

Transcript: Plant Breeding Stories Podcast
S2E6 Plant Breeding Stories - Dr Dave Bubeck



[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 talking to Dr Dave Bubeck, Research Director at Corteva. He spent most of his career in the world of corn breeding and as such has had a ringside seat in both the consolidation amongst seed and plant breeding companies during the last twenty to thirty years which created some of the world's giant agricultural companies. And in watching new technologies be applied to possibly the most well researched crop in human history. We talk about this and also his role this year as president of the National Association of Plant Breeders and the myriad ways in which collaborations across species when it comes to plant breeding, brings benefit to all. I hope you enjoy it.

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Hannah Senior: So perhaps just to get started, Dave, could you just tell me a little bit about yourself, maybe where you grew up or how you came to be interested in plants?

Dave Bubeck: Well, I grew up on a farm in Iowa and my grandfather had actually relocated from their family farm in Illinois. We were a very diverse farm. In the sixties and early seventies, we had numerous kinds of livestock. We had poultry. We had sheep. We had a cow calf, black Angus herd. We had horses, we had hogs, crops included oats, alfalfa, corn, soybeans. Of course, we went to the grocery store for more

diversity, but, you know, we raised a lot of what we ate on the farm. So, that diversity of agriculture, I really watched that through my early years of growing up through the 1970s and watched that diversity dropout of Midwestern US agriculture. My love for plants really started at a very early age. And I would say the livestock side of the business also drove me closer to plants because plants didn't talk back [They both laugh] and certainly hogs did. So ultimately it was an interest in general biology and life.

Hannah Senior: It sounds like you had a very solid agricultural foundation - what was it that sent you specifically down the plant breeding path?

Dave Bubeck: What really changed it for me, I was at Iowa state, and that summer I stayed in Ames, Iowa and worked on the soybean breeding project. And that's where everything really coalesced for me, my interest in plants, my love for biology and the connection with how you could bring that back to the farm through products developed through breeding and genetics. That really intrigued me.

Hannah Senior: So you did a degree in agronomy at Iowa state, and then a masters in plant breeding and cytogenetics. And then you left Iowa, notably one of the biggest - or maybe *the* biggest state for corn growing in the US, to study a PhD at North Carolina State University. Had you had enough of corn at that point?

Dave Bubeck: You know, I really did want to work on corn, corn as a model breeding system, the diversity of the genetics across the species, the history of it being developed from wild land races and wild relatives of things like Teosinte, it was a very fascinating how corn was domesticated. But the diversity in corn across the 250 plus races was really fascinating. And I actually just worked on corn. I left Iowa where corn is significant and I went all the way to North Carolina state to study corn breeding. That was really instrumental to the fundamental view of genetics and how important it was to have diversity in genetics, because we were actually trying to leverage tropical maize germplasm, and then adapt it to temperate regions in the United States.

Hannah Senior: For our listeners who have not had the benefit of your decades of experience in the corn industry, could you, at high level, talk a little bit more about the different categories of corn just to lay a foundation?

Dave Bubeck: There's very large collections of tens of thousands of different accessions, let's say, that are stored in genebanks. And one that we have in the U S that's a very strong collection is the USDA has a national plant germplasm system where these collections are stored. And within that diversity, some very specific, let's say market class opportunities, have been leveraged. Corn is grown on the most hectares in the United States and around the world as, as dent corn. Largely and significantly used as livestock feed, to a much, much lesser degree you have human consumption of different corn and corn products.

Dave Bubeck: Corn often gets a bad name from its domestication and use in high fructose corn syrup. That might be one of its more negative recognitions that it gets. Most dent corn is known for its yellow endosperm, whereas as white corn is traditionally used in grits, but you can also use yellow corn for grits as well. It literally tastes the same, it's more of a color preference. There are also other market classes in dent corn like silage corn, generally for livestock feed. Then there are specialties within silage corn that are known as higher digestibility, known to be higher digestibility in cattle feed. So that's the dent corn world. That's the biggest one in terms of total acres.

Dave Bubeck: And then people often think of sweetcorn first. In the United States in particular, sweetcorn is a huge market in terms of the fresh market sweetcorn business. And then popcorn, which I've already mentioned. Popcorn is just totally non dent. It has all hard endosperm, and when you heat it up, it basically explodes into a popcorn. So it's a very flinty endosperm with no soft starch in it, or very, very little soft starch in it. So those are the major classes I think, and very much leveraged as market classes of corn.

Hannah: Great, thank you. So - You finished your PhD and took a job at Northrop-king But before too long you were heading back to Iowa to join Pioneer - how did that come about?

