

## Transcript: Plant Breeding Stories Podcast

### S4 E6 Dr Ksenija Gasic



[Theme tune 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:** Series 4 will be the last in this podcast. And it has been the most incredible experience to dig into so many different aspects of the plant-breeding world. And literally the world. If you're listening to this, you're part of a community that spans the globe from Albania to Zambia, Adelaide, Australia and Ames, Iowa, to Zurich.

**Hannah Senior:** Ksenija Gasic is Professor of Horticulture, Peach Genetics and Breeding at Clemson University, South Carolina. Born into what was then part of Yugoslavia, now Serbia, her interest in fruit and horticulture began in the orchards and farms near her home. Her interest and expertise in genetic resources led to a period of international travel, despite the Balkans conflict of the 1990s. Eventually she relocated to the US where she now heads one of the biggest peach breeding programmes in the world. If you're curious about the difference between a peach and a nectarine, why so many varieties of peach are needed in commercial fruit production, or how it feels to eat peaches every year as a professional responsibility, I think you'll enjoy her story! Transcripts of this episode and all our podcasts are available at [PBSInternational.com/podcast](https://www.pbsinternational.com/podcast).

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**Hannah Senior:** Ksenija welcome to the podcast. Can you introduce yourself and tell me a little bit about what you do?

**Ksenija Gasic:** My name is Ksenija Gasic. I'm a Professor of Horticulture at Clemson University focusing on peach breeding and genetics. I grew up in former Yugoslavia, which is today Republic of Serbia in the Northern part, and finished my whole schooling in Serbia at the University of Novi Sad. I joined the faculty of agriculture, fruit growing, and viticulture for the bachelor's degree, and went into the postgraduate studies in genetics, specifically fruit breeding and genetics.

**Hannah Senior:** From what you've just said, it sounds like you always knew you wanted to go into horticulture or viticulture. What sparked your interest in plants?

**Ksenija Gasic:** Thinking back, I actually don't have a defining moment because I grew up in a village where we had gardens around the houses where we grew all of our vegetables and fruits. And my father was an avid gardener. He liked to have one of everything. So basically, as the season starts, we would have various fruits till the winter to eat and sample. And I would often take the book and go into the garden and lie under the tree and would just pick and eat whatever is there and read the book.

**Ksenija Gasic:** And so I just loved being outside and working with the plants. And then through my general education in high school where I was exposed to the field crops, animal husbandry, mechanical stuff in agriculture, I liked fruits and vegetables and grapes, something that you can eat when you work with it. [She laughs] And then that's why I decided to study fruit growing and viticulture.

**Hannah Senior:** And so when did your interest go from sort of horticulture and viticulture more generally into plant breeding and genetics specifically?

**Ksenija Gasic:** Oh, that defining moment I know. That's basically during the studies, first years at the college were just more general classes. And then once we went into the more specific ones and particularly genetics, that sparked my interest into how the traits are inherited and how you can actually manipulate them and differences and effects. And I wanted to know more. And that's basically how it naturally segued into the graduate school on genetics and breeding. And that's where I am today.

**Hannah Senior:** I know when you finished your bachelor's degree, you had an opportunity to go straight into the workforce because of the way that the government's agricultural policies were set up at the time. But you chose not to. Can you tell me more about that?

**Ksenija Gasic:** So at the time when I was going through my bachelor studies, once you finish you get your degree is agricultural engineer. And so the natural position or placement for the people with those types of degrees was in the governmentally owned farms. And so there was one fruit farm in my home village where actually they expected me to come back and work for them. But I just, I somehow I just didn't want to. There was an option of actually going back to my high school and do teaching, but my interest in learning and finding out more was kind of stronger than wanting to go straight into the workforce and earning money. And so I went to graduate school.

**Hannah Senior:** And what were you exploring in your masters?

**Ksenija Gasic:** My master's was focusing on trying to understand how to genetically modify peaches. And to make fun of it, even today, we cannot do it. And so...

[they both laugh]

**Hannah Senior:** You set yourself a challenge!

**Ksenija Gasic:** Exactly! So my professor at the time wanted me to try to explore what tissues would be more amiable to transformation regeneration. And unfortunately, we

picked the peach, and peach is one of the most notorious one to do any changes. So even today, people are not successful in having routine transformation events with peaches. So if people are worried out there, there are no transgenic peach fruits in the market.

**Hannah Senior:** And it was around that time that the conflict in Yugoslavia was brewing. And that conflict led, amongst other things, to the bombing of Novi Sad in 1999. Can you talk me through how that affected you and your studies?

