

## Transcript: Plant Breeding Stories Podcast S1E3 - Daljit S. Virk OBE



[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's 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:

This week, I'm speaking to professor Daljit S. Virk whose career in plant breeding spans 50 years. We talk about running regression analysis in the days before computers, breaking the mould and proving conventional wisdom wrong and how breeding crops for very low income farmers dramatically enhanced their food security. I hope you enjoy it.

[Theme Music Fades]

Hannah Senior:

Tell me a little bit about your background. Where did you go to school? Where did you grow up? Were you interested in plants from an early age? Just give me a little bit of background about you.

Professor Daljit Singh:

Yeah. I was born in India, just near the border between Pakistan and India. My family had moved from Pakistan during partition and my father died during those riots. And then I studied in the village school. In the high school, I stood first in the school. And then went to the college, which is about 10 miles from my village in Amritsar, in Punjab, Khalsa College, Amritsar, which is very old, more than 100 years old college. And I did BSC in agriculture there and stood first in the Punjab University. It was in 1964, I passed my graduation. And then went to do my MSC plant breeding in Punjab Agriculture University, Ludhiana.

Hannah Senior:

What made you interested in doing that and why that rather than, I don't know, accounting or something else?

Professor Daljit Singh:

Because I belong to a village, I'm a village boy, so agriculture is the main thing in the villages. So I was always interested in agriculture. It was a basic thing which we were doing at home also. So this was not a very different or new thing to me. And then secondly, what made me to choose BSC agriculture was my father had died, and then we had financial crisis in the family. And I wanted to do something which will give me some employment after graduation. I was assured by seniors that once I do graduation, I will get a job. And when I passed my BSC, I was sent an offer letter to my home without any interview because there was so much demand of inspectors in agriculture, or agricultural officers because of the new era beginning in agriculture, it was start of Green Revolution, just before Green Revolution. So agriculture was in a demand.

Hannah Senior:

I didn't know that. And how long did you do that job for?

Professor Daljit Singh:

I didn't do it.

Hannah Senior:

Oh, you didn't do it.

Professor Daljit Singh:

No, I didn't do it because I stood first in the university, in my BSC agriculture. So it gave me a good scholarship.

Hannah Senior:

Mm-hmm (affirmative).

Professor Daljit Singh:

And I won the scholarship, National Merit Scholarship, so I could do my MSC.

Hannah Senior:

And you did your MSC at the Punjab Agricultural University, but I gather you didn't want to start out doing plant sciences?

Professor Daljit Singh:

I wanted to do economics, economics and social sciences, agricultural economics. And then my senior friend came to me said, "Why are you doing this economics? You should be doing some science. You have done science in BSC, why don't you do science, and go to plant breeding? It's a thing which will serve the farmers better than economics." Then he convinced me and I shifted to plant breeding, and that became my passion.

Hannah Senior:

Do you ever think, would life have been different if you'd gone down the economics route?

Professor Daljit Singh:

Sometimes I do think that I could have excelled in economics as well because that subject I liked, but I did study economics in my BSC agriculture, so that's why I could do this economics as well.

Hannah Senior:

You could do both?

Professor Daljit Singh:

Yeah, I could do both. Yeah.

Hannah Senior:

It sounds like the context that you grew up in made agriculture very much just part of your life and was an obvious choice, but also a trade-off?

Professor Daljit Singh:

Of course, yeah. It was the circumstances, choices. I didn't have anybody else to guide me in family, so I got this guidance from my friends and the person who was senior to me.

Hannah Senior:

I'm curious about, it was really interesting timing. This was when the Green Revolution was beginning to roll out and have effect, how did that influence your work and your view of the world?

Professor Daljit Singh:

Yeah, in the universities, at that time when I was MSC student, we were involved in the breeding or selection of wheat variety, doing selection for the disease resistance in the field and studying the subject of plant breeding, it was exactly the same time. I started my MSC in '64 and then I passed out in '66. And just after that, the Green Revolution impact had started. New varieties of wheat, which had come from Mexico, they started being distributed to farmers and it was the beginning.

