

Transcript: Plant Breeding Stories Podcast
S4 E5 Dr Narinder Dhillon



[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.

Series four 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 in Switzerland.

Dr Narinder Dhillon is the principal plant breeder for cucurbits at the World Vegetable Centre, based in Bangkok, Thailand. When you think of the vegetables on your dinner plate you may not think of loofah or bitter melon, but these form a highly nutritious part of the diet in many regions of the world, and are the focus of his work.

Narinder talks about combining private and public resources to achieve optimal research outcomes, and how each wave of innovation in molecular biology should be considered building on the wave before, not replacing it.

Transcripts of this and all our podcasts are available at [PBSInternational.com/podcast](https://www.pbsinternational.com/podcast).

I hope you enjoy it.

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Hannah Senior: Narinder, welcome. To get us started, can you just tell me a bit about yourself?

Narinder Dhillon: I'm Narinder Dhillon and I joined the World Vegetable Center as a principle plant breeder, cucurbitaceae, and I'm working for the last more than 12 years. At the World Veg, I have the cucurbit breeding program, which aims to genetically improve the minor cucurbits, like bitter melon, bottle melon, ridge melon, sponge melon and tropical pumpkin. And we have partnerships with the international and national institution, private sector.

Hannah Senior: Okay, so that helps to set the scene. But it's always interesting to start right back at the beginning of the story and ask you to tell us a little bit about your early life. Where did you grow up? Where did you go to school and how did you get into plants?

Narinder Dhillon: Well, I'm basically a village boy. I grew up on the farm of my grandfather in a small village, and I used to tend crops with the help of my father. And from there, I got interested in the agriculture. And at that time, we used to grow a lot of melons also, and then other vegetables also in our backyard gardens. My father also has a background of agriculture, he was a graduate in agriculture. And then I started having a good interest in the agriculture subject at that time.

And then after passing my high school then to the college. And I did my PhD at Punjab Agricultural University, Ludhiana, specialising in Plant Breeding. And then I joined there as the assistant professor, and then risen through ranks up to professor, and then various stints in the various international organisations over the globe. And then finally picked up by World Vegetable Centre, and here I am.

Hannah Senior: What was it that interested you about plant breeding and about plants specifically? Why did you choose that as the direction for your career?

Narinder Dhillon: I got interested in genetics and plant breeding during my graduate studies, my teachers who taught me genetics and plant breeding, and that was very fascinating. And I thought that by genetically improving plants through this plant breeding process, I can contribute to the food security and enhance the income of small holder farmers in developing countries. That's why I became interested in plant breeding.

Hannah Senior: You've lived and worked in many different places around the world in your career, so could you tell me a bit about that, the kind of work that you've been involved in and where?

Narinder Dhillon: While I was working at Punjab Agricultural University, I got opportunities to work outside India. And the first, which was University of California, Davis, where I worked on the genetics of celery. And then later, I worked at Plant Breeding International, Cambridge, where my job was use of molecular markers for pea seed-borne mosaic virus, tagging of gene of that virus. And then for two years, I worked at Japan International Agriculture Centers in Japan, where my job again, was the use of molecular markers for conservation of the genetic diversity of sweet potato. And then I worked for one year at IRTA, Spain, as well as INRA, France, where my job was on the melons and studied the diversity of these melons using molecular markers.

Narinder Dhillon: Now, my experience of working at all these places helped me in various ways. For example, first it helped me to do excellent research, objective research, how to do it. And then exposure to the new technologies of the molecule markers at that time. And then also develop the partnerships, future partnerships, through these contacts. And also it improved my communication skills for writing publications, I remember very much. So, this is how it benefited. And later when I

pursued my career at the World Vegetable Centre, I'm using these molecular marker technologies for my research here also. And the other things which I learned for conducting and planning and organising research was very helpful, which I learned from these institutions.

Hannah Senior: And is there a reason that you chose specifically to specialise in vegetable crops rather than say, cereal crops?

Narinder Dhillon: When I entered into my graduate program at Punjab Agricultural University, my teachers told me that the vegetable breeding is a neglected area, you can do a lot here. And these are the vegetables which contribute to the nutritional security of the poor people in all the developing countries. And vegetables are cash crops, grown mainly by the smallholder farmers, so I can make a good impact. And second, the reason was, there was a scope of genetic improvement in vegetables, because for example, in vegetables, if you see the number of breeders and you see the number of breeders in grain crops, it's a tremendous difference. So, I thought that I can contribute much more better, in a significant way, while working for the breeding of vegetable crops.

