Transcript: Plant Breeding Stories Podcast
S1E6 - Steve McKeand

[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.

Hannah Senior:

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 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 Steve McKeand, Emeritus Professor of forest genetics at NC State University. In this conversation we talk about how and why cooperative breeding got underway in forestry, the critical importance of taking the very long view and some of the similarities and differences between tree improvement and row crops.

[Theme Music Fades]

Hannah Senior:

Would you like to introduce yourself and your name and what you do and give us an introduction?

Steve McKeand:

Yes. My name is Steve McKeand, Professor Emeritus at NC State University in Raleigh, North Carolina, in the US. Working with the Cooperative Tree Improvement Program in the Department of Forestry and Environmental Resources.

Steve McKeand:

I actually have a halftime appointment now, I'm semi-retired, enjoying partly the retired life.

Hannah Senior:

So I would be interested to kind of start the story with your background. So tell me a little bit about where you grew up, went to school, and in particular, where did your interest in plants and forestry and plant breeding come from?

Steve McKeand:

Well I grew up in Indiana in the Midwest of the United States in Indianapolis, not exactly the hotbed of forestry in this country, but as is so typical of young boys, I thoroughly enjoyed being outdoors. I enjoyed hunting and fishing with my dad, just enjoyed the outdoors. And when I started thinking about a career and opportunities, I thought, "Hmm, forestry, that sounds good." And of course, back in the late sixties and early seventies, when I was thinking about my future, there was a lot of interest in the environmental movement and sort of that wide-eyed desire to save the world and forestry seemed like a good opportunity to do that. So yeah, there was a lot of reasons, but that was one of them. Little did I know that forestry is a lot more than that, but it was really how I got interested in it.

Hannah Senior:

And when we spoke before you said, "I'm a forester." And I said, "What is a forester?"

Steve McKeand:

Right.

Hannah Senior:

So could you just tell me a little bit about that, just recap of what is a forester?

Steve McKeand:

I guess the best way to describe a forester it's a person who manages forests, manages forest landscapes for various objectives. Those objectives are incredibly diverse for landowner. A landowner might be a few hectares, it might be several hundred, several thousand or tens of thousands of hectares. Those objectives might be to produce timber to make money, financial benefits. More often here in the US a lot of small landowners are more interested in aesthetics, wildlife management. It could be for water management, but how you grow and manage those forest stands to meet those objectives is really what the art and science of forestry is all about. So it's incredibly diverse set of objectives and that's what I found really intriguing about forestry. We learn a lot of tools, we have a lot of decisions that are made from harvesting, from managing timber stands, forest stands, again, to meet the wide range of objectives that a landowner might have.

Hannah Senior:

It sounds like there's lots of different avenues that one could go with forestry, but you settled on academia and ended up in tree improvement. So tell me a bit about how did that come about?

Steve McKeand:

Yeah, I think as is so typical for many people beginning in their careers. Well, "What do you want to be when you grew up?" And I sure didn't know, but I had the good opportunity at Purdue, took some genetics courses, and I found that incredibly interesting. And then I had a professor there, Walt Beineke, who was an incredible teacher and just really got me interested in tree breeding and forest genetics. And I took his class and I was hooked. And, as again, I think happens so often in a young person's career, you meet that individual that has an impact on you and you say, "Oh, that's really cool stuff. That's what I would like to do." And that's exactly what happened with me. I decided to apply to NC State University and study under the master at the time Dr. Bruce Zobel and was accepted. And that's how I got here. And then a temporary job

came open a guy with a young family. I said, "Yeah, I better take that job." And one thing led to the next, and it turned into a permanent position. So a lot of it was happenstance, but it was a lot of it was meeting incredibly talented people along the way that I wanted to follow.

Hannah Senior:

And a lot of people who are outside the world of forestry might ask the question, "What is tree improvement?" Or, "How are trees improved?" Let's talk a little bit about that. Let's start with a really noddy question, what is tree improvement? Why would one walk to improve a tree?

Steve McKeand:

It's essentially the same thing that crop breeders, animal breeders have done for decades. You know, forest genetics is very broad. Tree improvement is a subset of forest genetics, and it really involves tree breeding just like you would with corn or soybean crop where the yield per hectare can be improved. The financial benefit of those fields of soybeans or corn can be improved. That's exactly what we do in tree improvement. It really relates to plantation forestry, which is a part of forestry.

