Transcript: Plant Breeding Stories Podcast
S3E6 - Dr Clare Mukankusi

[Theme music plays]

Hannah Senior: Welcome to this episode of the Plant Breeding Stories podcast, where I talk to leading lights in plant breeding, asking what they do, what makes them tick and what fascinates them about the world of plants. I'm your host, Hannah Senior of PBS International, world leaders in pollination control. We design and produce specialist pollination bags and tents used by plant breeders and seed producers all around the world. And through this, I've been privileged to get a unique perspective on how plant breeding globally affects our diets, farming systems and the environment. I'm excited to share a little of this with you, as we meet some of the amazing people who make plant breeding their life's work.

Hannah Senior: Today, I'm talking to Dr. Clare Mukankusi, who is the Global Breeding Lead for common beans at the Alliance of Biodiversity International and CIAT, the International Center for Tropical Agriculture. In this conversation, we talk about the forces driving a greater focus on beans as a priority for research, including reducing the devastating impact of root rot and why focusing on traits such as faster cooking time are so important. We also touch on how The Alliance's global reach and collaborative approach to research influences the work that they do.

Hannah Senior: Transcripts of this episode, and all our podcasts are available at pbsinternational.com/podcast. I hope you enjoy it.

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Hannah Senior: Dr. Clare Mukankusi, thank you for talking to me today. It will be great to start things off by understanding a little bit about you and your background. Would you like to introduce yourself and start the story there?

Dr. Clare Mukankusi: Thank you, Hannah. My name is Clare Mukankusi. I work as a breeder for common beans. I am working at the Alliance of Diversity International and CIAT. I am based in Uganda. I have worked as a breeder for the last 12 years. Really my interest in plants is more a general interest in biology and living things. I was interested in science subjects and through my education, I was able to pursue agriculture and then masters in crop science and plant pathology and a PhD in plant breeding that now led to my career throughout. I've been doing plant breeding for the last 12 years.

Hannah Senior: Tell me about the young Clare. Did you grow up in the countryside? Is that how you came to be interested in science or did your family have a scientific occupation or a scientific background? Tell me a little bit about your early years and how that led to your interests now.

Dr. Clare Mukankusi: Actually, I didn't grow up from the countryside. I grew up in the city, in Entebbe in Uganda. So my dad was a medical laboratory technician. He spent most of his time in the lab and we used to go spend time in the lab to see what he's doing. But I think also my interest came from the education I was getting at school, and I tended to prefer the technical type of subjects. Really, to me, they made more sense.

Hannah Senior: Tell me a little bit more about how you chose to go into plant breeding and food production and agriculture. I'm really enjoying hearing the sound of the birds and so on behind you. So I can tell you're not in a city at the moment !

[They both laugh]

Dr. Clare Mukankusi: The natural setting! Yes. I now live in the outskirts of Kampala, so it's really beautiful and there are a lot of birds and animals.

Hannah Senior: Yeah, it sounds lovely.

Dr. Clare Mukankusi: I had originally wanted to be a medical doctor, but I wasn't able to get the grades for me to be able to pursue medicine at university. The next big thing that I was offered under government sponsorship was agriculture. So it wasn't like my first choice at that time but once I dove into agriculture, I started loving it because the way I see it, what I would've done as a medical doctor is what I did with plants this time, because I majored in plant pathology. So really it was about diagnosing diseases trying to manage diseases in plants instead.

Hannah Senior: One of the things I noticed about plant breeding and agriculture is that people often don't know what kind of careers can come from it. People know what a doctor does, but did you know what a plant breeder does when you were young?

Dr. Clare Mukankusi: Not at all! Actually, I started understanding what plant breeding is at university. You know, I didn't really care so much, but I always wondered what made things different, what caused the diversity. So I knew it was natural. What I was seeing was naturally caused by pollination. I didn't know that the actual human beings are also behind the diversity that we see. So at that time at a young age, I really didn't know about plant breeding.

