Transcript: Plant Breeding Stories Podcast
S2E1 Plant Breeding Stories - Lee Hickey

[Theme Music Plays]

Hannah Senior: Welcome to this episode of the Plant Breeding Stories Podcast, where I talk to leading lights in plant breeding, asking what they do, what makes them tick and what fascinates them about the world of plants. I'm your host Hannah Senior of PBS International, world leaders in pollination control. We design and produce specialist pollination bags in tents used by plant breeders and seed producers all around the world. And through this, I've been privileged to get a unique perspective on how plant breeding globally affects our diets, farming systems and the environment.

Hannah Senior: I'm excited to share a little of this with you as we meet some of the amazing people who make plant breeding their life's work.

Hannah Senior: Today, I'm talking to Associate Professor Lee Hickey from the University of Queensland. He leads a research team focused on plant breeding innovation, that is finding and communicating ways to do plant breeding better, faster and more cost effectively. He talks in this conversation about how a limited view of what agricultural science is about originally set him on a path in life that didn't work out, and how this has made him passionate about bringing more bright young people into the sector. We also discuss how an explosion of technologies within and outside of plant breeding combined to transform what's possible in improving genetic gain, and how detractors are a fact of life when you're forging a new path forward.

[Theme music fades]

Hannah Senior: Thank you for joining me today, Lee. It's a real pleasure to talk to you. So just to get started, would you like to introduce yourself?

Lee Hickey: Yeah, I'm a plant breeder or crop geneticist, I suppose. I lead a lab on plant breeding innovation. What exactly is that? Well, we do research to help support

plant breeding programs, everything from, you know, understanding the genetics of important traits, like drought adaptation, or disease resistance to tools to help support more efficient plant breeding. So tools like speed breeding, or genomic selection, for example,

Hannah Senior: How did plants and plant breeding become a thing for you? Was there a childhood “a-ha!” moment? Or was it more gradual?

Lee Hickey: Well, maybe I have a bit of a weird story. But I grew up in the city. So I certainly wasn't around any farms. But at a very young age, I had this fascination for growing vegetables, I had a veggie patch in the backyard, from about eight years old. And I just loved, you know, reading up on, you know, selling guides, when to plant your potatoes and radishes and what's the best row spacing to use to maximize yield. And I found that I became a bit of a nerd of gardening. And I'd rush home from school, you know, to tend my veggie patch, at, eight, nine years of age and, but I think that's where my passion for this started for plants and food production.

Hannah Senior: So you had this interest early on, but I guess that could have led you into... Well, I mean, it could have led you into all sorts of different plant related fields, or indeed, you might have just kept it as a hobby. How did you get from there as a kid to what you're doing? Now? Tell me a little bit more about that journey.

Lee Hickey: Yeah, well, growing up in the city, and as a younger individual, you're very, you know, open to the opinion of your peers, going into work in agriculture is not something that a lot of kids are doing growing up in the city. And so I felt like, even though I was very good at Agricultural Science at school, I felt like I couldn't really pursue that as a career, I was under the impression that agricultural science was something like, driving tractors and you know, throwing around hay and that sort of thing. But, but what I didn't realize was that agricultural science was using cutting edge science and technology to really solve some of the big problems that we face in the world in terms of food production. And I guess growing up in the city, you don't really

realize that. And I think that's the big problem with this disconnect of worlds from where our food comes from.

Hannah Senior: Yeah.

Lee Hickey: And so yeah, I initially took marine biology at university. I actually dropped out - it's all timing in life, I wasn't really interested at all. And I took a full time job cleaning toilets. And I fast realized that that was literally pretty shit.

[They both laugh]

Lee Hickey: And I had to do something. So I took the plunge, and I re-enrolled back in agricultural science. And, it was interesting, but wasn't until a critical field trip that I actually missed out because I was out late partying the night before and actually missed the bus! And so the next week, I had to go to the field trip as a replacement option. I traveled with the professor and a bunch of other crop scientists from CSIRO. One of them was Greg Rebetzke a very famous geneticist. And I traveled the whole day around looking at different drought adaptive traits that they were working on. And I thought it was just fascinating how through Plant Breeding, you could harness these types of traits, and improve on farm production. Like, I guess I wasn't passionate about it at that stage, but at least it was interesting enough, you know, to pursue as a career, and, and you know, over time, the passion develops.