Hannah Senior:

And were you working on wheat early on?

Professor Daljit Singh:

Yeah, I did my MSC in wheat, but then after my MSC, I then shifted to lecturing in my old college from where I did BSC. I became a lecturer, and a lecturer in plant breeding

and agriculture botany. So I taught there for four years. Then I got a job in the Agricultural University as assistant professor and I was there for about three years.

Hannah Senior:

And it was while you were there that you applied for scholarship in the UK, right?

Professor Daljit Singh:

I applied for two scholarships, one was a German exchange scholarship, which is called DAAD. And the other one was Commonwealth Scholarship. And I got selected in both of them. And then I opted for British scholarship because I thought if I go to Germany, I have to learn German and I will spend another one year to learn it. And English, I know a bit, so I have been taught in English, so it will be easier for me to go to Britain and get my PhD. And that's what I did.

Hannah Senior:

And what year was that?

Professor Daljit Singh:

That was in '73. I was 26, something like that.

Hannah Senior:

And that was Birmingham, wasn't it? So 26 year-old Daljit came to Birmingham in the mid-seventies.

Professor Daljit Singh:

No. No, no. Yeah. Again, it's slightly different. I didn't come to Birmingham straight away. It was my dream to come to Birmingham because the professor there, professor John Jinks, he was so well-known in the world in biometrical genetics, just the very important person and I had a dream to work with him. But unfortunately I had written to Aberystwyth because the director of Aberystwyth at that time came to Delhi. And I met him in a conference and I said, "I want to come to Britain. If I apply, will you accept me?" He said, "Yes, if you have good references, he will accept." And I got accepted.

Hannah Senior:

So you've traveled halfway around the world as a young man, and you've arrived in Aberystwyth, in Wales in the early 1970s. What was that like?

Professor Daljit Singh:

I couldn't exist there because it was a new country, new people, no Indian there, no Punjabi there. I was alone. There was some Pakistanis. There were a few Pakistanis. I did some... About three months, I attended a biometrical genetic course, which I excelled. My professor said, "Oh, you know everything." So, but he also mentioned, "You should have been in Birmingham rather than Aberystwyth. You are so good in

quantitative genetics." And then I requested my professor, "I'm unable to adjust here. It's loneliness I am having. It's a new, strange country. I have never been out of my home, and I can't live on like this. I am feeling lonely." So then I got shifted to Birmingham because I had a friend there who was doing PhD with professor Jinks. I spoke to him, "If I opt for... will he accept me?" He said, "Yes, I have talked to him. He will accept you." And that's how it happened.

Hannah Senior:

And when you did finally make it to Birmingham, what did that feel like?

Professor Daljit Singh:

I was so happy. I spent that time happily. I did a lot of work, new work, new quantitative genetic modeling, and so much theoretical work. I excelled. And I developed a lot of skills in Birmingham because that was the institution which was on top in the world, in my subject.

Hannah Senior:

This was the mid to late seventies by this point, so computers would have been pretty thin on the ground. So how did you do the work, it was quite analytical?

Professor Daljit Singh:

When I was MSC student, we didn't have any computer. We used to work on hand calculator. Hand calculator was a machine which had nine digits on it, just like a typing machine. And you have to press one to nine figures, with zero. And then with combination, you have to rotate the handle nine times if you want to multiply by nine, multiple three by rotating three times. If you want to divide, you do it in reverse, so that sort of thing. And I did my analysis in MSC on that machine.

Hannah Senior:

Wow.

Professor Daljit Singh:

And I had specialized in quantitative genetics. And in works on metrics, we could do on that machine with a lot of labor. If you do one mistake, you have to do it again. And that's how I did my analysis, regression analysis, all those inversion of matrices, on that machine.