Hannah Senior: Just a moment ago, you mentioned that you became interested in plant pathology and then now you are a plant breeder. So just briefly describe for me, how did that transition happen between the sort of general agricultural training then focusing in pathology and then becoming a plant breeder? How did all that work?

Dr. Clare Mukankusi: To me, I see it like a perfect fit. So masters in plant pathology at that time, I understood diseases. I understood the resistance and susceptibility, how diseases affect different crops and the different aspects of plant pathology. But then when it came to how my knowledge could be useful to a farmer, I thought plant breeding was the way, actually plant pathology could contribute to what's actually getting to

farmers' fields. So maybe it wasn't very obvious for me at that time, because relief in Africa here, it's mainly where you get the opportunities and at that time there was a great emphasis on an “African Revolution”. So there was a lot of support from several donors trying to build capacity of young scientists to contribute to the African Green Revolution.

Dr. Clare Mukankusi: So at that time, the Rockefeller Foundation was offering scholarships in plant breeding. And I was just fresh from school after finishing my masters in plant pathology. I had only spent one year out of school, so when I saw this opportunity, I said, wow, this is great for me because I could still do plant pathology while I did plant breeding, because I could breed for plant resistance. So there was a very strong connection between the two fields.

Hannah Senior: Tell me a bit about the alliance between Biodiversity International and CIAT and what you do in your role as the global breeding lead for common beans.

Dr. Clare Mukankusi: The Alliance of Biodiversity International and CIAT has breeding hubs in Columbia, breeding hubs in Africa, there are three breeding hubs. The breeding hubs do have to work together. They work together with the national programs in Latin America, as well as in Africa, and they do this through breeding networks. So the role of our breeding lead really is to coordinate the breeding activities. So it is to offer strategic direction to ensure that the team is coordinated and having well outlined goals with the whole essence of achieving genetic gain and making impact in the farmer's fields.

Dr. Clare Mukankusi: So really the responsibilities are to oversee the breeding program, to ensure that our tasks are aligned to the vision that we have, all our operations and we are addressing our market segments to ensure that we utilize the resources that we have efficiently. And of course, trying to ensure that we keep track of the current building technologies to see how they apply to common beans and where we can actually be able to use them, but also ensure that the program remains relevant

and that the outputs that come from it are well communicated so that we continually attract the investments into the program. Our role is really to ensure that we continually improve and develop better varieties each time. We made a strong program.

Hannah Senior: The Alliance was formed when Biodiversity International and CIAT, the International Center for Tropical Agriculturejoined forces a few years ago. Both were, and The Alliance is now a centre within CGIR. Can you tell me about the kind of work that The Alliance is doing now?

Dr. Clare Mukankusi: So CIAT and Diversity were one of the first, maybe a few centers that started looking at their areas of focus and seeing, we are actually doing things that could be similar things that if we came together could actually be stronger than if you are separate. So the goal is to deliver research based solutions that harness agriculture biodiversity, and then sustainably transform food systems. So we look at food systems in general. We have research that goes towards understanding biodiversity to make improvements in the livelihoods of people. We also talk about the improvement of the biodiversity that we have. We have breeding programs also that are focused on specific crops. So when we came together, the work now is more food system driven, but at the same time, we also strengthened our breeding program because we've put several new capacities into the whole system. So we look at the whole of the chain of everything to do with agriculture.

Hannah Senior: And what crops do you focus on? What are you breeding?

Dr. Clare Mukankusi: The crops are beans, common beans that I work on. Cassava, forages and rice, specifically.

Hannah Senior: Your focus is on common beans. So just to make sure we're all on the same page, can you explain to me what's meant by common beans and why they're an important crop?