Hannah Senior: There's something in that isn't there, that story about …Well there is two things that strike me - one is you don't know what you don't know, most of us probably end up in careers we didn't even know existed when we were kids. So there's one piece about how do you just shed light on agriculture and all the amazing options and angles that can be taken within that? And then the other is you sort of said, all the peer groups, it wasn't really the done thing? And how do you, how do we make this much more... How do we express how exciting and how much opportunity there is in

agriculture and how important it is? There's quite a challenge there, isn't there for the agricultural and plant science community.

Lee Hickey: Yeah, I think we really need smart young people coming into agricultural science to solve some of these really big challenges we face. And the young people coming through have totally different skill sets, and very switched on, you know. A good example was I had a lab meeting the other week, and we had a summer intern give an overview of her research project that was just a few weeks long, but she has excellent programming skills. At the age of 19 she was able to write software where you could simulate a whole breeding program. And those are the skills that we need in plant breeding, to crunch big data and to connect phenotype, genotype information.

Hannah Senior: Wow, that's a great example.

Lee Hickey: So she won't be out of a job anytime soon.

Hannah Senior: She will not!

[They both laugh]

Hannah Senior: You mentioned that your focus is tools for plant breeding and techniques, ways of doing Plant Breeding, rather than developing a particular crop or a particular set of varieties. And one of the things you're most well known for is speed breeding, which I think we've already touched on some angles, it brings together technologies and different disciplines, and brings them to plant breeding. So let's start with the basics. What is speed breeding? And why would you need it? Could you just start with that?

Lee Hickey: Yeah, well, speed breeding is just a catchier name for rapid generation advance, I would say, and a lot of experienced plant breeders will be very familiar with rapid generation advance. It's been around for a long time. Essentially, speed breeding is all about growing plants fast. The only difference is, I guess, with speed breeding is that there are a lot of different applications for growing plants fast for all areas of

research, pre breeding, and actual breeding. So anytime we need to grow plants, you know a lot of plant scientists or geneticists, or plant breeders are just sitting around waiting for plants to grow. So if we can speed up this process, it can really accelerate research outcomes and applied plant breeding outcomes. Essentially, what it all comes down to is controlling key environmental factors like temperature and photoperiod, to promote early flowering, and achieve that rapid generation advance. So we have developed for a whole range of different long day and short day species now. Working together with collaborators, you know, here in Australia and and overseas.

Hannah Senior: And this wouldn't have been possible 10 years ago, 15 years ago, because the technologies to enable it just weren't there? Is that right?

Lee Hickey: Yeah, there's a convergence of technologies that have been rapidly developing. And that makes it possible to scale up and cost effectively apply speed breeding platforms as part of a mainstream plant breeding operation. And as part of a mainstream activity for research programs to utilize. And a key part of that has been around the LED lighting technology booming in recent years. What is possible today in terms of light intensity and quality of light that these LEDs can emit just wasn't there probably five years ago. And the costs have dramatically come down. This is converting to energy savings, which is really critical for driving down costs for Plant Breeding. And so plant breeders, both in the public and private sector have set up now very large scale speed breeding operations, which has changed completely how plant breeding is working. Going from the field to basically indoors, where they can grow large plant populations, essentially, “horticulturalize” the breeding process. Grow plants for just a few cents and rapidly cycle them all year round. So we're talking about tens of thousands of plants at once. It's almost like a plant factory, if you think of it this way. And I think it's really perfect for integrating with the whole genomics platforms that breeding programs used today.

Hannah Senior: So how does that translate into real world applications? I can see that speeding up the process is great, but how does that knock on and what's the big picture effect?

Lee Hickey: I think at the end of the day, the easiest way to think about this tool is around delivering better crop varieties sooner to farmers. But if we break it down, and we think about the components that its really influencing inside a breeding program, you can think of the genetic gain equation, if you like, which is really central to the whole plant breeding approach. So time, or breeding cycle length, is critical. Integrating speed breeding technology into a breeding program can save one to two years on a breeding cycle, which can have a huge effect on genetic gain over time. But not only that, because their systems are more cost efficient, you can generate larger numbers of population for evaluation in the field, you can integrate marker assisted selection or other types of selection as part of the process. So you can, you can already apply selection before these elite materials or inbred materials, hit the paddock for evaluation. So it's really targeting many aspects of the breeders equation to improve overall efficiency of breeding progress, which is really important for, you know, meeting the future demands. If we think about 2050, we supposedly have to feed 10 billion people, it means that in most of our crop improvement programs, it could double the rate of genetic gain to help achieve this goal.

