Transcript: Plant Breeding Stories Podcast
S1E5 - Dr Pete Iannetta

[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 and 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. 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 speaking to Dr. Pete Iannetta, from the James Hutton Institute in Scotland. Normally we talk to plant breeders but Pete describes himself as an agroecologist, although as you'll hear, his work does touch on plant breeding. He is an interesting guest because he brings a wide range of influences to his work and a perspective strongly influenced by systems thinking. We discuss how human behaviour, value chain capability, and ecology feed into thinking about breeding for legumes and demand for these crops. I hope you enjoy it.

[Theme music fades out]

Hannah Senior:

Pete, did you have an interest in plants from an early age? How did you get into this?

Dr. Pietro Iannetta:

By accident. I would say I had a love of the outdoors before I had a love for plants, particularly a love and fishing. And, from that, looked at just how fish were produced, what they did. Took a wider, broad interest in fish of all kinds. And that, I guess, set a seed for just considering things to do with protein and sustainable protein supply and it was built upon at university. There were individuals there who are big into fish farming and sustainable fish farming. And I think, from that, that I learned how much the plant system was becoming linked to aquaculture. So that's kind of a potted history of how I came to where I am, looking at that link of how plant systems drive the sustainable protein supply.

Hannah Senior:

And what you've just described, it highlights that you have had a non-linear path into research and your current role. So tell me a little bit about the diversity of things that you did before you came into agroecology research and plant biology research?

Dr. Pietro Iannetta:

Well, I guess I'm lucky, in many ways, I ended up where I am, because I think had I... I'm deaf in one ear and half deaf in the other, which not a lot of people know, and I could easily have ended up in the military, I think, before I ended to where I am. I was in the Naval Reserve for a short time with the territorial army in the medical corps. But, with that career route blocked off to me, I developed in another areas. I obviously went to study plant biology and ecology. I'm a bit of a people person, I guess. Tried to be a teacher and worked in residential social care with kids in care before coming back to do my PhD and keep going on what I was doing at university. So certainly, a nonlinear path with a big interest in sustainability and equality. I'm not really hung up on any one scientific method, but just, through the way I've evolved, I have a systems overview.

Hannah Senior:

Do you think that breadth of experience is one of the factors that has influenced you to have that systems overview? Or, has it influenced you in other ways?

Dr. Pietro Iannetta:

I think ecology, life and how you move on in it is probably multifunctional in that there's a breadth of influences. And then I think there's a confluence of factors that drives you down in certain directions. But being brought up... You'll know by my name, it's not a traditionally Scottish name. I come from a southern Italian family. There's a reasonably strong food culture, particularly from my mother's side. If I ask my mother often, "How are you?" She'll tell me what she's eaten. And that's not untypical in other cultures or in the world as well. So, you're always thinking about food and socializing around food.

Hannah Senior:

Now, when we spoke previously, you said something which kind of amused me, you said, "I went back to my first love, which was legumes." And there's not many people who would use that turn of phrase. [Hannah laughs] So I'd like to turn the conversation to legumes for a few minutes. And in particular the work you were involved in recently that made a splash in the press with the Arbikie Distillery and the launch of a carbon neutral gin called Nàdar made from peas. So could you tell me a little bit about that?

Dr. Pietro Iannetta:

So, that process started 10 years ago. We were working on a project, looking at air fractionated beans for aquaculture, predominantly. And air fractionation is an interesting process in itself in that you take the beans, you take the skin off, you mill them or dry them, mill them, and then you put them in an air cyclone. The protein bodies being lighter, go higher in that cyclone and the starch bodies being heavier, go lower. You then take off those different strata of that air cyclone. You end up with a protein concentrate from the top and a starch to concentrate from the bottom. And the protein concentrate works very, very well as a fish feed. Up to 70% of farmed salmon diets in Scotland are vegetable protein. But really, the commercial success of it stalled because of a route for the starch, so feeding pigs and poultry with the starch didn't stack up. It wasn't competitive with other food sources.

Dr. Pietro Iannetta:

So we were left wondering what we could do with that starch. And we originally then started working with Aberdeen through MSC students, Aberdeen University, to turn that starch into alcohol. And it worked very well, terrific levels of... And then we start, well, why are we even air fractionating the beans? Then we decided to start distilling the whole bean. And that was more challenging because there's issues with the hulls and inhibits the process of what we call saccharification, turning the starch into sugar that the yeast can then turn into alcohol.