Dr. Clare Mukankusi: Common beans actually is, I think one of the most important food legumes in the world, but in Africa here, it is a major food, especially in East and Central Africa. It's a major source of protein, a major source of nutrients, micronutrients, especially iron and zinc. It's a source of dietary fiber. It also contributes to the agriculture systems. So it fixes nitrogen in the soil. So it's used crop rotation systems to ensure that we have more fertile soils. Originally it used to be a small crop focused on women, those were growing it for food security in their homesteads, but with a lot of efforts that have come from different places, including what we do as Alliance of CIAT, but also under the Pan-African Bean Research Alliance, we've been able to promote beans to make sure that they reach a level where they're actually an income generating crop, not only for women also for men and youth.

Hannah Senior: (Affirmative) Can you tell me a bit about the breeding objectives in the program? What are the goals?

Dr. Clare Mukankusi: The goals for the program really are not static, they're ever changing. Our breeding goals are continually changing to continually be useful. But of course, over my time with beans I have noted that actually there are few traits that are very consistent when it comes for breeders. Some traits that are usually consistent and actually can guide a breeder, things to do with the seed size and seed color. So we see that in Africa and even Latin America, there's specific preferences of different grain classes of beans. Beans are endowed in a way that there are several types of beans based on color and seed size. So we have red beans, white beans, yellow beans, mottled beans, purple beans, and so on. And they have small beans, medium size, large size.

Dr. Clare Mukankusi: You find different geographies prefer different types of beans. So that's one thing that a breeder has to take note. What type of grain does that region prefer? But embedded within that, the grain, are those production traits, production traits

are the ones that will actually lead to a yield. Most of the farmers want something that is high yielding and to have high yield, you have to consider the production environment. So things to do with disease resistance, resistance to abiotic stresses like drought, heat, low soil fertility, things to do with toxicity of the soil. So there are things that actually could result in low yield, and those are some of the trait that we need to focus on.

Hannah Senior: While we're talking about disease resistance. I wanted to touch on a common problem, which is bean root rot. I know that was something you were involved with when you were doing your PhD.

Dr. Clare Mukankusi: Yeah I was straight from the university with a master's degree in plant pathology. I joined CIAT as a research assistant in plant pathology, working with the regional plant pathologist. That was Dr. Robin Buruchara at that time and he had a project on root rot, bean root rot and had me working on that. But it also gave me an opportunity to actually read and understand what was going on in the bean sector. It came out to me that diseases were a major production constraint for beans in Eastern and Central Africa. So I was based in Uganda and root rot came out as maybe number one, because there's angular leaf spot, anthracnose, the common bacterial blight, the bean common mosaic virus… But compared to those folia diseases, the root rot, once it affects beans, actually kills the plant. Because it's root rot, it kills the roots and the plant dies away unless you have a resistant variety.

Dr. Clare Mukankusi: And at that time, the were some management practices that were available for the others, but for root rot, it was becoming a challenge. Some farmers actually were abandoning beans because of root rot. Some of them were actually saying that this is witchcraft, because people would grow beans and they just rot. They didn't understand what was going on at that time. When I joined CIAT, it that's when root rot was actually very hot, it was really reducing the bean production in Eastern Central Africa. So that's how I came to work on it and actually I studied

fusarium root rot as part of my PhD. I was looking for sources of resistance to fusarium root rot. I was able to understand the genetics of inheritance for resistance to fusarium root rot. I was able to identify the sources and then be able to develop materials that are resistant out of the courses that I developed.

Hannah Senior: And if I remember rightly, you said that something like up to 60% of plants can be lost to root rot in heavily affected areas, is that right?

Dr. Clare Mukankusi: No, it's actually 100% percent. If you have a susceptible variety and you are growing in a root rot prone field, you'll get a hundred percent yield loss.

Hannah Senior: When we think about yield improvement, it's often in the context of “how can we get more pods on a plant?” or “more beans in a pod”. But actually if you are losing the vast majority, if not all of your plants to a disease, that's a completely different sense of the disease pressure on this crop. You can see why it is so pressing to find resistant varieties.

