers always, always have very tight margins. So even if they're really keen, and even if we drop the price to ridiculously low, it's still a cost that they weren't anticipating in dispersing as it were. However, because we are still in an R&D phase, we can work with farmers and try and find grants and try and find money elsewhere. And it's really valuable for us, of course, to work directly with farmers. To give you an example, we had a local farmer in the office yesterday. His farm is literally 200 metres from the office, and he's really quite amazing guy because he continues to be diversified. He's inherited his parents farm, he's got asparagus and strawberries and apple trees and vines, all sorts of things, and he's trying to make it work, as he says, with a mixture of low tech and high tech. And he's really keen to work with us. He hasn't got the money, but we're applying for a grant to work with him. And in the interim, we've already put one of our devices in his asparagus crop because we're really keen to know what an asparagus signal looks like.

Matt Eastland [00:13:46] Aren't we all!

Will Wells [00:13:48] If I can add to Marina. And by the way, I'm a massive fan of Vivent and this whole notion of like early warning systems because so when Hummingbird started, we actually did a lot of research into can we spot pre-symptomatic disease using a hyperspectral sensor on a drone? And the short answer was yes, but it was very expensive and basically, we couldn't scale it, because it's operationally so difficult to put, you know, a £50000 camera on a drone and then fly it around the field. But you could see early stress pre-symptomatic and not that the human eye could see it, let's say, up to 21 days before it became visible. Now that is a game changer for a farmer or an agronomist or anyone that's spending tens and tens of thousands on what is basically chemotherapy and reactive. So the equivalent is sort of, you know, immunotherapy. It's proactive, and

your unit costs for chemicals could come down so significantly that I can see this, you know, being adopted at huge scale once those use cases are working.

Matt Eastland [00:15:00] Could you explain that Will? So you're saying you think that will be a game changer, why does having that three week, 21 day pre-warning? Why is that such a big deal for a farmer?

Will Wells [00:15:10] I think at a high level, some chemical inputs are put on as a sort of preventative, and that tends to happen is a blanket spray. Some are put on as a reactive spray, and that tends to happen in a slightly more targeted fashion. But by in large, like the crop cycle is so short and you risk so much in terms. Of crop failure. That your best solution often is to pile on chemistry, which obviously builds up resistance, which obviously means more chemistry and and obviously higher input costs, you get stuck in this invirtuous sort of loop. Now, being able to detect something early like in cancer or life in any other human medicine is just a game changer in terms of patient outcome, plant outcome and overall biodiversity, I think. But Marina, I probably answered your question wrong?

Marina Martin Curran [00:16:02] Absolutely not. No. And funnily enough, the conversation yesterday with the asparagus farmer was, of course, prevention is better than cure. He loves that we're working on the early diagnosis of disease. However, he said, even if you give me a week's warning, it's too late because I don't want to be applying a curative treatment to the plants. He said I just don't want them to get sick at all. I need to be going into the season with a healthy crop. So for him, focussing on the drought stress and the nutrient stress algorithms is a better option because he says if you can get the nutrient balance right and build up the immunity to use that analogy, build up the immunity of the plant and have a robust plant in spring and early summer, that's much better.

Matt Eastland [00:16:55] Okay. Got it. Thank you. And I suppose we're already starting to answer some of this in terms of the next question. But you know, what's the big advantage in tech in the agri space? And is it that you can really radically scale up sustainable and regenerative farming so much quicker because of technology? And I asked that question because we've had a number of people on the show who talk about regenerative and starting to look towards tech and having this sort of merge of the kind of the traditional, let's say and you know, the high tech seems to be working and is that something that you'd agree with? Will?

Will Wells [00:17:30] I think that in parts of agriculture, you're beginning to see like such obvious return on investments, that technology is being adopted, but it tends to be fastest in areas where you know it's difficult to access labour. And therefore, like anything to do with automation, think about robotic harvest picking of soft fruit. Now a human is faster and is probably better. But in some areas, it's a bit like Ocado, and they started playing around with robotics 10 years ago. In some areas like it's just a no brainer. I think that we're beginning to see like pockets of the sector really benefit, but we're still lagging in other parts. So it's all to play for. But thankfully, there are some nice success stories now.