**Ksenija Gasic:** I finished my bachelor's at the end of 80s, beginning of 90s. And that's when I started my graduate school. It was kind of developing. And full-blown conflict started in '90s. The university is situated on the edge of the Danube River and the bridges right there were bombed during that event in '99. But our vineyards were across the Danube, some of the orchards, and some of the orchards were on the same side where the university campus was. But during the bombing, it was really challenging because across the country people would not go to work. You would just report if there is something that you needed to do, similar to what people experienced during this COVID pandemic. Only essential personnel was reporting.

**Ksenija Gasic:** And at the time, it was March, it was a full-bloom breeding time. And we could not kind of just forget that there are plants in the field and forget about our experiments. And if you think about that, it's agriculture. We do it during the year, growing season. So if you miss it, you lost a year. And when you are doing the PhD, you do not want to extend because you just missed it! And so we found our ways to get around. The bus transportation was not working. And so I had my bike and I would bike out these six, seven miles to the field and do whatever I needed to do to evaluate the plants or take care of them.

**Ksenija Gasic:** And one funny thing is that because we couldn't get across the Danube, we couldn't spray our plots. And then that's how we found resistance in our material

towards some diseases, because we did not spray. So out of the horrible situation, one good thing.

[They both laugh]

**Hannah Senior:** Well, and I suppose another good thing is that from a very early age you were learning to be resilient in difficult circumstances. So there's a silver lining there somewhere. And then also, while you were doing your PhD you got involved in the whole question of genetic resources. Tell me a little bit more about that.

**Ksenija Gasic:** So I was fortunate that my major professor even during my bachelor's degree was interested in genetic resources and particularly in collecting the peach germplasm on Balkan Peninsula. And why that is interesting is that peach originates in China, but as people were carrying the seeds and fruits and traveling, it went through Persia. That's why the scientific name is *Prunus persica* because people thought that it came from Persia. And it actually came from China, and then the silk roads and all of the trade roads brought it throughout the world.

**Ksenija Gasic:** And so we consider Balkan Peninsula as a secondary domestication center for peaches because what people would do, they would eat peach, they would throw the seed. And since peach is self-pollinating, the tree would grow. They would wait till it fruits to see if it's any good, and they would keep it. And so most of these type of peaches were grown in the vineyards. We call it Vineyard peach.

**Ksenija Gasic:** My professor was really interested in that. And he collaborated with the United States, USDA, scientists to get funding to collect that material because the material was really interesting with some unique sources of traits that are of importance for the production. But the quality and the appearance of the fruit was not that far away from the wild relatives, which would be much easier to use in breeding. That's how I became interested because I was part of that collection and evaluation, and so I got to

see with my own eyes how 400 and something different trees are similar, but very, very different.

**Hannah Senior:** So that work led you to an opportunity to live and work here in England for a year or so. How did that come about and what were you doing?

**Ksenija Gasic:** They awarded me to come to the United Kingdom, to East Malling and spend about a year to investigate that material on a molecular level for the differences. Because at that time, the techniques were really now ancient ones, isozymes and just the beginning of the PCR-based techniques. And whatever work was done on peaches, showed that there's no molecular variability. Genetic base is very narrow, but when you look into the phenotypes there were so many different colours, flavours, shapes. And so it was really interesting then, why don't we see that on the molecular level? So we thought that maybe by investigating this more or less natural population that we collected, we could get to answer this question and maybe get us closer to answering why we have so much phenotyping diversity, but we don't see that on the genetic level.

**Hannah Senior:** And your international travels didn't stop there did they, because later you travelled to the USA. How did that happen?

**Ksenija Gasic:** So right about the time when I finished my PhD, I was hired as an assistant professor at University of Novi Sad. There was an opportunity to go to the United States to spend a month meeting the researchers and getting the connections. And just by chance, I met the professor whose research I used in my master's, so that was really interesting. By walking down the corridor, I saw the name on the door, I knocked, went in, introduced myself, and the rest is the history as you say.

**Hannah Senior:** And it was that meeting that actually led you to moving to the USA, right?

**Ksenija Gasic:** So there is a funny story actually to that because when I was, for the first time, in United States for a month, I learned about the Green Card Lottery system.