Steve McKeand:

You ask about, "What's a forester do?" Well one thing a forester can do is manage plantations, where trees are established, planted for the objective of harvesting those trees a number of years later and making money. Again, foresters do more than that, but that's the part of forestry where tree improvement is really important.

Steve McKeand:

So what are the traits we try to improve? We try to improve volume yields, making them grow faster, bigger trees mean more money, bigger trees grow faster. Maybe the rotations can be reduced in length. We improve disease resistance, a lot of pests, depending on the species with our Loblolly pine here in the Southern US, fusiform rust disease, which is an endemic disease, it is co-evolved with Loblolly pine, but we've,

we've had a tremendous impact on improving disease resistance, wood quality, stem quality. Again, the value of the trees that are harvested are improved and the objective is to make money pure and simple. Just like it would be with crop improvement or animal improvement programs.

Hannah Senior:

And one of the things that's really different to breathing breeding maize or breeding animals is the timescales. You need a lot of patience to be in tree improvement don't you?

Steve McKeand:

I always like to joke with my students. I said, "You learn from your parents. That patience is a virtue." Well, that's absolutely true, but particularly in tree improvement, patience is an absolute requirement. It takes time. You know, even the most fast growing timber species, some of the fast growing tropical species, like the eucalypts in South America or South Africa, or another parts of the world, where they may have a five or a six year rotation period, that's incredibly long for... say compared to a maize or a soybean or a wheat crop, which is an annual crop. In some parts of the world, those plantations may grow for 100 or 150 years. Some of the slower growing more boreal forests.

Steve McKeand:

Here in the Southern US, a typical rotation length would be 25 to 35 years, depending on the product, depending on the landowners objective.

Steve McKeand:

So yeah, the trees we plant, you've got to be patient. But in some respects, it makes the value of the work we do incredibly important. You know, one of the things I always preach to landowners is, "The decision you make today about what genetics to plant, what are the different families, the different genotypes, the genetics that you decide to plant today, you're pretty much stuck with those until you harvest those trees 25, 35 years from now. So you better be making the right decision." And that's sort of a

humbling and incredibly important aspect of the work that we do is that it's longterm, the benefits are great, but realizing those benefits from our genetics and breeding program, it takes a long time.

Hannah Senior:

It must affect the way that you go about doing the work, running a tree breeding program. Or maybe even the culture in tree improvement compared to other crops, because it is longterm because you don't get the results of a trial within a year or so. Is that true?

Steve McKeand:

Absolutely. You know, I talked to my colleagues in agronomic crops, and we talk about how proud we are that we've been able to reduce our testing program, for being able to make crosses and do the field testing of our improved genetics. And we can make decisions now at age four or five or six years of age, as opposed to 12 to 16 years of age that we used to do. And I'm just so excited we can reduce that down to four or five or six years, and they just kind of laugh at me.

Steve McKeand:

The things that we're able to do in our tree breeding program, even under the most aggressive and optimistic programs, it still takes time. So yeah, it does impact the work that we do and sort of that attitude. But again, the way we go about our work, it's essentially the same as with any of the other crop species. You know, we make crosses, we harvest seed, we plant trees, we plant trials, we evaluate them. And the only difference is we do that work 10 meters, 20 meters, or higher up in the trees. You know, the crossing is up in the top of the trees where the flowers are.

Hannah Senior:

The job description has in it must have a head for heights.

Steve McKeand:

Yeah. I think so. I think so. [They laugh]

Hannah Senior:

Does it mean that there's a challenge with funding because you know, most breeding programs have difficulty with sort of long term funding commitments. But if a breeding program in tree improvement doesn't get a long term funding commitment, then either you don't get to the end of the program or the work that you have done gets undone or, or both?

Steve McKeand:

Absolutely funding and long term support is just absolutely critical. That's when one of the things I had been so fortunate in my career here at NC State is that our program, the Cooperative Tree Improvement Program started in 1956. And it started with good support from the university, and from industry, and from landowners, from the federal and state government agencies and it has continued. And thank goodness because if it waxes and wanes and funding comes and funding goes, and all of a sudden "Meh, we're just not interested. We'll pick that up, restart the program in four or five years." That's absolutely the kiss of death because these long term trials, people won't remember where they are. And again, you can't go out and measure a field trial at age one and get useful information off of it.

