Welcome to our first “Farmer Participatory Plant Breeding” Newsletter

Farmers are the world’s first and oldest plant breeders. The goal of this project is to restore the place of farmers in crop variety development. We are excited to work together with farmers to develop varieties suitable to your places and your unique growing environments. This first issue contains some background information on why farmer participation in plant breeding is important; how this program started; and an update on the 2013 season.

Iris Vaisman, our first coordinator, and Gary Martens explain participatory plant breeding in Carman, MB, 2011.

Background information on Farmer Participatory Breeding

An estimated 95% of the crop varieties currently used in organic agriculture are bred for conventional, high-input production. Canadian scientists (e.g., Kirk et al. 2012; Mason and Spaner 2006) are among a small group of plant breeders worldwide (Lammerts van Bueren et al. 2002) who have established, scientifically, that crop performance in organic systems is improved if cultivars are bred for typical organic conditions.
This project goes beyond simply breeding crops for organic production because it involves farmers directly in the plant breeding process. Such an approach has long been advocated for production systems where uniquely stressful growing conditions are encountered (Ceccarelli 1994). The alarming concentration of seed stocks in the hands a few multinationals (something that many governments appear completely comfortable with) is another reason to take action and give power back to farmers.

Farmer-participatory programs have been employed for potato in the Netherlands for over 40 years. There are a number of farmer-breeder efforts underway in North America, but arguably the most successful approach is getting farmers involved early in breeding/selection, and having them remain partners throughout the whole process.

Seed production involves a particular set of agronomic skills and knowledge (Moes et al. 1992), yet research on organic seed production is sorely lacking. Seed borne diseases, which are controlled in conventional production with synthetic fungicides, represent a special challenge to organic seed production. Management of these diseases in organic agriculture requires a deep understanding of the disease cycles and strict attention to sanitation (Menzies et al. 2009). We have recently started seed quality research for organic cereal production.


How we got started

We have been breeding oat and wheat varieties for organic production on the prairies since 2004. The project is a partnership between The University of Manitoba and Agriculture and Agri-Food Canada, and has yielded some promising organic varieties. Farmers were involved in this early work by providing organic land for yield trials.

The role of farmers in the organic breeding program changed in 2011. That year we started the farmer participatory program, where farmers, and not researchers, conducted the early generation selection of crops. That year 13 farmers in Manitoba and Saskatchewan were given F3 segregating populations of
spring wheat varieties for planting and selection. In 2012, oats were added to the program and in 2013, we added potato, corn and carrots.

The farmer participatory program is supported by the Bauta Family Initiative on Canadian Seed Security. This initiative will support the program for the next 4 years.

The project today...

This research involves 4 major crops: wheat, oats, corn and potato. In each case an experienced plant breeder will make the crosses. Wheat crosses are made by Dr. Stephen Fox and Anne Kirk. Oat crosses are made by Dr. Jennifer Mitchell-Fetch (Agriculture and Agri-Food Canada, Winnipeg, MB), potato crosses are made by Dr. Benoit Bizimungu (Agriculture and Agri-Food Canada, Fredericton, NB) and corn crosses are made by Dr. Lana Reid (Agriculture and Agri-Food Canada, Ottawa, ON). The segregating populations from these crosses are given to farmers who will select within the same population for 1 to 3 years. The number of farm sites range from 8 to 14 per crop.

The farmer-selected varieties will be returned to the breeder for evaluation and “stress testing”. Farmer lines will be compared also with standard crop cultivars, or “checks”.

Overview of the 2013 Season

After some challenging spring conditions in many parts of the country, the 2013 field season ended well for many farmers. We have received wheat and oat samples from many of the participants and they have started to be threshed and cleaned. This spring 42 oat, 74 wheat and 9 potato populations were distributed to 38 farms across the country. Due to wet spring conditions in much of Saskatchewan 10 of these farmers were not able to participate this year, but we are very happy with the number of farms that were able to plant and make selections in their populations.

![Location of participating farms.](image)
Wheat and Oat Breeding

Seeding
Most farmers seeded their plots with a garden seeder. Since these seeders are quite light there can be some issues with getting the seed deep enough. If seeding into rough or uneven ground these seeders can also bounce around and there are concerns that the seed is not being distributed evenly. At all farms that were visited this summer the farmers did a great job seeding their plots, and the plant stands looked even. There were a few farmers that marked out the plot size then broadcasted their populations by hand and raked them in. This method also worked quite well. Seeding dates differed across the country with some areas of Manitoba and Saskatchewan seeding quite late due to environmental conditions.

For the most part plots were seeded in a wheat or oat field as part of the regular crop rotation. This is recommended so that selection can occur under the same conditions that you would typically grow this crop. In some cases the plots experienced higher than typical weed pressure due to plot placement. Unless the weeds threaten to take over the wheat or oat population it is recommended that no hand weeding is done so that competitive plants can be selected.