Professor Daljit Singh:

Then I came to Birmingham, then there was something better. It was Olivetti machine. It was much faster and I was happy. "Oh, it's very good!" Then, there was a computer, which was mainframe computer, placed in one of the department, computer department in the university, about half a mile away from the department. You had to go there and feed the cards. You have to first punch the cards, which are binary function of punching of data on the card. Then feed the cards into the computer, write your own program, in

Fortran, or ask somebody to help you in that. So it was not easy, but still basic computer mainframe was there, which was a very, very big whole room machine. And every department at the university used to go there, and you had to go there by turn on certain days. So it was not that easy, but still we felt very comfortable because we had something better than doing it by hand.

Hannah Senior:

The work you were doing in Birmingham sounds like it was theory, you know, building the underlying principles and lab based. Can you explain the link between the theory and the practical applications in the field?

Professor Daljit Singh:

Quantitative genetics makes you understand how the genes travel from parents to the children, offspring. And if you know that, if you can maneuver them various ways, then you can select better plants from the segregating generations. Then it is the basis of crossing, how the populations of plants behave, how you can maneuver them for the benefit of farmers. The theoretical work was start up statistical extension into genetics, where you try to understand passes of chromosomes, passes of genes from parents to offspring, and how to monitor them, how to catch them for the benefit of the environment. So that's why exactly the theoretical work was totally linked with practical aspect.

Hannah Senior:

So was this work that was directly feeding into new varieties?

Professor Daljit Singh:

It was not variety oriented in the UK. It was more understanding the knowledge of genetics with quantitative genetics. I grew experiments there, which were large experiments, for example, different crossing schemes. For example, I took two crosses in which I developed 22 generations by crossing the progeny in different ways. For example, you have F<sub>1</sub>, you backcross with parents, then you have F<sub>2</sub>. You backcross with other parents, and reciprocal crosses, and various types of combinations. And then follow the genes through the different generations by genetic models, and find out which is good one, and how you can select, and how can you tap.

Hannah Senior:

So you your PhD and postdoctoral studies in Birmingham, focused mostly on the underlying techniques.

Professor Daljit Singh:

Yeah.

Hannah Senior:

And then after that, moved back to India and took the position of associate professor in genetics at the Punjab Agricultural University. What came next?

Professor Daljit Singh:

After two years teaching genetics, it became too much teaching, less of practical though I was doing some research for students, and all those things. But it was not directly practical. So then I shifted to plant breeding department where I was put in charge of millet breeding program. So then I started millet breeding, pearl millet was the main crop.

Hannah Senior:

And it was during this time that you started doing more practical research and publishing more papers, right?

Professor Daljit Singh:

I used to guide students and collect data, and from the practical data, I used to publish a lot. And I published about more than 300, 350 papers on that. I never did any separate experiment than my practical breeding program. So I would do practical breeding program, and collect data, and write it up. So that's how it has happened.

Professor Daljit Singh:

I evolved a number of varieties, hybrid varieties, composite varieties, male sterile lines in pearl millet, which were released for cultivation and breeding.

Hannah Senior:

I forget the term that you've used... Is it farmer-led breeding? Is that what you were doing throughout, or is that something that came later on?

Professor Daljit Singh:

While I was in Bangor University, I came in '94, there it was more of a farmer-led thing. And we used to call it participatory plant breeding, where farmers would participate in breeding of new varieties. And then we moved on in a different direction within this field, and that we call it client oriented breeding rather than farmer-led, or farmer participatory, or all those things. We said, "Farmer always participate. Farmer is always leader. But client orientation is a better term because client is not just the farmer. It's the consumer as well, it's the market, it's the industry. And we have to consider their opinion as well. There are multiple stakeholders in the breeding process, and the orientation of the breeding objectives. So we have to take those into consideration, and let it be client-oriented breeding. And that's what we did.