Hannah Senior: And when we talked previously, you touched on having a real sense of purpose around that need to feed people. You talked about just now that your passion for plants just because they're interesting in their own right. But also that's coupled with a sense of, look, there's a really important job to be done here. Do you want to just expand on that for a moment?

Lee Hickey: The reality is, we're not going to do things more efficiently by doing the same thing we've always done, where it requires change. And the tricky thing is with anything that works to make things better, it can be challenging, because “how much

better?" "Are you sure it's going to be better before I change?". I once heard it described as, actually from Hans Braun who was the previous leader of the week breeding program, at CIMMYT, he described it as steering a big ship. And if you want to change course, you've got to be sure because you know, it's critical, you're going to change the direction very much. So showing that these different technologies and tools can provide advantages in terms of improved efficiencies is really important. If we're going to, you know, help convince plant breeders across all the different crops, public sector, private sector, to start incorporating these things and change the way they're doing things. It's a big challenge. And there's so many technologies and ways in which you can integrate these things. You know, there's probably less stars in the galaxy, perhaps in terms of how all these different combinations can come together.

[Theme Music Plays]

Hannah Senior: You're listening to plant breeding stories brought to you by PBS International, world leaders in pollination control. We're exploring the personal stories behind people who've dedicated their careers to plant breeding, helping us to more productive plants, greater food security, and more sustainable agriculture. Now, back to the podcast.

[Theme Music Fades]

Hannah Senior: Tell me a little bit about something that, at the moment, is really energizing you and your work.

Lee Hickey: Oh, I think something that's really energizing me now, in the last week or two has really been around preparing for our field trials coming up. There's a really big effort we're trying to pull together this year for a lot of really big field experiments, testing a whole range of different drought adaptation traits in the field. And, and we've spent the last probably five years developing these materials to go into these field trials so we can really compare the value of different drought adaptive traits for breeders. And so yes, there's a real big effort to try to integrate above ground phenotyping using UAV

platforms, as well as all the below ground phenotyping with soil coring. So it's a pretty big effort with lots of people involved.

Hannah Senior: Oh, wow, that sounds really interesting. And working with such a mix of teams must be really exciting.

Lee Hickey: Yeah, it is. It's about working together in a multidisciplinary team, you know, bringing together expertise from physiology, quantitative genetics, modeling, engineering, as well, to try to better understand how these traits and genetics are working for drought adaptation. I think it's really exciting to be part of that team. Because you have these different ideas coming together from the different people bringing these complementary skill sets together. You know, I guess this is how a lot of commercial breeding sort of operates too with these different skill sets coming together. But yeah, I think that's where the magic happens in the sciences, these multidisciplinary sort of approaches that can solve some big problems.

Hannah Senior: One of the things that I'm really passionate about is bringing technology to agriculture more generally. And as those technologies develop for agriculture, in general, they're also developing for plant breeding. And I know that speed breeding is just one of the areas that you're working on. Do you want to give other examples of how you're combining technologies that are coming to agriculture for this purpose; for plant breeding.

Lee Hickey: Yeah, I think a lot of these technologies on their own, some of them are quite innovative, they have their own advantages. But the big gains, I think, from a plant breeding perspective, is effective integration of multiple technologies coming together. And that sounds a bit corny, but it's, I guess, “technology fusion” you could call it. A good example is, often a conversation we have with a lot of breeders and researchers is what's better: double haploids or SSD or speed breeding. And and then, we can have this conversation about the pros and cons. But ultimately, there's advantages in integrating them both as well. So we’ve got to stop thinking about these tools as individual and how they can be unified and come together to give us a better outcome.