Hannah Senior: The scale at which grains are grown, a single species wheat or a single species maize, is grown at such massive scale. Whereas vegetables, there's a much greater range of species. And that means each one gets less focus. Is that right? Have I understood that correctly?

Narinder Dhillon: Yes, you are right. Vegetables are a very diverse portfolio, and so many families to work on. And within one family, for example in cucurbitaceae, there are large number of crops, major crops, minor crops. So, there's a lot of scope to work here and to do the work, which was not done before that. So, that's a difference why I selected this option.

Hannah Senior: I know you have worked with some really exciting and cutting edge techniques in your time, but you're also very level headed about new technology and it's potential. Tell me about that?

Narinder Dhillon: Well, yeah. This use of molecular markers is about three decades business. I remember that when I was in UC Davis, at that time, everybody was talking about protein markers, Isozymes markers. They say it'll revolutionise the plant breeding world because basically the molecular markers are used by the plant breeders to accelerate their breeding programs with more precision.

Narinder Dhillon: So, when I left UC Davis, and then when I was in PBI Cambridge, then the era of restriction fragment length polymorphism, these are the markers which are repeatable and which are robust, and it has a future. At that time, everybody was using these markers, and then it has some limitations. And then one day, I was sitting in a cafeteria with my professor, he said, "Dhillon, a new kind of molecular marker that is random amplified polymorphic DNA has emerged. I think we will leave these RFLPs and merge into it." But later, it was found that they were not repeatable across the laboratories, and that's not reliable.

Narinder Dhillon: And then, these new kind of markers emerged, AFLP. And then there were simple sequence repeat markers, which are repeatable. But now at the present, it's the era of single nucleotide polymorphism markers. The reason is that, these molecular markers, SNP especially, their abundance in the genomes, abundance. And they are amenable through high throughput detection forwards and the plate forms. So now, these kind of molecular markers, we are using it for tagging disease resistance genes in cucurbits and understanding the diversity of, for example, recently we have collaborated with KU to understand the genetic diversity of our loofah breeding lines. So this is how this technology emerged over time.

Hannah Senior: As I understand it, each of these technologies builds on the one before. So, it's not that one of them is just a silver bullet. Is that your take on this?

Narinder Dhillon: Yeah, that's true. But, it doesn't mean that the other molecular markers become obsolete after SNP. It's need based, for example, one time I visited the lab of one leading seed company, and then I saw that they're trying to see the seed purity using isozyme markers. So, it depends from situation or situation. If these cheap, easy to handle isozyme markers give you a reliable results of the genetic purity of your material, then why to go for expensive SNPs? So, it's a situation based.

Hannah Senior: Mmmhmm [affirmative] So, I want to turn the conversation to cucurbits now.

Narinder Dhillon: Yeah, those are my favourite!

[They both laugh]

Hannah Senior: Exactly, your favourite. So, could you give me an overview of the cucurbit family in general and give us a sort of foundation to start from?

Narinder Dhillon: This cucurbit family is very diverse, and it has about 950 species, of which, cover about 90 genres. The term cucurbits basically refers to the cultivated species of the cucurbitaceae family. And we here don't focus on all the cucurbits, we focus on which the... Actually the people term them as a *minor* cucurbit, but they are not *minor* cucurbits. If you ask about those cucurbits to any person in the developing countries, they would say, "What are you talking? These are not minor, these are actually our food security!"

Hannah Senior: Can you give an example of a minor cucurbit?

Narinder Dhillon: People differentiate the cucurbits cultivated species as major cucurbits or minor cucurbits. Major cucurbit means they are grown extensively, globally.

And the minor cucurbit means they are non-global cultivation and consumption. For example, there's watermelon and melon and cucumbers. They're grown all over the world. They're the major crops, and they occupy about 80% of the cultivated area. But the minor crops, as I told you, which are not grown globally and use consumption not globally. So they occupy about 20% of the area. And almost, about more than 90% of that area is in the developing countries, especially in Asia. So, this is the difference. And the minor cucurbits we choose to work here at the World Vegetable Centre include four species. For example, bitter gourd, ridge gourd, sponge gourd, and then recently we started working on bottle gourds. And apart from that, the tropical pumpkins, not temperate pumpkins.

Hannah Senior: And did they contribute particular aspects to the diet or particular nutrients to the diet?