[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: One of the things that I would like to understand in a little bit detail is the priority that has been put on beans in the past versus now. You mentioned that most parts of the bean plant are edible. Plus it has agronomic benefits in improving the soil. It's important in the rotation, but traditionally beans have been lower priority compared to some other crops, particularly some of the grain crops like maize. So tell me a bit

about why that is the case and what's causing it to change now. Why are beans becoming more important?

Dr. Clare Mukankusi: So the research history for Africa is not long ago. Agriculture research in particular. So maybe 30 years ago, I think that's when research came on the agenda. And at that time there was a need to prioritize what are the major crops actually to do research on. So the step of crops actually got highly prioritized crops that could actually earn farmer's income, but sometimes also contribute to some nutrition. So things like maize were getting more attention compared to crops like beans. And actually even before maize itself, as a crop, there were crops that actually got more attention. The cash crops, those crops like coffee, cotton, tea, those were the expert crops for Uganda. So those crops got the research attention at that time. It's only when issues to do with food came up, malnutrition and so on came up, that food research also got a space in the research agenda.

Dr. Clare Mukankusi: Most of the research funds went to cereal crops and a bit of root crops. Then for the legumes, the legumes really struggled to get a place because they're always considered as, they can grow on their own, they are small crops, they cannot make it in the market. So they're already not given that attention and few issues to do with the importance of nutrition; protein and of course the nutrients like iron and zinc being provided from a cheap source or something that was already available. Because most people would say to get protein you had meat, animal products. You need to get it from either beef or eggs and most people couldn't afford those sources of protein and nutrients. So within the production system, there were beans and legumes that already growing there. And there could be sources of those type of nutrients. So that's when the focus on legumes became important. But of course there was competition. There's still competition up to now on research resources for the different crops.

Hannah Senior: So how did CIAT get involved?

Dr. Clare Mukankusi: CIAT in Colombia was the headquarters for CIAT and we do have a gene bank for *Phaseolus*, the common bean is *Phaseolus vulgaris*. So we do have a gene bank that we maintain up to 30,000 accessions of beans. So when the issue of nutrition and protein came up CIAT was quick to come up with a program in Africa - The Pan-African Bean Research Alliance. This is an Alliance that is facilitated by CIAT. So the Alliance brought together different national programs in Africa, brought together different partners to work together with support from a few donors. So they've been mainly two donors that have been supporting PABRA from the initiation. And that has been the Swiss development corporation plus the government of Canada. So they've been supporting PABRA since that time to be able to do research that benefits several countries. So the idea is to share resources, both human and financial.

Hannah Senior: Initially it was cash crops driving the agenda, and then more recently nutrition has become the concern to drive breeding priorities. And I wonder as we look to the future, what do you think will dictate the priorities as we go forward? Do you think it'll continue to be nutrition or perhaps demand for plant-based proteins internationally?

Dr. Clare Mukankusi: Yes, I think so and they're already driving the agenda. Because a lot of the populations, the people, these days are not the same, like the people over 20 years ago. They have been more of an urbanization that has taken place. So the preferences of the people are actually changing. We see more urban communities, demanding specific things. It's not really about having food alone, but it's also about the quality of the food. So things to do with nutrition are becoming more and more important and the beans really play a role here. So it becomes more and more important as you go along when you think about the nutrition aspects.

Hannah Senior: In the way that you were describing the work that the Alliance does and the structure of the organization, I get a very strong sense that it's extremely collaborative. You're working with different organizations and sharing human resources in multiple parts of the world and genetic resources from around the world. So let's talk about that in a little more detail. Can you give me an example of a collaboration that you're working on at the moment and tell me a bit about that?