Matt Eastland [00:18:22] Thanks, Will and Marina, do you see that you can blend sort of regenerative, let's say, and technology really successfully?

Marina Martin Curran [00:18:31] Yes, I mean, I think we're all still relatively speaking at the beginning of the journey and convincing the end user is, you know, that's still the hard part. I think that as as Will has said working B2B with the big companies, with the Nestlé's

and the PepsiCo's and so on is a brilliant way of promoting this to the end user. The other thing is that there was sort of a large part of agriculture, which is high value crops where they will try lots of new things, where they are innovative and they have the money to spend. I mean, I'm thinking of almond growers in California, tomatoes indoors in the Netherlands and of course, cannabis, which is on everybody's lips, if I dare say, in Switzerland at the moment.

Matt Eastland [00:19:24] Hmm.

Marina Martin Curran [00:19:25] So that's where, you know, companies like ours can focus. And then if you get traction in the high value side and you can, you know, democratise it eventually.

Matt Eastland [00:19:38] Ok and we were talking to our agricultural manager on a previous episode about this and he was talking about regenerative and how actually moving from traditional farming to regenerative already requires like a mindset shift. And you know, there was a lot of confusion about where you start there. I'm just wondering, does layering over like a technology element then make that nervousness even greater with farmers? And how do you overcome that? You know, Will, what's been your experience?

Will Wells [00:20:06] I hope that technology would help it. So for example, imagine you're in a supply chain with a food producer and a food retailer, and like ultimately, your product is being sold at the supermarket checkout desk and to a consumer that might now reward you if there's proven traceability and sustainability of that product. So what we're hoping is that technology can enable, you know, farmers that do make the switch to selling their produce at a premium to those that don't. And we're hoping that that same framework gets adopted with government subsidies or unregulated carbon markets. So the idea is that technology can facilitate an economic benefit flowing from consumer to the producer on account of something that's green. But you can't measure that, and you can't monitor that without technology because food production happens at such a vast scale. It would be impossible to do it otherwise.

Matt Eastland [00:21:11] OK. And, Marina, any thoughts?

Marina Martin Curran [00:21:13] One of the things that companies like ours have to do is have consumer trust, have the confidence of the consumer that we're not adding to the problem. So for example, we've been conducting a life cycle analysis. It's taken months. It's way more complex than I ever thought it would be. But a lifecycle analysis of our device and what goes into our electronics and our box and our electrodes and how much what the carbon footprint of it is. And also once you plug it in, how much energy it consumes. So if we're able to say to a farmer who's moving to regenerative agriculture and he says, Yeah, but if I'm adding technology, then am I adding, you know, more carbon into the story? Is it going to be using a lot of energy and so on? And if we can say no or very little or it's an insignificant cost compared to the benefits that you'll get from having a higher yields or less pre harvest loss, which is, you know, two sides of the same coin, then that can really help in their decision making.

Matt Eastland [00:22:24] It's interesting. I'd never even considered that element actually that by introducing technology, actually, farmers might be thinking this introduces even more carbon into what they do. So it's good that, you know, on both sides, it feels that there is an economic and an environmental benefit to going down this route, which is

great. And so, OK, so if you can kind of convince farmers one way or another via whether it's economically, you know, the consumer demand environmentally that this is the right thing to do - where do they start then? So, you know, I'm a regenerative farmer. I want to introduce this new technology. What's the first step? I mean, I guess you'll probably have a view on your own technologies, but I'm just interested in how you kind of overcome this with farmers. So, you know, Will, what's the first step for a farmer to kind of introduce Hummingbird Technology into their farming processes?

Will Wells [00:23:15] So all farmers that I've ever met experiment and they're all business people. So you have to start with the basics and what works for your farm might not work for someone else's farm and vice versa. So experimenting with the introduction of certain regenerative agricultural practises should begin with your own sort of mindset, and maybe you'll introduce cover cropping on one field. Maybe you'll switch tillage practises on another. Maybe you want to set aside parts of your land or change the land use, and all of those things can capture an economic benefit. So my best encouragement to anyone is attend events like Groundswell, where you can actually see a lot of these demos live. Watch what your neighbours are doing, speak your supply chain customers and see if there are kind of rewards or experimentation programmes that are out there that you can take part in to actually make it business sense, as well as agronomic sense. I think, you know, thankfully we're now in a world where all of the things that I've mentioned are going on.

