Software Brings Barley Breeding Data Together

Alberta's barley breeders will now have access to both phenomic and genomic data in one place. That's a first, and funding from Growing Forward 2 helped make it happen.

When Alberta farmers plant better, higher-yielding varieties of barley, who benefits? The answer is: almost everyone. From barley growers themselves to livestock producers to malt companies to health-conscious consumers, the province's signature crop creates billions of dollars in economic impact each year.

Barley breeding, then, is a dollars-and-cents imperative for Alberta's agriculture industry. Over years, breeders have achieved significant advances, but selecting the best plant based on the performance from field trials (or phenomic data) alone can be a slow, costly process. In Western Canada, it can take up to 12 years to move a new variety from germplasm in the lab to a commercial product in a seed catalogue.

What if barley breeders had a faster way to develop new varieties? Very soon, they will. Scientist and Biostatistician Rong-Cai Yang is set to cap an 18-month development process by launching a software program called the Barley Breeding Platform (BBP) to help this cause.

As Yang explains, the idea came out of his work with his colleagues at the Field Crop Development Centre (FCDC) at Alberta Agriculture and Forestry (AF).

"My role is to conduct breeding-related research and to provide high-level advice in statistical analysis," says Yang, who's cross-appointed between AF and the University of Alberta. "At AF, there's a group of professionals who conduct field and lab experiments. They come to me for advice on experiment design and statistical analysis."

Phenomics and Genomics: Better Together

As Yang describes it, there are two broad avenues to improving a plant like barley. Phenomic selection is the traditional breeding method. If you want higher yields, you cross between high-yielding parents, then improve yield by selecting and growing high-yielding breeding lines generation after generation. However, quite often, the same line may yield very differently in northern vs. southern Alberta in a particular year when weather conditions and disease pressures are different between those regions. Thus, a 'true' best breeding line can eventually be identified only through field testing at different locations over at least three years.

A newer approach is known as genomic selection. By looking at the plant's DNA, scientists can predict important agronomic traits such as yield and disease resistance. Unlike with a phenomic approach, genomic selection doesn't have to wait for several generations of breeding and many years of field testing to select the high-yielding lines. If the right information is available, this method should be faster.

"The phenomic data is in the hands of the breeder, but the genomic data are generated through lab work," says Yang. "Usually they can't talk to each other because they are produced in two different ways. The BBP brings them together."

The project began in October 2014, when Yang hired a computational biologist. Throughout most of 2015, they incorporated phenomic and genomic data from FCDC and other barley breeding programs and developed statistical and bioinformatics tools for joint analyses. The software puts all this data into a format that can easily be searched and analyzed. Yang expects to release the first version of the BBP by the end of March 2016. Similar software packages exist but the BBP is faster and easier to use and works on any computer with Microsoft Excel installed.

Barley Now, Other Crops May Follow

By using the BBP, barley breeders can more easily combine the best of the phenomic and genomic paths to plant improvement. That should make their work easier and more efficient, and potentially take years off the current development cycle for new barley varieties.

Seeing the potential advantages of shifting from the traditional phenomics-based plant improvement to genomic selection, Yang believed the key was to get them working together. The BBP is the important first step towards this transition.

In fact, if it works for barley, there's no reason a similar platform couldn't speed the advancement of other economically important crops. Yang sees other cereal crops such as wheat and triticale as natural candidates. After that, and with slight modification to accommodate for hybrid breeding, a platform for hybrid canola could be developed as well.

Says Yang: "We can expand this to many different aspects, beyond the barley program at the Field Crop Development Centre. It can help barley breeders across Canada and around the world, and eventually, other crops as well."

Growing Forward 2 is a federal – provincial – territorial initiative.