Dave Bubeck: I got a call from a recruiter actually for a position with Pioneer, and it was to breed corn in Johnston, Iowa, which was the headquarters for Pioneer. Growing up on the farm we were not exclusively Pioneer customers, but we grew a lot of Pioneer products. It was the dominant brand on our farm when I grew up. And so I was always intrigued by the company, the long look prescription of the company, just how they really viewed that they were in this as a partnership with farmers and that it was entirely about how do we develop better products for our customers.

Hannah Senior: And I gather you had already made a connection with some corn breeding legends at Pioneer at that point hadn't you?

Dave Bubeck: Yes! One thing I did not mention, when I was doing my PhD I had a chance to come back to Iowa for about eight months. And met folks like Dr. Bill Brown, who was actually the very first PhD that was ever hired by Pioneer and later became the president of the company. I had a very unique opportunity in '89 as well, that summer, to meet Raymond Baker, the first corn breeder that Henry Wallace hired when they started the corn company 95 years ago. So here I am crossing generations of corn breeders and working just in the summer with Pioneer and had the opportunity... Raymond Baker was already retired, but he loved being in the field. And he was, he lived a healthy life well and into his elderly years. And he was, he was doing popcorn actually as a breeding project. And I think I may be the only one that's still active in the business that actually pollinated corn with Mr. Baker.

Hannah Senior: Of course listeners can't see you, but you know, you're not ancient, you haven't been around forever and ever and ever. [They both laugh] So, you know, and yet you've managed to span this enormous history of Pioneer the 95 years that you talked about. And so I'm curious, has that given you a perspective on what's changed and what stayed the same in corn breeding maybe specifically and perhaps the company more generally over these years?

Dave Bubeck: So going back to my decision to come to Pioneer with that background and history it was obvious where I needed to go to have an opportunity to be a corn breeder right in the same exact backyard where Henry Wallace and Raymond Baker started. So what stayed the same is I believe successful plant breeders have always needed to be in the field and have intimate knowledge of the species that they're working with. So corn... anything, field crops, vegetables, flowers, it's essential that you really have an intimate knowledge with the species that you're working with. Knowing what are the vulnerabilities of that crop from a disease perspective, from an agronomic perspective, from a nutrition perspective, from a food value perspective, whatever that might be, know your crop intimately, know what it's used for today and know what it could be used for in the future. And I think those things are essential.

Dave Bubeck: Also knowing what is the range of genetic variation that exists. Many traits, many agronomic traits, many nutritional traits, have a normal bell shaped curve in their distribution of values. You have these fringes of the tails, let's say, both on the weak side, as well as on the strong side, whatever weak and strong is in terms of the performance of a given characteristic. And plant breeding is really ultimately all about seeking out transgressive segregation from what's used today. So how do I, how do I reach beyond the average and I go to exceptional performance, that's on the edge of where that genetic variation exists. And that's one thing that hasn't changed. Now what we do to reach that transgressive, segregation and performance for any characteristic. That is the part that has changed. Very fundamental to today's ability is the molecular genotyping that can be done. The understanding of genes and gene function and regulatory genes on a really fundamental level and driving this genomic era that we've lived through into a post-genomic one where that genomic knowledge is just put to the task in breeding and methods that we use to improve the performance of crop plants, that's been a big change.

Dave Bubeck: The human genome was sequenced around the turn of the century, I think. Published, actively worked on in the 1990s and all of the things that enabled a cost-effective way to do all the same things in plants. So tracking disease genes and identifying vulnerabilities in plants, identifying the genetic variation at the genomic level

that occurs in a given plant species so that you can make improvement. And also so that you can identify weaknesses that you may have to find different mechanisms to improve the performance of those than just standard genetic variation.

Hannah Senior: I want to talk a little about consolidation among companies in the agricultural, seed, and plant breeding world. Because you experienced the company you were working for being acquired or merging several times in your career, most notably when Dow and DuPont merged. Could you talk to me a bit about that?

Dave Bubeck: So the merger from the very beginning, was an intent to bring some components together and then to break them up into smaller pieces. Even from the very standpoint of the merger, when they were discussing it, the intention was to eventually, fairly rapidly, break them apart into three pieces. So the three pieces became actually... Dow became a name on its own once again, and DuPont became a name of its own once again. Well, the agricultural division, which they decided to split, contained both the seeds group, as well as a crop protection group. They didn't have a name for that company. And so, the agricultural part then was left, let's say without a name. Pioneer was big in the industry as a brand and as a trademark, as well as a company historically. However, it didn't really cover the name of the crop protection part of the business. So the merger and the spin then to what became Corteva. Corteva was selected as the name of the corporate entity of which the brand Pioneer continues to live as the flagship brand of the seed business.