Matt Eastland [00:24:28] Mm-Hmm. OK, so you kind of farmers need to be exposing themselves or exposed to this kind of tech and getting advice from, you know, the people who are already going there before? And Marina, what about you? So how does a farmer start using Vivent tech?

Marina Martin Curran [00:24:45] Yeah. Give us a call. So we are pretty generous in terms of organising trials and rental agreements rather than sales in order to get the farmer on board and get them to see for themselves what it can do. It's been actually really a wonderful journey for us to see how farmers respond to the data that they see, which initially looks like a pretty horrible signal and difficult for people to interpret, but which we are working on to have a more user friendly interface. But they interpret the signal themselves and see what, they see that the plant is communicating, and it's like a paradigm shift in terms of how a farmer perceives their crop.

Matt Eastland [00:25:34] Mm hmm.

Marina Martin Curran [00:25:35] I mean, I'm not a farmer. I have worked on farms, on dairy farms, and I obviously I know how fond a farmer is of their livestock. But I've never really had a feel for how fond they are of a crop. But yeah, it's their livelihood. So if they see that the plant is stressed, then they want to do something about it. And then, of course, you have word of mouth and on farm trials where you can bring farmers to come and have a look. We're doing a town hall and a couple of weeks time here in Switzerland, where we've invited about 50 local farmers and vineyard owners, hoping that we can get the message across in French. And yeah, and just get some people on board to try it. And then I think it will hopefully trickle down

Matt Eastland [00:26:27] Ok so maybe sort of starting smaller and then, you know, trickling down I like that. And does education need to really feature in here or something a bit more formalised for farmers in terms of like sustainable farming and technology? And you know, how does that even work? So it's great that this technology is out there and it's

available, and it's great that people can see it working. But how do farmers get educated and really up to speed on this stuff? You know, our agronomist up to scratch already on these sorts of things? So how do we go about better educating farmers to use this tech? What do you think Will?

Will Wells [00:26:59] I think most farmers are aware at least of all of the science content that's been mentioned today. I think it's important as well to kind of recognise where we sit in history and that there's an amazing opportunity for food and agriculture to be part of it, a sort of decarbonised world. And it's not like other sectors, energy and transport or sort of the fossil fuel sector that is all stick and no carrot. I think everyone I know in farming has clocked that there is this enormous potential for responsible food production to become a climate positive exercise. And I don't know that many farmers that don't consider it their responsibility to society for things like food security and dare I say, most of them now consider, you know, habitat restoration and biodiversity as key parts of that. So I'm pretty hopeful for farmers, more farmers getting involved and the ones that are the first adopters really seeing the benefits now.

Matt Eastland [00:28:12] So you think that they, farmers naturally embrace this kind of change because they think that it's the right thing to do?

Will Wells [00:28:18] I think in many places, yes, it is a tough, tough industry with very thin margins. And we all know, you know, problems like weather greatly outweigh kind of smaller things that you can do to impact production like regenerative AG. So I think within the context of it being a very tough industry, I think in the very long term, people acknowledge that they want to be part of the solution and not the problem.

Matt Eastland [00:28:45] OK, great and Marina, again I can see you nodding. You obviously agree. I mean, do you think there's a way to accelerate this education process for farmers perhaps?