Steve McKeand:

You need to wait until you can identify the winners and throw away the losers, like in any breeding program. And that takes time. And if you try to shortcut that, or you don't have the support to do that, then the breeding program just dies. It dies a very, very painful death. And that's happened with a lot of breeding programs. In our situation here in the Southern United States, and in particular with our Southern Pines is that the economic incentive to plant trees is so great that the economic incentive to plant trees that are better than they were a year ago or 10 years ago, or 20 years ago, that incentive is there to continue on with the tree improvement programs. And when you've got a financial incentive, people are willing to invest money, both from the government, from companies, from the university. And we've been very fortunate to have that support.

[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:

You mentioned the cooperative, and it'd be interesting for you to just describe how the Tree Improvement Cooperative works. You know, what it is, what the structure is. But also I'm curious about whether the cooperative structure thrives particularly in forestry, Because I don't know of any other crop improvement cooperatives apart from in forestry.

Steve McKeand:

That whole focus on co-operating among different companies started back in the 1950s and 60s. And here were a lot of different reasons. I think some of the important reasons was, is plantation forestry was still fairly new, but also the fact that the benefits, they came at the time when you harvested the timber. So these large timber companies that owned hundreds of thousands and even millions of hectares of land in the South, they planted trees. And of course they wanted to plant the best trees that they could, but where they figured they would be making money would be when they harvested those trees, reaping the benefits at the mill, at the sawmill, at the pulp and paper mill. And that was sort of the incentive for doing tree improvement. And of course that's long term, and long term means you're investing a lot of money upfront. And tree improvement, forest genetics is not cheap.

Steve McKeand:

It takes a lot of time and effort and finances to do the breeding work. And so there was a lot of incentive to try to keep those costs as reasonable, as low as possible. And, as again, I always like to joke, "It's always great that somebody else is willing to do my work for me." And in many respects, that's one of the reasons these companies that these agencies wanted to cooperate because it was expensive and they wanted to share the cost, share the investment in tree improvement, or in other forestry research areas like silviculture and pest management, a lot of the other cooperatives here in the Southern US.

Steve McKeand:

And you share the benefits of it too, but you don't really get any competitive advantage, so to speak. In that you share the costs and benefits, but you've got the same cost and benefits as other companies. So that's sort of the downside. And I think that's maybe one of the reasons why these cooperatives have not been as common with other crops because your neighbor and your competitor has the same advantages.

Hannah Senior:

Can you give a sense of the scale of the planting that goes on using improved genetics in the South?

Steve McKeand:

We've just completed some analysis looking at our program here at NC State and a little over a million acres, a little over 250,000 hectares, are planted every year with the genetics that comes from our tree improvement program. From the members that do the tree breeding and produce the improved seedlings again, over a million acres, 250,000 hectares every year. And so that's a huge planting program, and I'm pretty sure it's the largest planting program anywhere in the world in forest trees.

Hannah Senior:

That's huge, thats a massive scale. One of the other things that I'd be interested to dig into is in other areas of breeding, there are these huge developments that have come through in the last, 10, 15 years or so around marker-assisted breeding and gene

editing and so on. Are they also changing the landscape for tree improvement, those new technologies?

Steve McKeand:

Those technologies are starting to have an impact. It's been a challenge with some of the genomics, the marker-assisted selection, that sort of thing. It has been implemented in some programs, but it's still very much in the development phase. And in our research here at NC State, I've not been directly involved with it so much. I've been very supportive of that work over the years, and with some incredibly gifted colleagues that we're still in the development phase, sort of the proof of concept and carrying it on to making sure that it actually works, when you use the genomic tools. Again, and it has to do with the fact that we can't make final assessments for a few years down the road.

Steve McKeand:

You know, if we make predictions about this particular family, this particular line will be better than others. You make that prediction based on the markers. Well, you need to verify that and make sure that it worked as well as we think it will. And all things look like it will work quite well, but we need to verify that before we put it into practice. And again, it has to do with this fact that the trees take a long time to express the desired characteristics that we need to identify in those improved lines and improved families. But, I'll just say, we have benefited from the work that our colleagues have done in animal improvement, in crop improvement.