Hannah Senior: Both Dow and DuPont had these big chemical businesses running alongside their agricultural businesses. And many people may not have twigged, but this has historically been a common occurrence in lots of large agricultural companies. What's the connection? Why do they so often come together?

Dave Bubeck: Many of the crop protection chemicals go hand in hand with the agricultural system and the cropping systems that we're trying to deploy for our customers. And so if you think about what's in the bag, the seed has a very integral need for, for seed treatments. And so you have the seed and all the genetics and all the resources that went into developing that genetic strain. You also have crop protection

components that are in that bag that are covering, most of the time, fungicides. So soil borne fungi that caused damage to seed. You sometimes have a bit of insecticide targeted at insects that will destroy seed as they emerge and/or young seedlings.

Dave Bubeck: And so that's a very big component of what goes in the bag. But then whether vegetable or field crops, as a grower, you have this need to manage the agronomic condition of the crop itself. And so what goes hand in hand with growing in an agricultural system? Growing the crop and all the crop protection chemicals that you need to put on that crop, including even at times fertilizers and how do we do slow, timed release of nitrogen. And so Corteva has a product that does slow release of nitrogen so that you have the nutrients at the moment, at least at the moment when the plant really needs it. So building a system of total solutions for the farm, for what customers need in terms of products, whether it's out of a seed bag or whether it's out of a jug of chemicals.

Dave Bubeck: And I love the emphasis today on resilient agriculture and sustainability. We haven't talked about that yet, but organizations like Corteva are really looking hard at how do we build sustainable agricultural systems that minimize the environmental footprint that pay attention to both soil health as well as water quality is of course a huge one. We're paying very close attention to the United Nations sustainability goals that have been established. Corteva announced our sustainability goals in summer of 2020. We're, we're making sure that, you know, whether it's on the crop protection and the chemistry side, building green chemistries that are natural products and being environmentally friendly and really just improving the environment and sustainability and really resilience of the agricultural system.

[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.

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Hannah Senior:

Your current role, your title is a Research Director at Corteva Agriscience, and that's very broad, so tell me, what does that mean day to day for you?

Dave Bubeck: In my current job we have a group that I call Global Breeding Services, and that really has three major components. One is all the efforts to do plant disease or plant pathology work. So this Global Breeding Services provides that connection with plant breeders to make sure that we're leveraging genetic disease resistance in all the plants and the 10 or so species that we're breeding in field crops. So that global plant pathology group is really asking the question, "How do we devise plant disease solutions in the products that we deliver for our customers?"

Dave Bubeck: Then the second component of my global breeding services work is, we take it very seriously as our Germplasm is one of the most important assets that we own as a company. So I have a group where we do all the characterization of our inbreds and our varieties in order that we can seek intellectual property protection for those varieties. And so I lead a group that does that. The third area, that's a little harder to describe as all of the things from a regulatory compliance and stewardship aspect that go along with being in a regulated plant breeding world. So I'm a contact point for working back with our regulatory and compliance and stewardship people. So as those things concern how we deploy our field research breeding programs, I'm the connection point for a lot of those things. And also the other external facing role that I have is really trying to drive "How do we influence in a positive way, the policy agencies, driving future policy requirements for products" and paying careful attention to what are the risks and safety aspects of those products and how do we communicate what those future needs are going to be to the policy agencies even before they anticipate where that technology is going and what kinds of products and characteristics those technologies will enable plants to carry.

Hannah Senior: You must get this really interesting global overview as a consequence of that. You touched on global plant pathology and presumably that's not just different parts of the world, but also how things are moving. The regulatory environment is different... How does that global perspective influence the way you think about plant breeding and your role more generally?

Dave Bubeck: We are globally connected in so many ways and our crop and agricultural species that we leverage for food, feed, fuel, fiber is no different. And so we're globally connected. So what does that mean to the seed industry? From a disease and phytosanitary perspective we have to make sure as a global company that we're moving seed around healthy seed around the world in a safe and effective manner. From a plant breeding perspective we leverage our germplasm globally. If we're breeding corn or soybeans in Brazil or sunflowers in Europe, we are probably leveraging some of that same genetics around the world.