Narinder Dhillon: All these cucurbits have good nutritional value. For example, a bitter gourd is rich in vitamin C and the micronutrients. And the World Vegetable Centre has established through experiments done in the medical colleges in Africa and in South Asia, it has a significant value because it manages the blood glucose level. So, people use it as a food medicine. And then if you talk about other minor cucurbits, like a ridge gourd and the sponge gourd and the bottle gourd, they're also very rich in the micronutrients. For example, if you take this case of loofah, and if you take about 200 grams of loofah, cooked loofah, and that I think covers up to five to 16% of the recommended daily intake of the micronutrients. So, it is good. And similarly, if you talk about this tropical pumpkins, they're rich in beta-carotene, highly rich in beta-carotene.

Hannah Senior: We hear a lot these days about food as medicine, don't we? And so, describing about the bitter gourd being helpful for lowering blood glucose, when diabetes is a problem all around the world, including massively in the developed world. It seems to me, it's surprising that it's not getting more focus as a potential contributor to handling that challenge. So, why do you think that is?

Narinder Dhillon: First thing is that the area under bitter gourd cultivation is gradually growing, Asia. The reason is that people have got sufficient evidence that it manages the blood glucose level, it's area's increasing. Why the seed companies are not investing in developing, let's say the bitter gourd, which are rich in antidiabetic compounds. The reason is that there's no incentive for this, for the seed companies. It has not yet been established that if we develop the bitter gourd, whether the level in the fruit fluctuates over the environments or not.

Hannah Senior: You also mentioned sponge gourd, loofah. And I have to admit, I know that more as something that you use when you're bathing than something that you eat. [Hannah laughs] Are they the same thing? Tell me a little bit about that. And how would you use them?

Narinder Dhillon: Sponge gourd is used as a scrubbing sponge, all over the world. You can see in all the supermarkets, like that, but the story doesn't end here. For the developing countries, for the smaller farmers and the consumers in the developing countries, it's one of the major cucurbit food. And these loofahs, they're also very rich in micronutrients. As I explained to you earlier, that if you eat a 200 gram serving of this species, then it covers between five to 16% of the recommended daily dose of the micro vitamins. And these are also the smallholder farmer's crop, so it is a significant value. In fact, if you talk about Southeast Asia and Asia, in every country, this loofah is grown. In every country, the loofah is grown.

[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: We've been talking about your breeding work in cucurbits, and I know a big question in many plant breeders' minds is funding. Is there a lot of funding available for cucurbit breeding globally and how have you navigated that issue?

Narinder Dhillon: The major funding is for the major cucurbits, which are grown globally. For example, watermelon, melons - huge funding is there available for research. But when we started working on these kind of crops here, then we realised that this has immense value in this continent, South Asia. And then, we looked at the work of the private seed companies, then we realised that we can be different from the seed companies if we do things differently. So, what are the weaknesses in the breeding program? What traits do they want and what access do they have to the global germplasm? And then what are our advantages to work on that? And if we can find out that and then capitalise on that, and show them through our initial years of breeding, then we can attract significant funding. And we are able to do that successfully now.

Hannah Senior: So, that feels like a good moment to transition to talking about the World Vegetable Centre. Could you give us an overview of the World Vegetable Centre? What kind of vegetables, where is it based? Tell me a little bit about that.

Narinder Dhillon: World Vegetable Centre is a nonprofit, autonomous institution of international agriculture research centre, with headquarters in Taiwan. It was founded in 1971, and it has five regional offices globally. For example, we have three regional centres in Africa, one is Eastern and Southern centre in Arusha, in Tanzania. And then one is Western and Central Africa, dry regions in Mali, Bamako. And the third one is Western and Central Africa, coastal and humid regions in Cotonou, Benin. And in Asia, we have two. One is in Thailand, which is East and Southeast Asia office. And one is South Asia regional office in Hyderabad, in India. So, this is how we are spread globally.

Narinder Dhillon: Then we don't work on all the crops for breeding purpose. We work for example, on the global crops, such as tomato and hot pepper. And then we work on traditional vegetables, like amaranth, jute mallow, which belong to the African continent, which contribute to the food security of the African people. And then here, we work on the cucurbits, basically the minor cucurbits, where we are very strong. And then in South Asian office, we work on the mung bean, which is also rich in iron and other nutrients.