Steve McKeand:

Many of the tools that have been developed, the analytical tools, oh my goodness. You know, the computational capabilities that we have today compared to what we had early in my career, 40 years ago or so, just incredible. And those analytical tools have had a huge impact on our ability to select and breed for improved genetics. And so it's a whole list of technical capabilities have improved our ability to make genetic gain.

Hannah Senior:

I suppose, you're in the privileged position of being able to use tools that have been developed without having to go through the pain of developing them from first principles, you can modify and adapt that rather than start from scratch.

Steve McKeand:

Yeah. Yeah. Very good. Because I'm a firm believer in letting the smart people do the hard work and then people like me we'll pick and choose those tools that are most appropriate. And know, I think that's a good way of thinking about how tree breeding works is, we have a whole range of tools, whether it might be something as simple as a pollinator that works better than a different pollinator, or that we have a better pollination bag, or we have a better analytical tool, or a better selection tool, using genomic markers or a better phenotyping tool that we can use. Some of the LIDAR technology to characterize trees, a lot of that has been developed in other crops and in another areas of forestry and we've benefited from that. And we're in the enviable position of being able to pick and choose those tools that will allow us to do our jobs better.

Hannah Senior:

Another thing I noticed when I worked with you NC State, is that American universities, particularly the land grant universities, are very well attuned to working with industry. So I was wondering, is this something that goes for all land grant universities, or do you think that having members of industry as part of the tree improvement cooperative makes this type of collaboration just part of the co-ops DNA? Or maybe is it a result of a conscious effort to be less ivory tower and more connected to the needs of industry?

Steve McKeand:

In some of it, I think might be a bit unique to forestry because here in the South, the people were most interested in genetics and tree breeding and plantation management were these large companies. The real reason the cooperative was formed back in the 1950s and many of the other cooperatives a little bit later on, was because of the expertise here at the university. You know, the fact is there weren't a lot of tree breeders. There weren't a lot of plant geneticists in any fields back 50, 60, 70 years ago. So the expertise really existed at the university. So the companies recognized that.

Steve McKeand:

They had excellent foresters, but they didn't have the technical expertise. And that's why these cooperatives first started. And I think that had a lot to do with it. And again, I said it before the fact that they wanted to share the costs of doing tree breeding. And I think that that's true in the other cooperative programs.

Steve McKeand:

Now in other crops, I can't speak to those as much, but absolutely in forestry, particularly here in the South, particularly in areas where plantation forestry is so important, those university-industry cooperative programs are really key. University administrators recognize that, that these cooperatives, the finance from industry has been very important to support research, to support personnel, to support the broad range of activities that we do. Teaching, they've recognized the benefit from those industry dollars coming in to support that. And I think it has been an important part of these land grant universities and forestry in particular.

Hannah Senior:

Do you have any top tips for people who are interested in a career in forestry or tree improvements specifically?

Steve McKeand:

I guess the number one thing is again, patience. Patience is a necessity, but passion. Passion for the field of forestry, passion for your desire to wanting to work with landowners with other foresters of getting the best genetics out there and having an impact on those landowners, on those forests. Again, I joke with students and high school students, my grandkids, I say, "There's not many of you that woke up on a Saturday morning and said, 'Huh, I want to be a tree breeder.' You know, it's sort of one of those things that you catch. You catch the bug." And I've seen this over and over and over again, when people get exposed to the work that we do quite often, it doesn't happen with everybody, but quite often they say, "Wow, that is really cool. I mean, you can make money doing that."

Steve McKeand:

You can have a career doing tree breeding, getting involved with the incredibly technical aspects of quantitative genetics, and genomics, and plant physiology, and plant pathology and the broad range of topics that we all have to have a pretty deep understanding of. And you can apply that and really have an impact on forest lands. "Yeah, yeah. You can do that." And I think that passion is so common. I see it in the young folks that were on my staff when I was director of the cooperative, just incredibly talented people, but they absolutely have one thing in common. And that's the drive. The passion to continue on this work.

Hannah Senior:

When you first came into forestry, you mentioned that sort of environmental concerns were one of the motivations for you. Do you see that being a common thread and how's that changed over time are the same concerns that you have, the concerns that the students you work with now still have?

