INTERNATIONAL BARLEY HUB

Brian Steffenson

Professor of Plant Pathology at the University of Minnesota & Holder of the Lieberman-Okinow Endowed Chair

Q&A >

Brian, can you tell us where you are based and how you ended up working there?

I am based at the University of Minnesota and a Professor in plant pathology. However, I originally came to the. university tostudy journalism. I always had an interest in plants and gardening and at the urging of my uncle, a biochemist, I enrolled in my first plant pathology course. After my first year in plant pathology, I became more and more interested in the interaction between plants and pathogens and breeding for resistance and so I switched to this discipline from journalism.

Brian Steffenson

You are the Lieberman-Okinow Endowed Chair what exactly does this mean?

My position is really unique because it was a new position for our department back in 2000 with the focus of exploiting crop wild relatives for cultivated wheat and barley improvement. The position is an endowed chair which means the funds for my salary and operating costs come from the interest accruing from a large private donation that is administered through the University of Minnesota Foundation. My position was endowed by two local Jewish families who wanted to foster collaboration between the University of Minnesota and Tel Aviv University. The focus of the collaboration is the collection and evaluation of wild species of cereal grains--wheat, barley and oats--which still exist in Israel and across the Fertile Crescent today. Our focus is on the identification and exploitation of disease resistance genes from these wild species.

Brian Steffenson

Tell us a little bit about your main areas of research?

My work focuses on exploiting the valuable disease resistance genes that have been left behind in plant breeding. So the idea is that the domestication of cereal crops happened some 8,000 - 10,000 years ago, and during this process, just a few lineages of the progenitor species were selected and brought forward. This means that only a small fraction of useful genes were bred into our modern cereal cultivars. My job is really to capture that genetic diversity that's been left behind in the wild species and utilize it for breeding new small grain cereal crops. We do this by tapping into germplasm that has already been collected and stored in gene banks around the world.

Brian Steffenson

In your opinion, what are the most exciting innovations happening in cereals research today?

I would say there are three things that come to mind for me. Firstly, we can now efficiently generate DNA sequence data from many accessions of different plant species. Previously, this was prohibitively expensive, and we did not have all the tools to analyse the vast amounts of generated data. But now we can generate deep sequencing data on many different accessions and this has ultimately allowed us to isolate the causal genes for important traits such as disease resistance. If one can clone disease resistance genes using this methodology, their function can be studied in detail and they can be readily moved into breeding lines through transformation.

The second big development would be some of the new technologies for genetic modification of plants, specifically as gene editing. This wonderful new technology allows one to change one of the "letters of the DNA alphabet" to alter a gene to a more positive function that is desired by consumers and producers alike. Another new development in the genetic modification of plants is ability to transfer large "cassettes" of DNA comprised of up to seven disease resistance genes. This addresses one of the major problems that we have in the deployment of disease resistant cultivars in our large, mostly genetically uniform agroecosystems. Incorporating just a single resistance gene against a particular

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disease is a risky strategy because pathogen populations have a high evolutionary potential and can easily mutate to overcome a single deployed resistance gene. If, however, you can incorporate many resistance genes against a pathogen in a cultivar, it will likely result in the resistance being effective for a long time. We now have the ability to routinely insert cassettes of multiple disease resistance genes into a cultivar in one transformation event. These transformed lines are amazingly resistant in the field. I believe this technology holds great promise for ameliorating many of the major diseases of cereal crops. My focus is on developing resistance to the three rust diseases of wheat and barley: stem rust, leaf rust, and stripe rust.

The third major innovation I would highlight is high-throughput phenotyping. We now have the technology to capture phenotypes (i.e. obtain the visual characteristics of a trait) of plants either by drones (unmanned aerial vehicles or UAVs) or ground-based robots. Currently, we are working with robot that was developed with a subsidiary of the Google company. It can go through field plots at a fairly rapid speed and image the plants for various characters such as leaf area, seed numbers, and amount of disease. The robot is capable of obtaining far more precision for many complex traits than would ever be humanly possible. The data generated by this robot can greatly enhance the breeding process.

Brian Steffenson

What role do you think government agency and industry should play in supporting crop research, especially in light of current food security challenges?

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You only need to think about the current war in Ukraine to understand how such an event can impact the production and distribution of valuable foodstuffs and cooking oils to the rest of the world. Production has essentially been stopped or halted because of the war and this is a prime example of why we need to continue to advance agricultural research.

Of course, the other big issue is climate change. It is really important for governments and industry to partner and collaborate together instead of having their own separate silos for research. There is also a big opportunity for non-profits like the Gates Foundation and other charitable organisations to work together to address some of the food security issues that we're facing right now.

Brian Steffenson

Does your research impact the day to day lives of farmers and consumers?

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We're trying to solve plant disease problems and while I can provide some short-term advice to farmers about avoiding the planting of certain susceptible crop varieties or offering guidance on fungicides, I actually view most of my research being focused for the long-term. For example, breeding a cultivar with multiple disease resistance may take eight to ten years of research. However, I am hopeful that the development of cultivars with multiple disease resistance will help farmers economically and also be more environmentally friendly by minimising pesticide use.

Brian Steffenson

How has the research community changed over the years? Do you think there are enough opportunities for collaboration?

In my 30-year career we've seen more collaborations that reach well beyond our individual institutions to a global realm. The internet has really helped in this regard; however, there are also many more opportunities for additional interactions with scientists at other organisations in the same country and also internationally. Face to face interactions among scientists are very valuable and can never be fully replaced. I recently attended the International Barley Genetics Symposium in Latvia after the COVID pandemic, and I can't begin to tell you how wonderful it was to be able to see all of my good colleagues there and discuss pressing research questions. It is from these ad hoc conversations that productive collaborations begin--just talking about new research ideas over a beer.

Brian Steffenson

How would you encourage more people to study plant science given the need to enhance the vitally important research that underpins the future of our planet?

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I sort of stumbled into my profession, but I feel so lucky because I think I chose the best profession I could possibly have. I love my job and I love what I'm doing. I have a really strong sense that I'm helping the world, at least in a very small way.

I believe as a professor, educator and mentor that it is incumbent upon me to help instil in the next generation the importance of helping feed the burgeoning world population and also answer some intriguing scientific questions all at the same time.

Brian Steffenson

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