Hannah Senior: It's a bit like Is it better to have a hammer? Or is it better to have a screwdriver? Well, you're kind of better to have both. It's a bit simple, but I guess that's the point that you're making

[They laugh]

Lee Hickey: That's right. Yeah, you need the full toolkit don't you. Some other examples on how we're integrating different technologies, I guess, is around trying to integrate speed breeding with genome editing, or CRISPR, where you think there's an opportunity to try to take a CRISPR out of the lab, tried to do it in a glass house or speed breeding environment where theoretically, you could edit tens of thousands of plants at once, and avoid all these bottlenecks associated with the tissue culture process. If we could do that, we could integrate it with rapid cycling, genomic prediction as well. So that's an exciting space. Similarly we're working to integrate speed breeding and genomic selection. And working with my colleagues Kai Voss-Fels, Ben Hayes, we're looking at ways not just using the standard genomic selection approach, but how can we further advance that and try to use methods that predict the best parents to use for crosses. Which is a bit different. And we're using artificial intelligence algorithms to tap into the massive data sets that we have on some of these breeding populations, whether we're talking 700, 900 yield data sets, with with 1000s of SNPs across the genome, and trying to pick the best parents to bring complimentary parts of the genome together in the shortest time frame possible. And that's where speed breeding comes in, to help make that a reality faster, to create those stacks. Quickly.

Hannah Senior: One of the consequences of this, you can't be specialist in every single technology. You know, it's about pulling those technologies together. But the consequences is that it's very collaborative, and you touch previously on this sort of collaboration point. So can you just expand on that for me? How do you go about that? What do you get out of it? Tell me a little bit more about the collaboration piece.

Lee Hickey: Sometimes I wonder if I'm not an expert on anything at all. Actually! One of my best skills, I think that it's common for a lot of plant breeders actually, is that they're effective integrators of different disciplines and seeking and collaborating with the right people to achieve what they want to achieve. And I guess I've been fortunate, I've had so many mentors, from different fields, from crop modeling, to quantitative genetics to plant breeders to pathologists, I've gained really valuable insight from each of them. And I think that the key behind the success of any successful plant breeder is that they are really effective integrators.

Hannah Senior: Why do you put so much emphasis on communication and communicating about what you're doing? Can you give me an example of how that helps you?

Lee Hickey: Yeah, for me, I'm very passionate about communicating science. And playing around with new ways that we can do that. Innovative ways of communicating. I think it's really critical for the whole of science, not just plant breeding, that all scientists are doing a better job, at communicating what they do….

Hannah Senior: To the public? Or to each other?

Lee Hickey: Well, you could argue both. [Lee laughs.] But I guess I'm more referring to the public. And, because science is so critical for so many fields, and yet, the general public just have no idea a lot of the time what we do, let alone the outcomes of that research. And let's face it, we need more support and more funding for science. You know, here in Australia, we've faced a lot of cuts around science. And you know, at the end of the day, we need the general public to understand the value of science and what we do, if they're going to be the ones that fund it. So it comes back to us, and we've got to do a better job at communicating. And I think that will hopefully improve the exposure of the great work that a lot of scientists do.

Hannah Senior: Is there a particular reason that speed breeding was the thing that brought that passion for communication, together with the passion for developing new tools? Or was that just circumstance, that's just the way it worked out?

Lee Hickey: I think the speed breeding one is a good example, where the protocols and the technique and the opportunity to scale this technology hadn't been effectively communicated at all. And in fact, when I first started working in this area, you know, my colleagues here at UQ, they develop some of the speed breeding protocols. And we're using it for their research and for breeding. Similar protocols had also emerged in different Institute's around the world, other private breeding companies developed their own protocols. But of course, it's not in the business model to make some of that information public - so accessibility to protocols for public breeding programs, were just not there. And for the common researcher, how do they grow plants fast? And so we saw are an opportunity to really, you know, write the protocols in a way that makes all the information digestible and accessible in a step by step guide, if you like, and we were lucky, we got these articles published in some of the, you know, the fanciest science journals, you know, in nature plants, or nature protocols, nature biotechnology. These journals don't often publish traditional plant breeding stuff, but we managed to get these articles in these journals, which also increased the exposure. Coupled with a lot of media effort and communication you know, I think we've seen some pretty widespread adoption of the technology now, which is really exciting

Hannah Senior: Not everybody approves of communicating science in the way that you are, and that the energy and passion that you put behind it. Tell me a bit about the people who detract from that effort that you've been, that you've been pursuing.

Lee Hickey: Any field, you know, if people become successful, or they get a spotlight put on them, or there's a certain amount of haters that they have. I guess that can be caused by many things. It could be jealousy, or it could be just genuine dislike for the way that they're doing things. Or they just might not like the clothes I wear or whatever.

Hannah Senior: Is it trolls or is it more like just, academic disagreement?