Steve McKeand:

I think so very much so. You know, forestry has become very broad, in our department here. We not only teach forest management where our graduates are foresters, but we have environmental science, we have wildlife management, environmental technology, conservation biology, a wide range of different topics, but they're all geared towards management of our forested ecosystems. I think in the more narrow area of forestry, the benefits, the wide range of benefits. I mentioned this earlier, the forest can be managed for a wide range of different objectives, whether it be for wildlife, or aesthetics, for water. Carbon sequestration, that's a great example.

Steve McKeand:

And I think the plantation forestry side of enhancing the ecosystem, you know, a lot of people say, "Oh my God, that plantation, that's not a real forest. It's a prop, it's just like a 100 hectare field of corn or a 100 field of wheat. It's just a sterile crop of trees growing. It's not a real forest". No, I just, I absolutely disagree with that. No, it's not as diverse as

a pristine old growth forest in the mountains of North Carolina. No, it's not the same, but it is diverse. It has an incredible amount of wildlife in it.

Steve McKeand:

But I think most importantly, what those plantations do is it alleviates the pressure on other forest lands. You know, one of the things that's difficult to do is to manage every hectare of forest for every possible objective. But what you can do is manage if one of the key products of our forest is timber. And oh yeah, timber production, in timber, the demand for forest products is not going away. The demand for packaging, the demand for paper, the demand for wood to build our houses and some of our high rise buildings now with engineered wood products, that demand is not going away. And I would much rather meet that demand from a planted forest than I would from going in and harvesting trees from a more ecologically sensitive forest. The fact is, is that you're managing those areas so that you can alleviate pressure on other areas. And I think that's had a tremendous impact, been one of the real positive impacts of our plantation forestry here in the Southern US and specifically of our tree improvement program.

Hannah Senior:

When you look to the future, do you see more concerns or more opportunities in that respect when you think about the environment and the role of forestry and tree improvement?

Steve McKeand:

I'm incredibly optimistic. I've been accused of being a Pollyanna in my career that, "Steve, you're just a wild-eyed idealist." And, guilty as charged Your Honor, but I have every reason to be optimistic. You know, we've got some of the most talented, incredibly gifted people working in this area and thank goodness for them.

Steve McKeand:

So I think the future of forestry and of tree breeding is very great, and the new technologies are coming online, I think will enhance that. And the old tried and true

technologies still worked very well also. There's no substitute for good, hard work and dedication, and fortunately we have that.

Steve McKeand:

My concern and there's not many things that keep me up at night, but one of the concerns that I have is will the funding, will the support continue to be there? Yeah, I worry about that, but I think it's still strong. I think people recognize the ability of that. But the real concern I have, it's from the environmental standpoint is some of the invasive, exotic pests. You know, in this global environment, the fact that people move about, internationally, so much that the invasive pest can be just horrific.

Steve McKeand:

You know, the current pandemic was a COVID-19 that we all face, whether you're in great Britain or Raleigh, North Carolina or Indonesia, or China or wherever, is a great example, a horrific example of how wide and quickly a pest can spread. And that's been true in forestry. We've got a very long sorrowful history of invasive, exotic pests.

Steve McKeand:

Here in the US the Chestnut blight, the Balsam woolly adelgid, the recent Emerald Ash borer, just decimated those species, essentially wiped them out, and that's one of the concerns I have. The best mitigation tool is to keep those pests out. Is for sanitation and not allowing invasive, exotic pests to move from one country to the next or from one geographic region to the next. But the fact is, is they are going to move. And basically the best mitigation tool that we have, often the only mitigation tool that we have is genetics. Is trying to find resistance. And that's the concern that I have, but it's also some of the optimism that I have is that the need for tree improvement, the need for forest genetics will continue and even be greater in the future.

Hannah Senior:

That is a great note to leave things on. Professor Steve McKeand, thank you very much indeed for your time today.

Steve McKeand:

Well, thank you, Hannah. It's been a pleasure. And as always, I enjoy talking with you.

[Theme music fades up]

Hannah Senior:

You've been listening to plant breeding stories by PBS International, and I'm your host Hannah Senior.

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 enjoyed the podcast, recommend it to your friends and colleagues, and please help others in the plant science community find it by rating this episode and subscribing to the series. If you want to suggest people you'd like us to interview contact me on Twitter PBSInt or on Instagram @PBS_Int.

Hannah Senior:

Until next time, stay well.

[Theme music fades out]