And then when I went back home, I sent that letter and my husband and I, we applied and I forgot about that. And then the next year, when I was getting ready to go to United States to represent my country as a genetic resources representative, my husband was actually picked in the lottery. So to actually complete the whole process, you either had to have a lot of money or you had to have a job. And that's how I contacted my professor in Illinois and said "okay, you see I have this situation, do you have a position?" And he did not have anything for the PhD. He did have the position for the master level, but he could not find anybody. And so it was kind of the match made in heaven, so to speak, that I contacted him because he was getting at the end of the period when he had to actually hire somebody.

**Ksenija Gasic:** And so I said, "You know what? I don't care. I just want to have the experience and see if I can complete that green card residency." And that's how I ended up in his lab. But the project that I was hired to do was completely out of my comfort zone. It was about genetic modification of *Brassica juncea* to remediate soils polluted by cadmium. And so the techniques involved are something that I was trained in, like the tissue culture, the transformation, which I tried to do in my master's with the peach, but the plant was completely new and unknown to me. So it was a bit of a learning curve, but after two years working on that project my professor got a project on apples, understanding the expression part of the apple genome and he kept me on that position. And that's how I kind of came back into the fruits.

**Ksenija Gasic:** And so that was a really good experience for me because my training was basic genetics. I was never trained in the molecular. So I've had the quantitative genetics and basic inheritance. All of these things I was really well trained, but the techniques to how you get the genotyping data that's now like an everyday thing and normal, all of these things were very expensive at the time, still are for some countries. And in my country we could not generate those type of data. So we went through the

old school type of things with evaluations in the fields and trying to understand the genetics by observing the phenotype. Like Mendel did at the beginning.

[Theme tune 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 tune fades out]

**Hannah Senior:** We've been talking about the opportunities that you took advantage of that led to you moving to the United States. And one thing that struck me is that you've not been afraid of taking a step down to learn something new or progress your career. Which is something that many people are not prepared to do. But it's obviously a risk that's served you well.

**Ksenija Gasic:** Yeah. It looks like that when you put it that way. But at the time, I didn't look at it that way. I was more after the knowledge than at the position. Maybe now in these years, I would go, okay, I don't want to relocate unless it's the equal level or higher or whatnot. But at the time, I was hungry for learning more. And the post-doc education and position in United States provided me not only the excellent facilities and environment, but also the people to interact with that came from all around the world with different stories and different experiences.

**Ksenija Gasic:** And that opened my eyes to not just the fruit breeding, but all other, the techniques that... Because all of the molecular education I got from doing it and then going backwards and learning, okay, why am I doing this? Why am I using this buffer or this chemical? While now what we do, we train students to basically take compounds



created by companies that sell you the kits. And rarely (do) they know what's in those kits because that's proprietary information for the companies. But that's the key information for you to know how to troubleshoot if something doesn't work.

**Ksenija Gasic:** When I started, everything was from scratch. And now, you basically buy buffer one or two. And now I know what's in that buffer because I used to make that buffer. We forget that the advancements that are made throughout the time sometimes makes us stupid because we do not need to think how to troubleshoot or how to do the changes or tweak things so they work better or more efficient. And so I think that applies to all the life, not just science.

**Hannah Senior:** So I want to dive in and talk more about peaches now. But before we do, can you tell me which countries are major peach-growing countries? And which states in the US are major peach-growing states? And I guess now is the time I should admit that when I think of peaches in the US, I think of Georgia rather than South Carolina, but I suspect you might correct me.

**Ksenija Gasic:** Okay. Thank you for that question because we always kind of have friendly discussions with our colleagues from Georgia State because within their state name, they have a Peach State. That's kind of on the license plates and everything. But actually, South Carolina grows more peaches, almost double the acreage and production of Georgia, or even more than double.

**Ksenija Gasic:** In the United States, the majority of the peach production is done in California, both for fresh market and processing. And the second in the country is South Carolina for fresh market peaches. In the whole world, China is the lead producer of peaches and exporter as well. Although because of the different hemisphere, Chile is kind of exporting the peaches when it's dormant season for us. There's lots of great cultivars coming from different parts of the world.

**Hannah Senior:** But when you joined Clemson's peach-breeding program, were you breeding for the global or local markets?

**Ksenija Gasic:** When I was hired, the peach-breeding program at Clemson University was dormant for 25 years. And that's primarily because neighbouring Georgia State had the USDA-breeding program. And so most of the cultivars that were bred for our type of environment came from Georgia for our growers.