Dr. Clare Mukankusi: I'll give you an example within PABRA because PABRA is also an example of a successful partnership. So PABRA presents a framework where The Alliance is able to facilitate research on beans. So the research on beans is from variety development to crop management, to marketing, to actual consumption and actually studying the impact that comes out of all that process. So within The Alliance, the PABRA, several projects do take place that target different aspects of that framework. And several partners are able to tag it to different entry points within that framework. So within the breeding, for example, the variety development, we don't work with one partner. We work with several partners for different topics and different innovations. For example, is a new project that we have on breeding rapid cooking beans that have a higher iron and zinc where we are collaborating with the University of Western Australia and working with six national programs in Africa that is Kenya, Uganda, Ethiopia, Tanzania, Burundi and Rwanda. So those are six countries. We are collaborating with the University of Western Australia. So the University of Western Australia brings to us a body of knowledge on new technology that can help us to increase the speed at which we achieve genetic gain for cooking time and iron and zinc content. It's using technology that is based on what animal breeders have been doing for a long time. And maybe even maize breeders, let's say, for example, that we've not used in common bean.

Hannah Senior: What kind of gains are you aiming for in your breeding program?

Dr. Clare Mukankusi: We expect that we'll be able to achieve at least 30% increase in the iron content after five cycles of crossing. And then 15% increase in iron and zinc, no, iron not zinc. And then we also expect at least to see a 10% increase in yield of the materials that come out of that program. So it's a very exciting breeding program that we're currently implementing with the University of Western Australia.

Hannah Senior: I would like to talk a little bit more about the traits that are selected. You mentioned cooking time, iron content, zinc content being among the high priority traits. How were those chosen?

Dr. Clare Mukankusi: We really wanted to focus on women and children really. So this choice really add our traits that women demand. We know cooking time is a trait that once you have faster cooking time, it's a trait that possibly would save women some time in cooking. At the same time it also saves them the time they spend in collecting firewood. Most of the women, the rural women especially, use firewood or charcoal for cooking. And they collect the firewood from the forest and so on, and this is also time consuming, sometimes dangerous activity. So we expect that these faster cooking beans will save women time, but also something that is very important to notice is that we know that faster cooking beans will maintain the nutrition qualities. So like there is already studies that have been done that have shown that longer cooking beans, actually leach minerals. So the longer it cooks, the more it's losing the iron and zinc, but the faster it cooks, it maintains the iron and zinc. So we should be able to have varieties that are faster cooking but at the same time are more nutritious.

Hannah Senior: And can you give me an example of when you say faster cooking, how long can they take now and what's the objective in terms of the breeding program?

Dr. Clare Mukankusi: Yeah, so most of the beans varieties currently used in the traditional ways of cooking would take up to three to four hours cooking.

Hannah Senior: Wow.

Dr. Clare Mukankusi: So if you reduce that by 30%, let's say, we're talking about a variety that can cook for one hour, one and a half hours, that's dry beans.

Hannah Senior: Right. Yeah. That's a big difference. And as you say, it has a lot of implications, not just for how they use their time, but also the amount of fuel that's needed and therefore natural resources. And I guess, will it also benefit the food industry as well as the domestic or home cooking market?

Dr. Clare Mukankusi: Some of the companies that have come up currently in East Africa are aimed at developing products, pre-cooked products or that have high iron and zinc. So they want to have variety that they'll be sure that through the cooking process, they will be able to maintain that value of iron and zinc in them. So this will go beyond the women, because the rural women really are our main target, but we know that this product is going to go even beyond the target. But of course they could act as a market for the women that we are trying to target.

Hannah Senior: How did the project come about?

Dr. Clare Mukankusi: It actually took a long time for this project to come about. And actually it was through interactions. You know, it was through a project that we call the Demand Led Breeding Project. The Demand Led Breeding Project funded by the Syngenta Foundation and The Crawford Fund. We had of course, through friendship, or collegiality with the people that we were working with, who developed that project that interacted with my current director, Jean Claude Rubyogo, had this conversation and they were very interested. Now we talked about cooking time. They got interested. So it just came there and then, because we had been having this conversation about cooking time and then chasing the market. And actually the traders are also saying that people's

demand for cooking times. So from there you said, no, we need to work all this. So that is how it came about. Really it was through this Demand Led Breeding Project and the interactions we've been having with the teams and the conversations.