Dave Bubeck: And the technologies that we applied to improving those varieties and hybrids have to be accounted for when we move things from one region of the world to another. And so let me just jump right into the deepest challenges of this with Europe being entirely non-GMO. Oh, I should say almost, almost exclusively non-GMO. We leverage a lot of the temperate latitudes across Europe and the temperate latitudes across the US with the same genetic backgrounds. But in the U S we're, we're putting GMOs on there. So herbicide resistance traits, as well as insect control traits. And we can't use those in Europe, generally speaking, for either herbicide resistance or insect resistance. So we have to separate the breeding and technology pipeline. So we are essentially keeping the base genetics, the non-GMO, the non-traded genetics, as the fundamental basis for our improvement of the performance of those varieties or hybrids.

Dave Bubeck: We add later on top of that, before we commercialize the GMO traits that are required for the US market today, and we leave them off of the Europe market. So it makes it more challenging to be part of a global environment. When you think about crops that are leveraged globally, and most of them are, what will the world do with genome editing and will the world have the same approach that they had with GMOs?

Or will we get to a more, I don't even want to say 'synchronous approval', a synchronous view of the acceptance of these technologies. Will the policy agencies around the world treat these products the same way with the same considerations? And number two will the social acceptance around the world, will they align with the same attitude towards these technologies?

Hannah Senior: In addition to your role at Corteva you are the current president of the National Association of Plant Breeders or NAPB. I am also a member of NAPB but we have listeners in over 50 countries so perhaps you can tell me a little bit about the organisation for the benefit of listeners who may not have heard of it before now?

Dave Bubeck: The National Association of Plant Breeders is an association that was started in the early two thousands. And they found a need in the US - and US and Canada is primarily where the membership of NAPB is located. There wasn't one place where they could go as an association and talk about all the technologies that contribute to plant breeding, to cultivar improvement.

Dave Bubeck: And it's such an important area in terms of feeding and fueling the world. The National Association of Plant Breeders, our mission is to strengthen plant breeding, to promote food security, quality of life, and a sustainable future. Also there was a recognition that the world really didn't know that much about what plant breeding actually delivered. In spite of, people are on a diet every day that's entirely impacted by the results of plant breeding and cultivar improvement. And so we really want to be able to communicate that plant breeding itself is not a science. It's a collection of science and engineering and technology applications that help us to improve plant breeding.

Hannah Senior : You talked about coming across all different species, or breeding in all different species in the NAPD. Do you have an example of the kind of - excuse the pun - "cross-fertilization" that goes on when that happens?

Dave Bubeck: There are some very common problems that plant breeders encounter. Let me just pick on one, on phenotyping. So it's very important for plant breeders to have ways to measure those phenotypes that matter and the way to measure and

assay that. So when, when plant breeders get together, you know, all plants have disease problems is another example. And plant breeders means to have an assay for evaluating disease resistance levels, or disease resistance to susceptibility. And so when we talk about the methods by which we're measuring, we talk about what traits are important. We talk about how do we manage disease resistance from a durability perspective and the cultivars that we released commercially. These are common things that cut across all species. Being a corn breeder in my background, myself and in practice, there's a lot of intense resources that get applied to corn breeding and hybrid seed corn production. And some of the learnings that can happen from one species where it's heavily invested, can be applied to other species. So sharing that for any one crop and our annual meetings, our webinars are geared towards sharing these ideas across both the public and private sector and breeders garnish many ideas from people that are breeding other species.

Hannah Senior: And so you get this really nice perspective across plant breeding as a whole through the NAPB. So that makes an interesting question - are there any themes or common issues that plant breeders around the U S or indeed more widely than that are focusing on at the moment?

Dave Bubeck: I think every species that is dealt with has to deal with plant diseases. Some of those issues put some species in a more vulnerable situation from production than others. Species like bananas where the vast majority, I think it's at least 80% of the world's banana production, is based off of one clonal variety. And, and that presents a real problem, especially if you have a concentration of production of bananas and in one certain area of the world and you have viruses or other diseases that can cause a problem for that banana production. And so resolving problems like that, and, and getting together to identify common technologies that may be able to help resolve those problems. And it's not always a crisis. Everything isn't necessarily a moment of, of risk of taking a given species of importance to human food consumption out of our diet completely. The point is we don't want it to be. The whole point is how do we anticipate the environmental changes so that we have the diversity that we don't put ourselves in

vulnerable situations with a given crop. You know, we, we, we try to leverage technology so that we avoid those risks and vulnerabilities for the future.

Hannah Senior: And the NAPB is a volunteer organisation isn't it?

Dave Bubeck: Yeah! So I do want to emphasize that the NAPB is a collection of 450 plus members today. We are entirely a volunteer organization and dependant on people with a passion and inspiration about plant breeding to come do some after hours work. Plant breeders already work hard - the work ethic of the plant breeder has never been in question I don't think! They believe in their mission. They believe in the work that they're doing. We have a number of committees that are really important to make the organization work.