Marina Martin Curran [00:28:55] Yeah. Two things come to mind. One is the story that your guest last week gave Philip on the peach farmers, and I think stories like that are becoming more and more prevalent in the media. I don't know if it's general media I'm reading, but I've certainly read similar stories recently, so that will help to accelerate the thought process of - oh wow, if I can increase my yield by 25 percent within a year and I'd be crazy not to try to reduce my inputs and dramatically rethink what kind of fertiliser I'm putting on the ground. The other thing, of course, is sitting in Switzerland, I have a very different perspective. Swiss farmers are a very powerful voice here, and there were two rotations earlier this year that resulted in double nul. Both rotations were to do with environment and sustainability and reducing inputs. One was in order to improve the quality of the water table, and the other one was to dramatically reduce inputs in farms, including buying an external forage, and that you should be self-sufficient in forage for the livestock that you keep. But the double norm was not because farmers are against change or against sustainability, per say. It was that the certainly the farmers that I spoke to said that it went too far too quickly with no reasonable alternatives being given. The other side of the argument is, of course, there are alternatives. Everybody knows that there are. You just need to go out there and get them, but they are more expensive and they're not necessarily as efficient. So we feel that we can support those farmers in that transition that if they have to start using some novel bio control bio stimulant, but you know, we can support them to see when and how much they need to apply it, where they need to apply it and get the results that they want.

Matt Eastland [00:31:08] Perfect. Thank you. And I want to talk about the future in a second, but I pick up on something you said there about going too far in this, I think this is one of the things that constantly plays on people's minds in this space. Maybe with farmers, and maybe that's not actually true, but is there a worry that we can use too much tech and we can take things too far? So is there a potential negative side effect, you know? Will, you were talking at the beginning of the show about the fact that you can kind of over mechanised and actually that might not be the right solution. So is there a kind of a potential trap that we might fall into if we kind of apply too much technology?

Will Wells [00:31:47] Of course. But if you and this is not to be too cynical, but we've been debating elms and what will happen for years and years, but nothing's really happened yet, or nothing's happened at scale and sort of absolute clear policy terms. So there's still a lot of talk about the role of technology and a switch to more sort of regenerative subsidy based farming in Europe, but we're still waiting for some very big moves to happen. Ditto in the US, in spite of lots of corporates kind of piling in and testing things. And just to give you one example, you get carbon purists that argue, oh, we have to measure every single square metre of a field and measure soil organic carbon and send it to a lab. Now, that would be amazing if it was practical and if it wasn't like monstrously expensive and then you have at the other end of the scale that says, well, it's just principles, and I'm Microsoft, I'll buy a carbon credit if someone is trying to be more regenerative and they abide by certain frameworks. And I think that that last approach obviously is vulnerable to everything from greenwashing to fraud to, you know, everything in between. But at least it acknowledges that we're in a crisis and let's do something about it and let's get this thing moving. And technology is really a tool to do all of that. I don't think it's a blocker so long as it works. It's a tool to accelerate adoption or to facilitate an easier or more cost effective transition. And it's not something that stands in the way I think governments and capital markets and agriculture being very tough, are probably bigger barriers than technology.

Matt Eastland [00:33:35] Marina, what's your view? I mean, can it go too far and actually is this just something that everybody needs to adopt?

Marina Martin Curran [00:33:44] Well, just bringing it back to a really practical level and experience that I've had recently speaking with growers is them saying, 'Oh God, another dashboard, another sensor, more data. I spend half my morning looking at screens rather than being out in my greenhouse or in the fields'. So I think we have to make this technology easy to adopt.

Matt Eastland [00:34:09] Hmm.

Marina Martin Curran [00:34:10] I think that we are a lot of players in the market, if I dare say that Will, that that there's going to be some consolidation amongst the tech companies for sure. And if we can join up and work together and have APIs that work well, then we're going to get a lot more traction.

Will Wells [00:34:28] This is a really important point. Now, six years ago, everyone was worried about having to log in to 20 different dashboards. That still exists today but as Marina mentioned, software is now integrated with other software through APIs and like we believe that the entire verification of regen ag will happen in the back end. No one will even need to log in at all, it will happen like a credit check, like an audit, and that parcel of data will be verified by another technological tool. And once farmers, customers, buyers, sellers all trust the technology, I don't even think they need to see it. So looking at some really advanced stuff. A friend of mine has mapped 44 million homes in France and

created a digital twin of every house, and the purposes is to simulate heat emissions being lost and energy savings across the grid. Now imagine you could do that for agriculture, all in a virtual world, and you could simulate all types of scenarios. This doesn't need, you know, farmers logging in or sensors on the ground. This is all possible now with technology, and it's a sort of big picture thematic breakthrough that we need to sort of move the needle properly.