Hannah Senior: Right. It's really interesting then. So it sounds like it was a story of asking good questions, listening carefully to the answers and then collaboration and relationships with colleagues all over the world that led to the project.

Dr. Clare Mukankusi: Very correct. Yes. The conversations that go on and...yeah.

Hannah Senior: The other thing I wanted to just touch on is something that we discussed previously, and I know it's important to you, which is this idea of being willing to learn and I suppose that seems to follow naturally from the question about where did that project come from, because clearly a big part of the project came from an open-mindedness to what's important in regard of beans and the needs of women and children. And that's how this, this need for shorter cooking times came out. So let's go back to this topic of willingness to learn. Tell me a bit about why is that important to you? What does it mean to you?

Dr. Clare Mukankusi: Thanks Hannah. For me, the way I see, I can talk about myself individually is because I see over the time and my career, the way it has come about is actually has been a learning curve for me. Every step of the way has always been about learning. There's always something to learn. You can never know everything. Listening to people, sharing ideas, and not being shy to say that you don't know that, so that you're able to have these partners that bring different aspects into something that you could easily have shunned. You would have said “I'm not going to do that, that is too hard” or “I don't have that.” I would look bad if I say, “I don't know genomic selection”, for example. But if you say, “oh, I have no idea. I am not trained in genomic, so I have no idea, but this is what I do.”

Then you have this expert who has been doing this fantastic research and they show you how they're able to actually contribute their knowledge to what you're doing and actually have better results.

Dr. Clare Mukankusi: So I will not be shy to say, why not? Let's try it. Cause I have no idea what it is I would like to learn. And if you're a person I have spent time with, and you've really convinced me that it actually works given evidence, let's do it. Let's learn together because even the people whom I have interacted with, I also learned something from me. I have also learned something from them and to me it is always a continuous learning process. And I always encourage all the young scientists to continually be open to learning and not to be shy to say that they don't know something.

Hannah Senior: There's a lesson in there for us all definitely about always asking questions.... Which leads me to my next question! [Hannah laughs] What are you most proud of in the work that you've done so far?

Dr. Clare Mukankusi: I'm proud of so many things. First of all, I'm very grateful for the opportunity to be working where I am. The CGIR and The Alliance and specially the PABRA has given me the opportunity to work with so many people from different disciplines. It has given me the opportunity to learn so much. It has given me the opportunity to see many things, go to many places, see many countries to see how things are done elsewhere, and be able to improve myself, but also has given me an opportunity, a platform to contribute my knowledge. And I am proud of that. I am proud of all the people I have been able to train, a number of students and they're now way out there. They're contributing. They're also doing some work in their countries. I am very proud of that.

Hannah Senior: So what's next? Where do you think things will take you for the future or what things are interesting you at the moment?

Dr. Clare Mukankusi: [Clare laughs] Well, I'm just starting this new role of the global breeding lead. It's a challenging job on its own. And as usual, I'm going to take it on slowly. I'm going to spend time learning. And of course I won't be shy to take on new things, I won't be shy to take on challenges. But I also see myself not only contributing to the bean program only. I'm seeing myself contributing to more crops. Why I say that is that, because now we are going into this one CGIR and this is going to allow me to interact with different disciplines from different crops, so this is then to give me a platform to actually contribute more and be part of the bigger picture.

Dr. Clare Mukankusi: Not only to look at one crop, but also to see what works in beans, what has worked in maize that can work in beans, what has worked in fourages, how are people doing their things? What have they been doing? What are they not doing that maybe we could actually contribute from the bean area? So I'm seeing myself playing a bigger role in that direction at the CGIR level. I'm seeing a very bright future. Very busy, bright future!

Hannah Senior: Fantastic. I am going to have to wrap the conversation up, but it has been so great talking to you, Dr. Clare Mukankusi, global breeding lead for the common beans program at The Alliance of Biodiversity International and CIAT. It's been a real pleasure.

Dr. Clare Mukankusi: Thank you so much, Hannah. Thank you 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

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[Theme music fades]