Hannah Senior:

At this point, is this the work you were doing for the UK government's Department for International Development, DFID? `

Professor Daljit Singh:

Yeah, DFID. Yeah, DFID had a big, big program for the tribal, poor people in the villages, ignored areas, far-flung villages where people are poor. They don't have food even for a full year, very small holdings, no irrigation, no fertilizer. We said we will use plant breeding to improve their food security. And we found that what are the crops farmers are growing, and then shortlist which are the most important, start breeding in them. Then we started breeding in some of the crops where we couldn't get varieties which was suitable for farmers, but the crops were very important. For example, rice, for the upland situation, all varieties were failing. We tested all varieties available, nothing proved good for the farmers. Farmer were growing their own landraces. So we wanted to replace the landraces with the better variety. So that's where we started breeding up upland rice.

Professor Daljit Singh:

Then, similarly in maize, farmers were not having good composite varieties. The Indian government policy was to give them hybrids, and hybrids will not grow with poor farmers. So we developed composite varieties which was suitable for the farmers. And similarly for other crops, wherever varieties were available, we didn't breed. We just provided them the varieties, let them test and choose the best one. And where the variety is not available, we bred the varieties along with farmers, and that we called it as a client-oriented breeding because we had a research farm as well as farmer field.

[Theme music fades up]

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.

Hannah Senior:

Now back to the podcast.

[Theme music fades out]

Hannah Senior:

So a lot of your work, it sounds like perhaps even the majority of your work through your career, has been developing varieties for very poor, underserved farmers who don't have the advantages of tools, fertilizer technologies that we might think of when we think about the developed world for farming.

Professor Daljit Singh:

Yes, sure. Yeah, that's exactly right. I worked in Ethiopia, worked in Namibia, and other countries in Africa. And always the target was poor farmers, marginal farmers, rainfed farmers. And poor in the sense, their soil is poor, also their resources are poor. They can't afford to put high doses of fertilizer, maybe little bit. They don't have the irrigation,



or maybe irrigation there is very, very small irrigation they have. They cannot do too much. So that was the target. And the food securities is not there. They have only meal for six months in a year, something like that. Then they migrate to cities for labor and all that.

Professor Daljit Singh:

And so they were really poor people and they don't have access to various infrastructures like roads and other facilities from the government. So we used to work in watershed. In Ethiopia, I worked in watersheds where we involved universities, Department of Agriculture, they call it Bureau of Agriculture, food security department, then agriculture research institutes. So all those, we were working together in a consortium. And we used to work in watershed where there was many villages and there was very poor, and sort of a hilly terrain. There's no irrigation at all. So that was a challenge, how to increase their food.<sup>36</sup>

Hannah Senior:

And what would you say is the achievement that you're most proud of through... I mean, you've done amazing work throughout your career in developing new ways of doing things and developing varieties that help these really, really important sectors that are otherwise overlooked. What are you most proud of?

Professor Daljit Singh:

You are right, we have been very innovative. We did things in different ways. Sometimes the traditional plant breeders laughed at us that you will fail. And we said, "No. What we are thinking is based on theory and we will not fail." And we did succeed. And they were amazed that how much success we have. So it was re-orienting our plant breeding approach which will give us, A, high success, B, at a high speed. And that's what we targeted and modified our methods of breeding, which were very successful. And now people are follow them.

Hannah Senior:

Can you give me an example of that, of when somebody said, or you had an idea, others said it wouldn't work and you proved it and it had an impact?

Professor Daljit Singh:

Yeah, sure. Taking the example of rice, what we did was, we said we will not do many crosses. Previously, the plant breeder will do thousands of crosses. And why they do a 1,000 crosses? Because they come from international institutes like IRRI in Philippines, like CIMMYT, rice, maize, and weed breeding program in Mexico. They go and get training there. So they do thousands of crosses. Then in the end, they get confused. But we said, "No. We will do very few crosses." For example, per year, we only did one or two crosses. Not more than that. And before doing the cross, we will deliberate why we want to do this cross. What is the female parent? What defects its' had? How would the defects can be cleared by other parent, and how we were going to cross? What sort of variation we expect and how we will handle the generations.