**Ksenija Gasic:** One thing people need to remember about the peach fruit is that it's perishable. So it doesn't last long. That's why our growers have about 40 to 50 cultivars that they grow throughout the season because the season starts the beginning of May and ends about the beginning or mid-September. So the harvest for each cultivar is about two to three weeks. And so you have a continuous supply of different cultivars to the market. That's why there's job security for the breeders because there's always some issues throughout the season because we cannot store them like we can store apples and then put them on market six or eight months later.

**Ksenija Gasic:** And so that kind of makes the peach breeding more focusing on developing the cultivars that fit the local industry. And that's how my position was created because the industry was really pushing the university for opening this position so the person that gets it would focus on what are the problems in South Carolina. We are really neighbouring with Georgia and we have similar climate and similar problems, but there are always differences, that when you're breeding in South Carolina you would focus more towards those issues.

**Hannah Senior:** And when you're breeding, I know there's always a focus on increasing yield or looking for disease resistance, but are there any sensory characteristics that you're breeding for too?

**Ksenija Gasic:** That's an excellent question. When you're starting the program, you need to understand the market you are targeting. Peaches could be yellow and white

fleshed. If you think about the markets, Asian markets prefer white flesh, Western markets prefer yellow flesh peaches. The melting, that's a sensation you have in your mouth when you bite into the peach. So the people in United States are used to peaches then when you bite into that, you can find the juices flowing out of your mouth, you're all covered with juices, everything melts into your mouth, that's called melting, and disintegrating into your mouth.

**Ksenija Gasic:** And there are non-melting peaches, which are equally good quality, good taste. It's just a different mouth feel. The flesh is more, we would say rubbery, although that's not a good term because it reflects poorly. But it's kind of you need to chew bit more. And those are the type of the flesh that are common for the processing peaches. So if you buy canned peaches, that would be the non-melting type of flesh. We are trying to educate people here in United States that they're equally good and you can have equal pleasure from melting or non-melting peach by eating it.

**Ksenija Gasic:** But the last maybe 10, 20 years of breeding, kind of more focused towards the peaches that can stay longer on the tree so to reduce the number of harvest because labour is issue with everything, not just peach growing. And so if you can reduce the number of passes through the orchard, that can save a lot of money, you can increase the value for the consumer and the producer. And so those type of peaches are very firm. And so when you pick it from the tree and you bite into it, the sensation is like biting into apple. And people don't like it. They said I wanted to eat peach. If I wanted to eat an apple, I would take then a apple. But then those type of peaches require few days at room temperature to soften. And then after that, they're perfectly melting and freestone like what you would expect from the peach.

**Ksenija Gasic:** And so if you don't explain that to the person that's buying them, they would bite into it, they would, it's too firm, it's crispy, and they would not eat it. And then I tell them, okay, this one you eat today. This one keep for few days. And if you want to enjoy it longer, put it in the fridge because then it won't soften. It requires the room

temperature to activate some genes, and so I'm not going to go into the science, but basically to soften it and make it to the best peach that you can experience.

**Hannah Senior:** And while we're talking about breeding targets, where do nectarines and donut peaches fit in? Or are they just completely separate?

**Ksenija Gasic:** They are basically the same. There is just a gene difference between them, so the gene that creates the fuzz on the peach or no fuzz on the nectarine. And in a nectarine, it's a recessive gene. So when you cross to peaches, you might end up with a quarter of the progeny being nectarines if those peaches are heterozygous, if they have a gene for peach, for fuzz, and gene for nectarine. Similar thing is for the saucer or donut type of peaches. That's a niche market.

**Ksenija Gasic:** Breeding each of these types has its own challenges. To do the saucer or the donut type of peaches, you really have to choose the right material to get that type of shape. There are great breeding programs in Spain and France that have a excellent list of cultivars, and they have all the characteristics of a classical round peach, that change in shape did not change other characteristics. It's just the shape of the fruit.

**Hannah Senior:** Can you describe the breeding process to me and the kind of timelines that you're dealing with?

**Ksenija Gasic:** So many people don't understand how long does it take to actually create a new fruit cultivar. It takes about three years from the moment you make a cross till the moment that they flower and fruit. You need to plant them in the field to let them grow and to flower and get the fruit. So that creates the problem because peaches are very diverse, or all the fruit is. I choose the mother tree and I choose the pollen to kind of get the combination of traits that I want, but to make sure that I actually get the combination I want I need to have as many progeny as I can get.