Lee Hickey: There is an element of academic disagreement. And that's healthy, that's good. I guess there are some small number of people out there that are very spiteful, and really don't like the way that we've been communicating some of the things. And I find that to be really not the best attitude when we're trying to promote science in general. And new technologies that a lot of breeding programs still don't use or don't have the capacity to use; and just because they might have used that technology for a long time in their breeding program it doesn't mean everyone else does. And, so we've gotta look at the bigger picture here, that there's a lot of plant breeding going on and a lot of different species around the world in developing countries as well. It's not just about if "You've got a breeding program with a $20 million budget - have you been doing it for the last 10 years?" It's about getting all those other plant breeders to catch up to where we are in some of these other crops in some of these other regions. So I think, you know, that's what's being the ambition and drives a lot of the communication that we've been doing.

Hannah Senior: Can you give me an example of the sort of negative pushback that you've had?

Lee Hickey: In the beginning, they said, "You literally, you can't speed breed crops" "You can't grow them indoors and cycle them quickly and grow them fast." And well, we know that that myth is busted now. Commercial breeders do this as part of their program daily, at a big scale. And there's people that just think that "Well, it's been around for a long time. So why are you promoting this technology?" Or "I knew someone back in the 80s, who grew a plant really fast in their basement. And so yeah, that's been done. So what's new about this?" And I say, "Yes, that's correct. It has been around a long time!" In fact, some of the first experiments done on plants, using continuous light were done back in the early 1900s. And that's, that's great. But it's about integrating this tool into breeding programs, doing it at scale, doing it cost effectively, streamlining the process. And, that's the difference to making this a once off thing, to embedding it as a mainstream tool. It's a different thing.

Hannah Senior: That's a great example. So how do you deal with that? Do you have any tips for people who are getting the pushback on their efforts or pursuits to promote something?

Lee Hickey: Yeah, I think, you know, if you're getting a small number of haters, then you're on the right track. Keep pushing. Because no matter what field you are, there's these people out there that are going to be spiteful, they're going to not like it. And they're not going to like change and just keep pushing. As long as you have a lot more supporters than you do haters, you're going to end up winning at the end of the day. It's hard. It's hard, though, some days, because those haters really get you down.

Hannah Senior: Right, right [Affirmative]. What opportunities do you see for the future?

Lee Hickey: Yeah, I suppose if I could predict the future, I'd be doing it already. I think around the integration of the technologies, we're working on integrating speed breeding with genomic prediction approaches with some of my colleagues here at UQ. That's an exciting space. And, and one we know seems to be quite successful and popular in the private sector, developing those protocols for more public breeding programs is important. But yeah, I think it's tricky to say, I'm always thinking about this, like, what's what's going to be impactful for the future? So we're doing it working and investing our time on this correctly. It's hard.

Hannah Senior: Are there any influences you're particularly grateful for so far in your career?

Lee Hickey: I'm really grateful for a lot of the mentors I've had, this is really priceless. And it's funny how it happens over time. A lot of people who maybe haven't had the opportunities that I've had, and I'm really grateful for this. And I feel like because I've had such exposure and mentoring and support along the way, I feel such immense pressure to do something impactful, that's going to make a difference. And so I feel all this time and effort that we've been working on these things and training and, and developing, if I don't achieve something impactful, then all of that's a waste. I really see

the next generation and training the next generation to be critical in that it's almost too late for me. [He laughs]

Hannah Senior: [laughing] Oh! Don’t say that! That's depressing!

[They laugh]

Lee Hickey: But in a way, yeah, like I mentioned earlier, the 19 year old with the amazing coding skills, you know, that's the future and if we can be helping to train these young people coming through into agricultural science, and particularly Plant Breeding, equipping them with the right sort of skill sets to go on to make a big difference. If I can just play a small role in that that would be very rewarding.

Hannah Senior: Well, that feels like a really good place to wrap things up. So thank you very much for your time today, Associate Professor Lee Hickey. Thank you.

Lee Hickey: Thank you so much for having me Hannah.

[Theme music plays]

Hannah Senior: You've been listening to plant breeding stories by PBS International and I'm your host, Hannah Senior. Plant Breeding is a pretty specialist podcast topic, which can make it difficult for people who share our interest in this kind of thing to find it. So if you've enjoyed the podcast, recommend it to your friends and colleagues, and please help others in the plant science community to find it. By rating this episode and subscribing to the series. I'd love to hear from you. If you want to suggest people you'd like me to interview, you can contact me on twitter @PBSInt or on Instagram @PBS_Int. Until next time, stay well.

[Theme music fades]