Hannah Senior: So if you're in the world of plant breeding, you should, you should join up.

Dave Bubeck: Absolutely.

Hannah Senior: And actually you don't have to be just based in the U S do you? You can be an international member, which is also worth mentioning. So thinking about, say the next 10 years where do you think as a community, we should be putting our effort to maximise the impact of breeding in the next 10 years?

Dave Bubeck: We need to be very diligent to continue to support public plant breeding so that we train the next generation of our workforce both in the public and the private sectors and get accustomed to working around the periphery of what traditionally has been applied to plant breeding. So statistical rigour, good field plot techniques, getting uniform testing and trial sites, identifying ways of collecting uniform assays to phenotype all these traits that we need to phenotype for a given species. All these basic principles of running a good solid breeding program, those need to remain in place. Where we need to get more rigorous, I think, is how do we drive genomic technologies? Really driving us into a post genomic world where we can leverage genes of small effect and are there technologies and means to affect genes, a very small quantitative incremental size and turn them into genes of large effect?

Dave Bubeck: So those are some of the questions that we will be addressing. And I think in the long term, it's not the current state of genome editing that's going to drive that change. We have to get the regulatory pathway acceptance of genome editing. If we don't get through the current version, let's say 1.0 or 2.0 of genome editing, we will never have an opportunity to see version 10.0 or 15.0. And at some point we don't even call it genome editing. It's how do we influence and affect the performance of many genes, dozens of genes, hundreds of genes at the same time? That's the rigor that could be applied in the future technologies. So we've got to figure out how to leverage and show value as plant breeders in the current phase of genome editing. But if we don't do that well, we'll never see future generations of genome manipulation.

Hannah Senior: What do you think are exciting opportunities for the future?

Dave Bubeck: My heart is really close to watching new graduate students find their way on a career path. It's an entirely inspiring point of time to leverage science and technology and engineering to improve cultivars. And there has never been a time at any point in my career, nor before where we had so many different technologies, right at our fingertips to utilize. There are of course economic considerations of which ones can we afford to use, which ones add the most value to cultivar improvement, but there's never been a better time to be in this business. I never would have expected that in 2021 the consumers are paying so much attention to where their food comes from. And so it's also a very imperative in the future that we think about that social license that we need to firmly establish. We need to be able to communicate and advocate for all the technologies that improve what goes into our grocery stores and what comes out of our grocery stores. There's just a tremendous opportunity to leverage technology and a tremendous obligation to communicate to society the safety of the technologies and the history of the safe activities done in plant breeding that have delivered so many wonderful cultivars to the marketplace.

Hannah Senior: Final question, if you think back over the portion of your career that has gone before today, is there anything with hindsight that you would've done differently or that might've set you on a different path had you done it differently?

Dave Bubeck: Yeah, I okay. When I was active in managing a plant breeding program directly myself, I didn't really have time to think about how important it was to communicate externally and advocate for the technologies we were using and what we did. I was naive in thinking that the world like... can you understand the value of improving the output of grain on a per unit land area and actually the sustainability that that contributes. A really good example - if nobody ever would have done corn breeding for the last 95 years, as I said before, you know, pioneer hybrid international is 95 years old as a company. But in that 95 years, if you go back to 1926 and just in the 48 contiguous United States of America, if we were to produce the same amount of corn grain that we produced today in 2021, what land would be required if we were producing at the same levels of output per acre, that we did in 1926. And it would require that one in every four acres across the entire 48 states was grown in row crop corn. And instead we're, you know, we produce about plus or minus 90 million acres of corn in the United States.

Hannah Senior: Wow. Instead of something like one in twenty, one in twenty one acres given over to corn today. That is remarkable.

Dave Bubeck: And it's not all just about the volume of production, it's also about producing vegetables and field crops that are more nutritious, that are safe, that have great reductions in mycotoxin production, from disease characteristics, disease traits. So all of these things. I think where we need to do a better job in the future, and NAPB can help do this I think, the private sector, as well as the public sector together need to join up in this - is how do we advocate and share the many and countless benefits that the world of plant breeding and that that improvement that's done on cultivars can offer the world. So we need to do a better job of that. That's the one thing I think if we were to realize this 30 years ago, we'd probably be in a better place today.

Hannah Senior: That's a really powerful example. So Dr. David Bubeck, Research Director at Corteva, President at the NAPB and powerful advocate for plant breeding. Thank you very much for sharing your plant breeding story with me today.

Dave Bubeck: Thank you, 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.

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