Professor Daljit Singh:

For example, in rice, we did two crosses. One was best local variety. Farmers want something to improve on this, so one parent is fixed. Take the second parent, which is very diverse and it gives you various good traits. For example, we crossed Kalinga III three variety, which was popular with farmers, with upland. It was short duration variety, but it has certain defects. For example, the defect was, it lodges when there's more rain, more fertile soil, and its roots are poor. But otherwise, its grain quality is very good. Its yield is very good. People like it. So we want to remove those defects. Then we said, "What will be second parent?" We crossed it with IR64. IR64 was the most popular variety at that time in the world. And it was high yielding, high disease resistant, and it was adapted for irrigation. We crossed it.

Professor Daljit Singh:

And another variety next was IR36. We crossed that. We thought it will not succeed, and that's what happened. In the F2 we said, "We will grow large population to get all sorts of variation created by genetic recombination." And we said, "We will not grow less than 10,000 to 20,000 plants per cross." So we had two crosses and we grow more than 15,000 plants for each. One cross we studied, in the F2 we found a lot of variation, but the grain quality was not good. And we rejected it. The second cross, it was the best cross. And we chose plants from that. We bulked it, and then we said, "We will not do very rigorous selection in the F2. We will delay our selection up to F5, of F4. And once F5 is there, then we brought the farmers.

Professor Daljit Singh:

One varieties was selected on farmer field, other on our search station with farmers. And then we made it true breeding and put it in trials immediately. Within three years, we were doing the testing. And in a year or so, in three, four years, we had the variety which we gave to the university. You test in your trials, and all India trials, we put the variety. And then we got it released.

Professor Daljit Singh:

So this is the difference. One, doing the diverse cross, doing very few crosses, delaying the selection till there's homozygosity. And then doing farmer field testing once the variety is established along with other varieties, and release it immediately.

Hannah Senior:

Who benefited from that? When it was released, who used it and how did it get to them?

Professor Daljit Singh:

Oh yeah, it was benefited by the university's staff, researchers, because they were our collaborators. And then we produced the seed and gave farmer seed in large quantity. We said, "This variety is good." We said to farmers, "You grow this variety next year, keep the seed and share it with the other people." Which they did.

Hannah Senior:

And this was farmers in India, was it?

Professor Daljit Singh:

Yeah, in India.

Professor Daljit Singh:

And then we started our cooperative seed production with farmers. The success adaptation over the variety was very good. It was spreading. We isolated some money for seed production and gave the seed free to farmers in small quantity, say one kg, two kg, so that it spreads, goes to many farmers. And then Rockefeller Foundation came in. I said, "Okay, come on, I will show you in the villages." We took him to the villages. And then we had meetings with farmers, and he was so impressed. He said, "How can we help you?" So I said, "In what?" He said, "We want that this variety should spread more, and we also get credit." Because they were not having any impact with their programs, which he had fund.

Hannah Senior:

So the lead from the Rockefeller Foundation wanted to help?

Professor Daljit Singh:

He said, "Give me a proposal, I will give you a project on seed, private-public partnership." And that was the seed production. And we rode the project. They gave us money for five years. And they gave us seed processing plants. We bought them, put them at two, three places and involved hundreds of farmers for seed production, and produced the seed every year, and distributed. And sold as well, sold to Department of Agriculture, sold to different agencies, private agencies, private NGOs, so that they spread to farmers. So it was millions of farmers who got benefited from those varieties which farmers will grow without additional irrigation, without additional fertilizer, or doing anything different what they are doing for their own variety, but harvesting five times more.

Hannah Senior:

It's a brilliant story of how doing things differently can give great results.

Professor Daljit Singh:

Yes. Yeah, that's what I said. These breeders were not believing that how fast we will succeed, and we are doing one or two crosses, it's not possible. And I tell you, from the same cross, we developed a dozen varieties.