Dr. Pietro Iannetta:

But we got around all these problems and actually, we found that you get different qualities of alcohol. And we've trialed lentils and we've trialed peas and beans, but the peas made more sense for the Scottish climate, but also for the challenges of the alcohol, as well. Lentils equally make a nice spirit too. That's, would you believe, a brief history of that process. And it's still ongoing. We're now looking at playing with the core product from that process, because of course the protein from that distilling process falls out in the waste material, which is called pot ale.

Hannah Senior:

So what's interesting to me about making alcohol from legumes is that the UK isn’t really known for its legume production, although as nitrogen fixing plants, they can be very beneficial. Can you explain why that is?

Dr. Pietro Iannetta:

Crop systems are driven by nitrogen. If you want to optimize crop growth, nitrogen is the key chemical to drive crop growth. Of course, you need potassium and phosphorus and there's other nutrients, including mineral nutrients, but the big driver is nitrogen. So if you really want productive systems, you've got to get a decent amount of nitrogen into those systems. And therein lies a double-edged sword in that, while you need nitrogen to drive productivity, too much of it, if delivery is uncontrolled, leaches nitrogen into the system, whether it's pollution of waterways or whether it escapes as greenhouse gases. So being a well-managed, legume supported system can be nutrient efficient. And that nutrient efficiency is really, really important.

Hannah Senior:

And we don't grow that many legumes in the UK. So how does it fit into the rotation?

Dr. Pietro Iannetta:

In terms of these high protein grains, no, they don't feature much at all. Probably if you look at the UK as a whole, it's more like 3% cover grain legumes. With my agroecology hat on, the level should be closer to 15% of the rotation being grain legume. I would ideally like to see 25, to be honest. But to achieve that, you really need to have quite a range of different legume types. And we just don't have that range available yet, certainly for Scotland. So the character of rotation, a well-balanced crop rotation would see pulses in the system. You want to see them at least one in six to one in seven of the rotation. And it's not as simple as putting them in. They do still need to be well-managed as well as having a crop that doesn't demand nitrogen. The residues that are left in the field can offset nitrogen requirements for later crops if those residues are trapped properly. But if they're not trapped and managed properly, they will mineralize quite quickly and be lost to your next crop.

Dr. Pietro Iannetta:

So it's not just about legumes, of course. It's about the behavior that goes with growing those legumes, that they're managed, that they're grown well. But all too often, legumes are treated as a break crop. I don't even like that term. I hate the term break crop, but it does emphasize that there are more important cash crops to the farmers in those systems. But really, well managed grain legumes can be the most profitable crop in your rotation. You can certainly get premiums above wheat because of the... Especially for the demand for aquaculture, but increasingly an emerging demand for direct human food consumption.

Hannah Senior:

So it's a bit of an odd thing, isn't it? Because if it can be a profitable crop and it's beneficial when appropriately done for the soil and for the subsequent crops, it does

beg the question, what are the barriers? Why is there so little legume production in Europe?

Dr. Pietro Iannetta:

There's many factors, I think. One hand, it's short termism, in that if you look at the benefit of legumes over the whole rotation, the benefits become clear. Whereas, in any one year, it's probably driven more by market. And certainly the prices of local grown legumes are undermined by really cheap imports coming in from some very unsustainable sources at times. There's a lot of things missing outside the farm gate. But just to stay within the farm gate for a moment. I think it's worth mentioning that extension services in the UK have been decimated. Having independent agronomy advice is critical. And I believe agencies like ADAS used to number in the thousands. Whereas now, you're talking about a few hundred people with a very broad remit. So, I think that's a problem because farmers do grow things in fashions. And sometimes I think skills can be lost in between those fashions going up and down.

Dr. Pietro Iannetta:

So having independent agencies to direct behavior within the farm system is good. But outside the farm system, there's things lacking. There's a few dehullers in England. There's no dehullers in Scotland for peas or beans. There's nobody air fractionating pulses into their component parts because each one of those... Pulses are of value, but if you start fractionating, the value goes up enormously. So hulls are generally fed to cattle, but, actually, they've got really terrific health value. And there's people now making pastas and breads with them because of their high antioxidant and high gut health values. You can separate the starch and the protein components from pulses. But then, you can imagine the number of routes to market that increases. But you quickly get to breeding as well because there's no really bred peas or beans for different markets. They can be malted, but they've never been bred for malting.