Selections:
Most participants practiced positive selection, collecting the spikes or panicles that they wanted to move forward to the next generation. A couple of participants practiced negative selection; they pulled plants that they did not want to move forward to the next generation and harvested the rest of the plot as a bulk. The participants made selections based on:

<table>
<thead>
<tr>
<th>Wheat</th>
<th>Oat</th>
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<tbody>
<tr>
<td>- height (medium height)</td>
<td>- height (some prefer medium height,</td>
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<tr>
<td></td>
<td>others prefer taller plants that cover</td>
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<td></td>
<td>the row faster)</td>
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<tr>
<td>- straw strength</td>
<td>- straw strength</td>
</tr>
<tr>
<td>- leaf size (prefer wide leaves)</td>
<td>- disease resistance</td>
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<tr>
<td>- disease resistance</td>
<td>- heat resistance (resistance to blasting)</td>
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<tr>
<td>- tillering (like plants that produce a lot</td>
<td>- yield (some people select panicles with</td>
</tr>
<tr>
<td>of tillers)</td>
<td>the most seeds)</td>
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<tr>
<td>- competitive ability (looking for a</td>
<td>- kernel appearance and size</td>
</tr>
<tr>
<td>vigorous plant)</td>
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<tr>
<td>- spike appearance (long spike with lots</td>
<td></td>
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<tr>
<td>of seed)</td>
<td></td>
</tr>
<tr>
<td>- maturity (prefer earlier varieties)</td>
<td></td>
</tr>
<tr>
<td>- yield</td>
<td></td>
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<tr>
<td>- seed appearance (select larger seeds)</td>
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</table>
Some participants have reported that they had some difficulties making selections due to:

- Lodging: difficult to see individual plants
- Maturity: due to environmental conditions some plots were planted late and frost came before selections could be made
- Width of plots: difficult in plots that are wider than 1 m
- Drought: thin plant stands, short plants and little disease and weed competition

Each year we expect environmental conditions to be different than the last; this is why it is important to make selections over a number of years. When making selections under different environmental conditions plants are selected for that are well adapted to the range of conditions that you would expect to find on your farm.

Next steps for the wheat and oat populations:

- Threshing and cleaning of populations sent back to the U of M from participants
- Measurement of seed size, test weight and protein content to see how the populations evolve over the years

Samples from Swift Current being cleaned at the University of Manitoba
Potato Breeding

Seeding

At five of the six participating farms potato populations were hand seeded, and at one farm a small plot seeder was used to plant the potatoes. At some of the farms the producer dug the row with their potato planter then hand planted into the dug row. Each population contained about 450 tubers and took two people about two hours to seed by hand. Tubers were seeded at about 3 times the normal within row spacing to ensure that the tubers from each plant could be individually dug at harvest time. Generally participants were looking to select a specific colour of tubers so the populations were planted by colour to make selections easier.

Characteristics participants are looking for in a potato:

- Disease resistance
- Colour
  - Two participants are looking for a yellow variety with a taste and colour similar to Yukon Gold, but better adapted to organic growing conditions
  - One participant is looking for a red potato similar to Redsen, but with better quality
- Early maturity
- Smooth skin with shallow eyes
- Large tops to outcompete weeds
- Uniform size
- Ability to scavenge for nutrients
- Good skin set
- Good taste
- Storability
- Local adaptation

Harvest

At five of the six farms the potatoes were dug by hand. At the remaining farm a small plot harvester was used to dig the potatoes. Each hill had to be dug individually to avoid mixing up tubers from different plants. At most farms the tubers from each hill were dug up then laid on top of the soil. Most people find it easier to make selections when tubers from all hills can be compared. It was recommended that participants keep 10-30% of the tubers, but this number did vary depending on the characteristics of the potatoes that were dug.
New Populations for 2014

Feedback from PPB participants and other interested farmers was collected throughout the spring and summer to help the plant breeders plan future crosses for the potato, wheat and oat programs. Farmers were asked to identify varieties that they would like to see used as parents as well as characteristics that they are looking for in a population. The potato information was sent to Dr. Bizimungu in August 2013 to assist him in future crosses for the PPB potato program. The wheat and oat information was used to plan crosses this summer.

For the wheat and oat programs Anne focused on making crosses for farmers outside of the Prairie Provinces and on using lines from the existing organic wheat and oat breeding programs as parental lines. F1 seed was harvested from the crosses in early November and that seed will be increased in a greenhouse this winter. F2 seed from the crosses made this summer will be available for farmers in the spring of 2014.

We thank you for your hard work and diligence in making selections!

If you are interested in participating in this program or know someone who would like more information please contact Anne Kirk or Martin Entz.

Please feel free to contact us with any questions or comments.

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