Matt Eastland [00:35:50] That's amazing. So your view is that potentially the technology will get so advanced that it almost then goes the other way that from a farming perspective, it's just then super straightforward because they never, like to your point, they never even see the tech. It's just doing everything that's required in the background.

Will Wells [00:36:07] I think that's right, and it just happens, and the food production is very opaque. But imagine if you were able to map sugar globally or create a digital twin of palm oil and trace every single plant to its consumer product. Now that is very, very hard, and I'm sure one day it will be possible. But if that was possible, consumers would be able to choose. And once you unlock that sort of traceability problem, then anything's possible.

Matt Eastland [00:36:39] That's amazing, I love that. And Marina, do you feel the same that, you know, technology can advance so far, that actually just makes it super, super easy and super simple for everyone involved.

Marina Martin Curran [00:36:52] I certainly hope so. I suppose we're at the much more at the micro level as opposed to Will's macro level, so we would still need to have something in the plant unless we were able to capture their signals remotely. That would be incredible, that would be a real advance in technology that we're certainly working on the next generation of our device, which will be small you know size of a mouse, let's say, with electrodes and which will have a battery and you'll be able to fix this on to a plant in the middle of the field and you won't need to have cables and solar panels and batteries and so on. And certainly in terms of then giving the minimum amount of data to the farmer to not overwhelm them, but for them to make a decision would be obviously a system of alerts that would come up on a screen or a phone or something and say, You know, we go, no, go water nutrient, whatever it is. So we're not quite able to go Will's way, which is totally hands off. I think that's in the nature of our tech.

Will Wells [00:38:00] Yeah and I don't want to get intoxicated on my own singularity vision. And it's not meant to sound scary or far fetched. I think it's probably a long way off. But imagine you're a farmer today and you've been farming for 20 years. It's all about pattern recognition, and the pace of change in the last five years is so much faster than the previous five. All you need to do is follow the curve upwards and then imagine what it will be like in 10 years time. I think I've seen 20 companies or 20 decks in the last month for cellular protein. I don't even know existed three years ago, and I know there are hundreds, hundreds and hundreds of new start-ups in that arena out there. So I think big change is possible in a very short space of time. It's not as binary as it will replace livestock. I don't think that's going to happen, but it might balance it out so the livestock will rise gently in terms of beef consumption and not as deeply as it's been going. And I think it's the sort of technology as a crutch, technology as a tool, alternative things as a substitute, but not so much that it's just a binary switch. I think it's a coexisting dimension that we're going to see.

Matt Eastland [00:39:20] And you just started to answer that. One of the last questions I wanted to ask, So, you know, what do you think then are going to be the biggest changes

in the world of sustainable agriculture over the next sort of, say, 5 to 10 years? If you say you can kind of see the curve, what's coming on the curve?

Will Wells [00:39:37] For me, just to point out a couple of areas. So I don't think the vertical farming is going to replace outdoor agriculture. I think that a hybrid model will settle in which, you know, fresh produce growers will transplant things that have been grown inside into the fields and the whole system will be improved. There's a massive problem with that subsector in terms of the cost of electricity and the cost to energise an indoor thing unless you're in hydroponics or by bioponics and use natural light. But that's a good example of a sector that's disrupting conventional agriculture. It's not going to replace it, but it may well find its sort of value pockets, you know, and for places where there's a high unit economic cost of food imports like the Middle East or you're next a massive urban centres, I can see that technology really marching on and settling in a nice position. But I think it's about coexistence again along the curve, not of something kind of completely weird and sort of Apocalypse Now type.

Matt Eastland [00:40:49] Thanks for your view Will, and Marina, what's your perspective? Where are we heading in the next 5 to 10 years?

Marina Martin Curran [00:40:57] I think it's this mixture of low tech and high tech of rediscovering things that the grandparents or great grandparents or, I would say, even pre Second World War and the use of heavy use of fertilisers combined with the high tech. We've been talking a lot about urban agriculture. Greenhouses, CEA, rooftop greenhouses, but again, I think it's really we have to remember that we can't live off lettuces and berries. So the focus is going to be on large crops where Will's technology is obviously going to be at the fore and how to get those large crop growers on board because they're going to be the last to adopt regenerative agriculture, if you think of the big Canadian wheat fields.