Hannah Senior:

And that was where I was going to go next, which was to say, when I think of legume growing, I think of maybe the Midwest or Canada or Brazil. I don't think about northern,

rather damp climates like we have. And so that would suggest that there are different breeding objectives if you were to be breeding for this climate. Is there breeding for this part of the world? Tell me a little bit about the breeding landscape for legumes.

Dr. Pietro Iannetta:

Yeah. It's not very big. There are agencies breeding legumes in the UK. The main one I'm aware of is in Wales. I believe they're contracted breeding for the larger companies. I'm not aware of any serious breeding going on with a view to the targeting of the UK market. There are much bigger markets and the breeding that I'm aware of going on in England is largely academically focused, I would say. So it's genomics and genetics and looking at ways to assess molecular marker assisted breeding.

Hannah Senior:

Is it more screening that goes on for varieties that are suitable for this kind of climate?

Dr. Pietro Iannetta:

Yeah, I think screening is an adequate term. I think they're screening for crops in the UK and there's not really any serious breeding programs. And even if you move across the UK, there are very different climes. I know that how they grow beans in Scotland, we look for a very different plant architecture compared to somebody who might be growing beans in England, just to do with the amount of water they might get and things like that. We might be prone to a wetter environment up here. So we look for different architecture or spacing. And that would vary as well between whether you're growing for the vining market - that is fresh peas and beans or dry peas and beans.

Dr. Pietro Iannetta:

Often now we've got climate change. So your crops also have to be resilient. They have to start coping increasingly so with weather. People keep calling it global warming. That's kind of a little bit annoying to hear it couched in that way. It's true, on average, we're getting warmer, but the bigger impact of climate change is weather stochasticity. That is unpredictable weather, being really hot and then really wet and then really dry

and then really cool all mixed up. So you're losing consistency of weather pattern and you need a particular kind of crop to deal with that.

Hannah Senior:

We certainly saw that in the UK this year, didn't we, with a phenomenally wet period, followed by weeks and weeks and weeks and weeks of dry weather. It was really conspicuous.

[Theme music plays]

Hannah Senior:

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[Theme music fades]

Hannah Senior:

One of the things I'm curious to talk to you about is a rather unconventional piece of work that you've been doing. You mentioned the big attraction of legumes is their ability to fix nitrogen. And yet, I understand you're doing a piece of work looking at how you can breed out nitrogen fixing capability. So tell me a bit about that. [They both laugh]

Dr. Pietro Iannetta:

Oh, now, you're just causing trouble for me. There's been long running questions in academia about what the cost is of nitrogen fixation, because it's a symbiosis and because you have these rhizobia you have to feed. And also, it's actually a tripartite, it's a three-way symbiosis between a soil fungus called mycorrhiza. So between the mycorrhiza and the rhizobia and the plant, they allow this process of grabbing phosphorus on nitrogen to drive this biological nitrogen fixation. So there's been long running issues. What is the cost of that? That's one aspect, I would like to know what

the cost is. And even if there is a cost, I've done some early experiments with pulses where I've applied lots of nitrogen to them, and they actually grow less well with the one you apply lots of nitrogen. At least fava beans do. Common beans, less so.

Dr. Pietro Iannetta:

So actually the legumes vary in that capacity, but even if I bred out nitrogen fixation from legumes and I had to apply fertilizer, they still may not do well because they've simply not evolved their physiology. Their physiology is not evolved for that sort of system. They just need a low nitrogen environment. We also have a process, a particular method to measure biological nitrogen fixation. It relies on looking at what we call a reference plant. Nitrogen exists, generally speaking in a form that's called 15N. There's different isotopes of nitrogen. Whereas air is 14N. The more nitrogen I acquire from air, my 15N signature becomes dilute. So I'll acquire some nitrogen from the soil. The more nitrogen I acquire from the soil, the higher my 15N signature. As I acquire nitrogen from air, I dilute that 15N signature.

Dr. Pietro Iannetta:

So we use what's called reference plants to find out what is the 15N signature of the soil that our legumes are growing in. And to do that, we use a non-fixing plant. So we use a wheat that isn't a legume or another crop plant that isn't a legume. And we'll find out what the value is of a plant that's in that soil, that's only obtaining its nitrogen from the soil. And then we look at the legume and generally, of course, the legume has that 15N signature diluted.