Narinder Dhillon: Besides this, we have a very huge gene bank, which houses about 65,000 accessions, collected from 158 countries. So, we also give to the farmers the improved production technology. And then the post harvest methods, which help farmers to increase their productivity of vegetable crops, and then also enhance their incomes, basically the incomes of the poor rural and the urban households in developing countries. And they also provide healthier, more nutritious diets for the families and communities in Asia, Africa, and Latin America.

Hannah Senior: You're based in Thailand. Is that a particularly good place to be based for cucurbit breeding or vegetable breeding?

Narinder Dhillon: Yeah, cucurbit breeding. Yeah, because the centre is dedicated to the cucurbit. You are right, because initially, this program was based in Taiwan and then the management shifted it to Thailand after three years. There were many reasons for that. One reason was that here in Thailand, the climate is such that you can grow cucurbits around the year. It means you can grow many generations, you can accelerate your breeding program. This is one reason.

Narinder Dhillon: Second is there's no winter here. Cucurbits are warm season crops, very fit here. No typhoons, nothing of that sort. No climatic calamities, nothing bad. And second, Bangkok is very well connected with other parts of the world. And then all the seed companies with which we are partnering with for collaboration, all these seed

companies have their offices in Thailand, which is a very big advantage. And also when we moved from Taiwan to Thailand, doing research is also cheaper here because of the pay rates of the labour and other things, they're cheaper than doing over there. And by moving from Taiwan to Thailand, it's really a turning point in the cucurbit breeding program of the centre.

Hannah Senior: You mentioned the seed companies have presence in Thailand. Tell me a bit about how you work with the seed companies. Because I understand that's fairly unusual, the way that it's so collaborative, there's so much communication.

Narinder Dhillon: Our collaboration with the seed companies is very intense, hugely intense. For example, currently our cucurbit breeding program is funded by 25 seed companies. The World Vegetable Centre has established a consortium with the help of Asia Pacific Seed Alliance. APSA, we call it APSA. So, it's a World Veg APSA consortium.

Narinder Dhillon: So, the seed companies first become the members of this consortium, where they have access to the limited breeding material, but they get a chance to look into details of all programs. And then the seed companies who are the members of this World Veg APSA project, they make bilateral projects with the breeders of individual crops. For example, I told you that I have bilateral projects with about 25 seed companies. And it is not like the seed companies just come and make a bilateral project for that, there's a lot of work behind the scenes.

Narinder Dhillon: We hold here every year, the crop field is separate for bitter melon, separate for tropical pumpkins, separate for loofah. And then we display our elite lines and F1 hybrids with the specific traits. Then we invite most of these companies to visit us on that field day. Then the breeders, plant pathologists, sales and marketing managers, product development managers, and many times the CEOs and the managing directors or the owners of the seed companies, spend the whole day evaluating our breeding line hybrids. Then once they're convinced that they can make

tremendous progress by utilising this unexploited variability, then they write to us to join the project.

Narinder Dhillon: So, this is how we chose to work on the minor cucurbits because we have a strength here. The strength for us, we have access to the global diversity of the cucurbits, which the individual seed companies do not have. Then we have strong breeding facilities here. Then we have the lines which have specific traits, which they do not have.

Hannah Senior: And I know you're keen to promote this kind of private/public breeding partnership and in fact you just published a paper on it. Tell me more about that?

Narinder Dhillon: Because for example, if you see the publication history of vegetable crops, you can see some kind of collaboration with the major vegetables, like tomato and chili with the private seed industry. But it's never happened with the cucurbits, and especially the minor cucurbits. You can find it for the wheat, you can find it for the rice. For example IRRI, rice institute in Philippines, and the CIMMYT in Mexico. They are making good collaboration with the seed companies for the wheat breeding, for the rice breeding, there's the hybrid rice breeding. And recently ICRISAT in Hyderabad also for their millet program. But nobody came forward for this cucurbit, especially minor cucurbit breeding. So, when we established this consortium and then we brought the results, the companies started benefiting from it. Then we joined hands with a few seed companies to write this paper. And it was very much appreciated globally. I remember that we got some comments from the Crop Diversity Trust also, that if they can do for cucurbits, why not the other crops they can do? For example, IITA Nigeria, they refer to that.