Hannah Senior:

I've known you for many years now and though you're supposed to be semi-retired, you're still a man of enormous energies. You're doing work with us at PBS International, until recent times with the covid restrictions you were lecturing in Ethiopia and you're a leader in the Sikh community. So I'm curious, at this point given all the changes that

have happened over the last year, what things are attracting your interests and energy? And where do you see opportunities for the future or concerns for the future?

Professor Daljit Singh:

Well, during the COVID, I have been restricted to my home and I do what I can do from here only. I was due to go to Ethiopia in April, which I canceled. And one of my student, who was in Bangor, she has now risen to the post of President, which is Vice-Chancellor in the Mekelle University. And she has excelled in plant breeding. And she always calls me for lecturing and also helping in her research, so things have been going on.

Professor Daljit Singh:

Then, whatever time I have, I study some of the news in India, I get interested in there, what's happening there with the new laws in agriculture passed by Indian government, its impact, and farmers striking, a lot of opposition. I like to follow it. And then I was thinking now to do something, to study more in religion and write something. This coming to my mind again and again, I may start it.

Hannah Senior:

You were awarded an OBE a couple of ago. Tell me a little bit about that.

Professor Daljit Singh:

Yes, I was given OBE, which is Officer of the Order of the British Empire by the Queen in 2019, New Years Honor list. My nomination was not on my scientific career, but it did mention one paragraph about my contribution to farmers and its impact and the varieties which had most impact. The rice variety, it was mentioned there too. And the second was my services to education in UK. So these were the two things. So that's very prestigious and very high.

Hannah Senior:

You must be... Well, I'm very proud for you, your family, and your community, and your colleagues. And I know there's a huge amount of pride because it's well-deserved. It's recognition of all the tremendous work that you've done.

Professor Daljit Singh:

Yeah, when I was receiving it, Prince Charles spent about a minute talking to me about the rice varieties.

Hannah Senior:

Really?

Professor Daljit Singh:

Yeah. He mentioned about it and then asked me about it, maybe minute or two, something like that. He just talked to me personally, probably he's prompted with all those things.

Hannah Senior:

But he's interested in agriculture as well, isn't he? So it would be something, I think that appeals to his interests.

Professor Daljit Singh:

Probably that would have made him interested in this, it's possible.

Hannah Senior:

Mm-hmm (affirmative).

Professor Daljit Singh:

But he did talk to me quite elaborately.

Hannah Senior:

So last question, what opportunities do you see for the future? And you could think about that in just a general sense, or maybe if you were starting over... If you're starting your career now, what opportunities would you see?

Professor Daljit Singh:

Climate change is a big thing which is coming in the future for plant breeders, and it's a challenge, and how we are going to develop varieties which are best suited under the climate change. So this is a challenge for... of course the challenge will be use of more of a DNA techniques with field oriented techniques, which quantitative genetics field designs, and all those things for evaluation with farmers. And more orientation towards client breeding where you will like to map the demands of the market, demand of the producer, demand of the consumer, demand of the industry. All those things have to be combined. And then have specifically target oriented breeding programs for various situation.

Professor Daljit Singh:

But on the other thing, any plant breeding you do, it always involves crossing. Pollination. That's a part of plant breeding. So in future, as the plant breeding is progressing, pollination control systems have also to progress and also have different alternative provision so that you can do them on small scale, individual plant scale, multiple plant scale, and large scale to hasten the breeding process.

Professor Daljit Singh:

But as the population is increasing over this small globe, I would say the need for more food production will always be there and we have to cope with it. And second is the food supply chain will also need to be more developed because, at the moment, even the

food is there, but it's not being made available to the people who need it, not on a price which they can afford, not where they are living. So it's distribution is also a big, big challenge. Even if you produce lot of food, how you going to distribute all over the world. It's not just food production, it's food supply chain, and food distribution, and availability where it's required.

Hannah Senior:

Professor Daljit S. Virk, OBE, thank you very much for sharing your plant breeding story with me today. It has been fascinating.

Professor Daljit Singh:

Thank you very much.

[Theme music plays]

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. Until next time, stay well.

[Theme music fades]