Dr. Pietro Iannetta:

Now, the problem with that is, the reference plants we use, if I'm looking at fava beans, the reference plants we use are not fava bean. They're a non fixing plant, but they're physiologically very different from fava beans. So we don't have a non- fixing physiological equivalent. So I'm looking to as well have a plant that's a physiological equivalent to a fava bean but doesn't fix nitrogen. And it would mean that our estimates of biological nitrogen fixation, maybe they're fine using the wheat as a reference plant

and the other non-fixing crop plants, but it could be that they're not as good and that our estimates of nitrogen fixation are not accurate.

Dr. Pietro Iannetta:

There's not enough people measuring biological nitrogen fixation as a whole. There's lots of people doing studies on enzymes and a whole load of biochemistry and molecular biology around this area. But nobody, even the scientists, very few, are actually measuring how much nitrogen is fixed. I find that fascinating.

Hannah Senior:

It's really interesting from all the things that you've said so far, that you're sort of constitutionally oriented towards quite collaborative work. The example of the gin was very collaborative. I'm interested to dig into your thinking on collaboration and particularly cross disciplinary collaboration. Previously, we discussed the role of social sciences in agriculture. Do you want to just expand a little bit on how you think social sciences can and should be brought into the work of plant breeders and others in agricultural research?

Dr. Pietro Iannetta:

We have this habit, probably stems from the common agricultural policy and post-war food policies, that you can gain the most out of simple systems by just increasing production. And I don't believe it's that simple at all. Certainly, a lot of the barriers to uptake of pulse crops in Europe, of course, are influenced by global trade and things like that. But we've got to a point now where we lack the capacity to upscale, even if we wanted to. So there are technical limitations here. We talked about processing ones.

Dr. Pietro Iannetta:

But also there are social limitations in terms of food literacy. Because humans have learned to become passive in this process of food systems. They trust the retailers to do what's right. And they trust businesses along the value chain to do what's right. We know we can't. We've seen what happened with plastics and nitrogen pollution. And a lot of people just simply don't have access to sustainable food. So, to me, there's huge

bias in education. But even faced with the knowledge of what is good and bad, humans consistently make poor choices. It's a curiosity of people's psychology. And also some places, cultures around the world are much better at forming self-help groups.

Dr. Pietro Iannetta:

Because I work quite often in the European context, I know there are places around, particularly Eastern Europe, where there was a war not long ago. You try to create a farmer network in some of these areas, and you'll still find a reticence to do that because of the legacy of that. So I think social science in its broader sense, once you start looking into how people are and why they make the choices they make, you quickly uncover quite a lot of challenges. I've heard a friend from Natural England saying that it's much more easy, he said, to set up farmer groups, network groups, self-help groups in England than it is in Scotland. And I don't know why that is.

Hannah Senior:

In addition to you seeing a home for social science in agriculture, you also see ecology or ecological thinking in the way that the economy runs. We were talking previously about that. Could you just explain a little bit about how your thoughts about systems and ecology influence your view of the economy as a whole?

Dr. Pietro Iannetta:

Certainly, I'm biased by my professional experience, life experience, but if you have a system, any system, it could be a marriage, it could be a field of beans, if you're continually taking from it, should you be surprised when the system collapses? So you need to be feeding back those essential elements and ensuring those essential functions that maintain your system. Now, if I was looking at crop system, the soil would be key, for sure. The soil, the soil qualities, its physics, its functions, the resultant water quality and air qualities that result in all these things.

Dr. Pietro Iannetta:

And in that sense, if you take the idea and translate it to an economic system, if you have the individuals in that system not catered for in a way, if you consider people like

soil, that they're not able to sustain themselves next year, can you be surprised when that system collapses? So I guess in the same way that nitrogen has to move within a system, I hope that money would move within a system and in a way that's equitable and fair and ensures that the important, what we call in science circles, ecosystem services... But I hate the term, ecosystem services. But really what we mean is, those traits of the system, those particular functions are preserved.

Dr. Pietro Iannetta:

And surely, in the same way that your soil wellbeing is paramount, if you want a socio-ecological system to work, you would want the wellbeing of your people to be paramount. To me, it makes sense. So I'm not against the market forces that are dominant at the moment. I don't believe in a free market. I think markets are regulated and I think the markets have to be better regulated to ensure that what we crop at home, doesn't just sustain good soils, but sustains healthy people as well.

Hannah Senior:

From where you are now, what things are you seeing that are attracting your energies and your interests?