Narinder Dhillon: So, the idea was to let more seed companies, more partners in the private seed sector know our progress, that we have made tangible progress by joining hands with the World Vegetable Centre, and they're getting tremendous benefits from that collaboration. And then the more seed companies will come forward. And also not

only the companies, our public sector donors also read these papers. That means very good for the World Vegetable Centre. They also are encouraged to support our program. For example, not only from the private sector we are getting funding, World Veg is getting funding from the public sector also.

Hannah Senior: So what would be your tips for making a successful cucurbit breeding program.

Narinder Dhillon: Breeding programs are successful for only a few reasons. If they're very stable and their staff is very competent and the funding is very good. And in case of cucurbits also, the funding should be very much adequate otherwise you can't run a global cucurbit breeding program. Plant breeding is a number game. And when you cross the two different breeding lines with the different traits, and then you try to fix it, these traits in the segregated population, or you focus on large number of the traits, then you need a large population. Because, as the more number of genes growing those old characters, then you need more number of population to find a ideal plant which has all these genes, hence expressing all these traits. But the cucurbits is grown in such a way that they're vine crops. For example, in tomatoes. Tomato breeders can accommodate about 98,000 plants and chili breeder also 98,000 plants like that.

Hannah Senior: Is that per hectare or per acre?

Narinder Dhillon: Sorry. It's a per hectare. 65,000 plants, not 95. But the mung bean breeding can accommodate 95,000 plants. But what for the cucurbits? Bitter gourd I can accommodate only 6,000 plants. In my tropical pumpkin I can accommodate only 3,000 plants. And then it means a large area is required. And second, the breeding procedure. For example, in the tomato or in the legumes, the mung bean is our flagship crop. They're the self pollinated crops. But if I am to select the plant, I have to first self pollinate the plant, all the plants. And then select only desirable ones. But in the case of tomato, they don't need to do the self pollinate of plants. These automatically self

pollinate. They come, they reject and select. But the cucurbit breeder has to do the additional effort for that.

Hannah Senior: And we've almost run out of time but one last question before we finish up. You've had this really diverse career working with people and crops all over the world. So I'm wondering, have you any influences or mentors that you're particularly grateful for? And why?

Narinder Dhillon: Oh yeah. I think this is the most important question you have asked me and given me, the opportunity to pay my... Really, thanks to the people who has shaped me as a plant breeder. So, one person I want to specifically mention is Dr. Darshan Brar, he was my teacher. He ignited the fire in me to be a good breeder and to be a good teacher of plant breeding. He was also a tremendously successful plant breeder. He retired as a head of the division of plant breeding in International Rice Research Institute. This is one person who's behind the scene, but the success the companies or our stakeholders see today in me and my program, it has a great influence of that great person. He's no more now. May his soul rest in peace.

Narinder Dhillon: And the second, when I went to Plant Breeding International, so I worked with Professor Graham Jellis there in Cambridge. At that time, it was a private company and I think it was Unilever company, right. While working with Professor Graham Jellis, I learned many things from him. So I learned from him how to approach a research problem, how to choose a research problem, how to tackle the research problem, how to write a good paper. I remember that he was, at that time, editor of the Plant Pathology Journal. And one day I came to him, his office, I said, "I have written two papers. I want your help to teach me where I'm wrong, where I'm right, where I should put more references." He sat with me for hours together to complete and to teach me. So, these two people have made a significant impact in my career. And I remained in touch with these two personalities for a long time.

Narinder Dhillon: For example, with Dr. Darshan Brar, till the end of his life, I was in contact with him. I go to home leave, I used to meet him, discuss the ideas, exchange ideas, learn good things, new things from him. And I'm still in touch with Professor Graham Jellis. He's retired, but I'm still in touch with him. And then, for example, last time I was writing one research proposal, I sent to him for his comments. He obliged me immediately. I remember when I left Cambridge, he came to see me off. He said, "I give you one gift, a parting gift. Whenever you write some proposal or paper, don't hesitate to approach me, I will strengthen that quality of the paper." So see, these teachers make you what you are today. I'm thankful to them.

Hannah Senior: There's that phrase that says, "No man is an island." I think no plant breeder is an island.

Narinder Dhillon: Yeah.

Hannah Senior: But the people that you work with and the people that you in turn influence are hugely important.

Narinder Dhillon: Yeah, yeah.

Hannah Senior: That feels like a great note to leave things on. Thank you so much for your time today. I really enjoyed learning about all these different types of gourds and cucurbits. So, thank you very much for your time, Dr. Narinder Dhillon.

Narinder Dhillon: Thanks Hannah for having 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]