**Ksenija Gasic:** There is a funny anecdotal story. When I started a position at Clemson, normally we would shoot for like 3,000 to 4,000 hybrids to produce in a year. First year, I got 2,000. Second year, I got 1,500. And so I was like, what's going on? I cannot get to my targeted 3,000 to 4,000 because there were things. There was frost. Their maintenance in the field. I mean, you have to think that those trees have to grow, and all of the other things that can affect the tree in the field.

**Ksenija Gasic:** And so in the 2010, I solicited anybody that would want to go into the field and help me emasculate, pollinate, and I ended up with 10,000 trees planted in the field. And you have to remember, if you're ever at the peach, you have one seed per fruit. So one seed, one plant. When you look in the apple, you have at least 10 seeds or maximum 20. So from one apple fruit, you can potentially have 10 to 20 seedlings that are all different, that are segregating. And in my case, I just get one. So it's really labour-intensive. We pollinate about 2,000 to 3,000 flowers on the whole tree. And we are lucky if we get 200, 300 fruits with the seed in them that we grow the plants. So it's the numbers game.

**Hannah Senior:** That is a lot of peaches to evaluate!

**Ksenija Gasic:** Well, let me tell you never again! Because what I've done three years past that I would be walking day in, out and eating peaches for the whole summer. And by the time I start in Monday and get to Friday, I'm done with the whole block. I need to start again because they don't all ripen at the same time. And so I was so tired of eating peaches. That's why when I was hired, my position was a place to be a combination of the traditional breeding, where you have your phenotyping in the field and you make the cross plant, the trees, and trying to develop molecular tools that would target the traits of interest and predict how they will develop in the field so that what I can do I can test them in the greenhouse stage and eliminate those that don't have the traits that I'm looking for, reducing the number. So from these 10,000, I went back the next few years

to normal for me, 3,000 to 4,000, which let's say for the apple breeders those numbers are much bigger.

**Hannah Senior:** So it takes you a number of years to get a peach that you think is a winner and worth passing on. But then it has more stages it has to go through before it can be produced by a commercial grower. Can you tell me more about that? The process and the timelines?

**Ksenija Gasic:** Yes. It's three years before you see the first fruit. Then we basically wait for two years to see if that quality or something great that we've seen in the first year would repeat. And then after that, we make a initial selection. And those trees we graft on the rootstocks. We have to evaluate them for several years on the rootstock to see if everything looks good. And if they pass that check, that's the second level of selection, then we propagate them and we give them to a select number of growers that are participating in this evaluation to look at them and to treat them as all other trees in their operation. And then we meet with them after two or three years of fruiting to see what they like, what they don't like. And then after that, we decide that one cultivar, one selection is going to be released and patented.

**Ksenija Gasic:** Right now, my program is in that phase when my material is in the grower trial stage. And we have already one genotype or selection that they really like, and that we started collecting the data and that we want to do a release and naming. My program is right now, it's going to be 14 years since I was hired this January. So it's full 13 years of breeding. So in the next three to five years, the selection we release will be first cleaned, because once you decide what you're going to patent and release to growers it has to go through the virus-cleaning process to establish the so-called clean trees from which the nurseries will take the buds to produce the trees for selling to the growers.

**Ksenija Gasic:** So it's about 15 to 20 years to release something. And if you're lucky and if everything works out, maybe 20 years before they actually can take a significant acreage in the field and be on the market. But it takes time. It takes time. Yes.

**Hannah Senior:** And very last question, are there any influences you're particularly grateful for?

**Ksenija Gasic:** Oh, there are many. But one of the biggest one would be that mentor that I mentioned. She's now passed. And she was a really great energetic lady in the men's world. And so she taught me not just about science, but about life itself and how I should position myself and how to navigate the men's world. You know? And I think that's basically what shaped me up with all other things, with my parents and my family and growing up in the small village and working during the summers. When my friends went swimming and having fun, I actually went into the vineyards and orchards. And sometimes I was mad that I had to work. But that shaped me up to be what I am today.

**Ksenija Gasic:** And hopefully, I can pass that to my students and my kids that are growing in the United States and in the new world. And it's really hard to connect with where you come from, where the food comes from, and all the troubles people go through to actually develop the fruit that you just pick in the store and don't think about that.

**Hannah Senior:** Yeah. Take it for granted so easily. We all do.

**Ksenija Gasic:** Exactly. Yeah.

**Hannah Senior:** Well I'm afraid we are out of time but thank you so much for talking to me today it's been great. Professor Ksenija Gasic.

**Ksenija Gasic:** Thank you very much for inviting me.

[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 out]