Dr. Pietro Iannetta:

I'm really happy to be working in an agroecology group. The ecologists are holistic in their mindset and supportive. So I can see myself developing more of an interest in the forage legumes and grass legume based systems. Also, how some of those forage legume based approaches could be embedded within the arable system. The situation with legumes is really indicative of a bigger issue with crop systems, is that they're not diverse. We have a wheat dominant rotation, generally speaking in England, barley dominated rotation in Scotland. And I can't speak for the dominance of wheat in England, but certainly, in Scotland, barley is two-thirds of the rotation.

Dr. Pietro Iannetta:

So this concept of crop rotation, your holistic crop rotation kind of gets thrown out the window when two crops in three is barley. But it drives a very important economy. Don't

get me wrong. And in that sense, economically, it's really important. But we need to diversify our crop systems to gain not just a diversity. It's not as simple as just having a diversity of crops in the system. It's about also delivering a diversity of food. And from that diversity comes resilience. If the bottom was to drop out of the barley market for whatever reason, what would we do?

Hannah Senior:

Can you just explain, you touched on this previously, but you mentioned that barley makes up this two-thirds of the rotation. Can you just describe where that barley goes? And then, also link that back into why legumes would help in that rotation and improve that.

Dr. Pietro Iannetta:

It was certainly a concern about soil qualities. And of that barley proportion, half approximately is for food and the other half goes for brewing and distilling. So it drives the Scottish whiskey and beer market, which you know Scotland has a great reputation for and quite rightly so. There's other dominant markets in Scotland as well, which is aquaculture. And if we were to grow beans for aquaculture in Scotland, my back of a postage stamp estimate was that we'd need beans on 1/12th of the rotation. So one crop in 12. That isn't really frightening. And that's just to serve Scottish aquaculture. So that should be quite achievable with the right capacities in the value chain in place.

Hannah Senior:

And that would add benefits to the soil, to diversifying the rotation.

Dr. Pietro Iannetta:

Yeah. Lowering greenhouse gas footprints. Absolutely. Properly managed, it would be a nice, sustainable circular economy picture that we get with that. If you look at Arbikie as a small example, Arbikie was, if you recall, that distillery that's developed the Nàdar, which is a Gaelic name for nature, the climate positive Nàdar gin and Nàdar vodka, they had no pulses in their rotation before we started working together. And last year they had 22%.

Hannah Senior:

Wow.

Dr. Pietro Iannetta:

Pea cover. Yeah. Sure. And they're using that on farm. So they're maximizing the profit. That's not quite a free raw material, but it goes into their on farm distillery and the waste material goes to feed cattle. So they've got the soil benefits, they've got the offset feed benefits. They don't need to import or buy any feed for their animals. And also the connection they're making with the consumer. It's a great route to educate or to share narratives on sustainability and that local isn't just something that's nice and touchy-feely. It delivers something very tangible and real to the local system. Beyond supporting your local business, you're supporting your local ecology.

Hannah Senior:

Last question from me is, and I'm going to roll two questions into one, do you have concerns about the future and where do you see the opportunity?

Dr. Pietro Iannetta:

Oh, as a scientist, I've got concerns. Probably ask me this question on a different day, I'd give you a very different answer. But certainly, when we need transformation urgently, I can't help but look at the big players, the big brewers, the big distillers, at least in the Scottish context. But even in the UK context, actually. The big brewers, the big distillers, the aquaculture people, food manufacturers, the big ones, if they decided to take peas and beans on with their value chains in the product and realize grain legumes as a vehicle to make the non-legume parts of their product more sustainable, it could be a game changer.

Dr. Pietro Iannetta:

The reality is, I know that these are big companies with big processing plants. They're locked into what they're doing, and it's not as easy as just saying we'll accept peas and beans tomorrow. Maybe it is. Maybe they do have capacities that can do that. But if the

big players decide to step up and say, "We want peas and beans to make those products." Then, the aggregators, the middle people who take the produce from the farms and ensure it's delivered in the right quantities and qualities and on time to the processors, it would be achieved. So if you want quick transformation, and we do need quick transformation, I would like to see the big players step up and balance their consumption of non-legumes. And all we're asking really for is that the balance that we see in the crop system needs to be seen throughout the value chain.

Hannah Senior:

That is a great challenge to put out there and great food for thought. So, we'll leave it at that. Thank you very much for joining me and for sharing all your experience. Dr. Pietro Iannetta of the James Hutton Institute.

Dr. Pietro Iannetta:

Thank you.

[Theme music plays]

Hannah Senior:

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