Matt Eastland [00:41:45] You think so?

Marina Martin Curran [00:41:45] I think it's the most difficult for them, but they have the most to lose and the most to gain. So they're the ones that we need to be really engaging with on trials and experimentation and new hybrids and cultivars that are resistant to drought and disease and so on without having to adopt to GMO or CRISPR. I love CRISPR. But Patrick Holden doesn't so.

Matt Eastland [00:42:15] I think we probably did a whole show on CRISPR. But Marina, sorry, did you have anything to add?

Marina Martin Curran [00:42:23] I think my last point was going to be to do with meat. And I think that there is this vast array of cellular proteins that is coming on board, as well as obviously developing higher protein content in existing plants like soy and beans and even wheat or rice or whatever. And I definitely think that in 5 to 10 years time, eating a steak will be a great luxury.

Matt Eastland [00:42:52] Thanks. And Will your final thoughts?

Will Wells [00:42:55] I think so and Marina sort of succinctly talked about CRISPR and gene editing and plant proteins and I'm not a geneticist, but what I am seeing is the sort of rise of the great biological revolution that's coming on the back of what we've seen, which is a technological revolution. And if you think of the first generation of CRISPR vintage

biotechnology companies, they're really just at the start of what is massive and there's a company in the UK called Tropic Biosciences, breeding climate change resistant seeds for sub-Saharan Africa. Amazing. Or trying to breed a variety of banana that won't get a certain disease. And if we're serious about food production, we must also get serious about genetics and the biological potential of lots of things that are going on. It can't all be solved by robots and drones. I mean, even I accept that, and that's my day job.

Matt Eastland [00:43:59] Thanks Will, to go from sort of something serious to maybe finishing up on something a little bit more fun then, just have a kind of an out there question for you both. So other than your own fantastic technologies, obviously, if you had unlimited funding, you know what technology would you like to invent right now to help the agriculture industry? Or maybe what technology would you'd like to see invented to help the agriculture industry? So big question who'd like to go first? Marina, any thoughts?

Marina Martin Curran [00:44:34] I'm thinking of Africa? We haven't even touched on feeding the world in a developing country context, which is huge and has been ongoing for 60 years in the development arena without coming up with the right answer. I wish I could wave my magic wand. I haven't got the imagination right now to think what that technology would be, but to wave my magic wand because if anyone knows about regenerative agriculture, it's an African farmer who can't afford to buy fertilisers and pesticides and needs to be reusing seeds and tubers year on year. So something to help them.

Matt Eastland [00:45:17] Thank you. And Will, if you had your magic wand, what would it be?

Will Wells [00:45:20] If I had a magic wand and a billion dollars? I would invent something that would allow me rather like of Harry at Hogwarts to look at a plant or a piece of food, and for it to tell me the exact nutritious content or how good the taste was, as if I could see taste like I see colour or see nutrition like I can see colour. I think that would be an amazing goggle/wand to have.

Matt Eastland [00:45:48] Fab. I think that's the first time we've had Harry Potter introduced on the show. So good. Good effort. Love it. Cool. Well, thank you both so, so much. It's one of these topics that we could talk about forever, and maybe theres a session where we just need to talk about the future in this space, actually. But thank you again. Just before we finish, then where can listeners go to find out a little bit more information about you and what your companies do?

Marina Martin Curran [00:46:13] You can go to www.vivent.ch

Matt Eastland [00:46:21] Great stuff. And Will?

Will Wells [00:46:23] hummingbirdtech.com and we're across all social media handles. And if you're a regenerative ag farmer or you're doing any experiments in that domain, get in touch because we're always looking for partners and places to test our technology.

Matt Eastland [00:46:39] Thanks Will - open invitation to everyone, so please take everybody up on that. And that just leaves me to say a big thank you to Marina and Will and thank you everybody for listening in. This has been The Food Fight podcast, and as ever, if you'd like to find out more, head over to the EIT Food website at www.eitfood.eu. Also join the conversation via #EITFoodFight on our Twitter channel @EITFood. And if you

haven't already, please hit the follow buttons that you never miss an episode. That's it for now. See you all next on!