Hard Red Winter Wheat pre-breeding through recurrent mass selection

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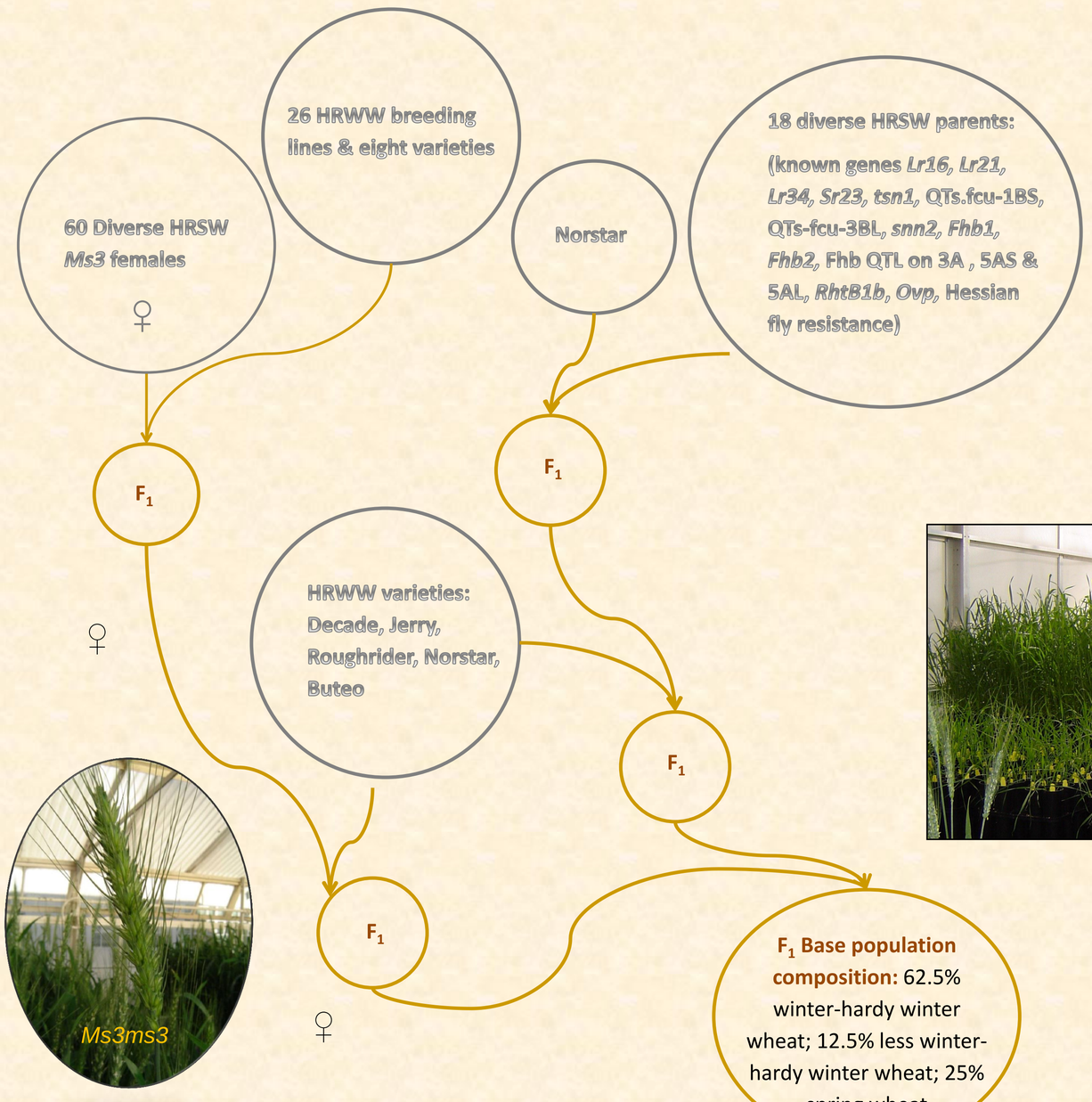
A recurrent mass selection (RMS) pre-breeding program is being implemented to facilitate development of improved breeding parents with high levels of winter-hardiness coupled with effective resistance against major diseases such as Fusarium head blight, leaf and stem rust, tan spot and the septoria complex. The technique is ideally suited to this purpose as it does not impose a yield ceiling or limit genetic background diversity as is typical of backcrossing. It furthermore maximizes opportunities for genetic recombination and gene pyramiding. Execution and effectiveness of a RMS program can be greatly enhanced with the use of genetic male sterility; incorporation of marker-aided selection and the use of generation acceleration methodologies.

Development of a heterogeneous base population



A highly diverse pre-breeding base population has been established through a complex cross that involved ± 110 diverse genotypes contained within five populations. These involved a range of native and exotic resistance and adaptation genes (rust, Fusarium and sawfly resistance, tan spot and Stagonospora nodorum insensitivity, pre-harvest sprouting resistance, processing quality, etc) most of which derived from either spring wheat or less cold-hardy winter wheat. While making the cross, the *Ms3* (dominant male sterility) gene was established within the hybrid population such that the final F_1 segregate 1:1 for male sterility/ fertility. The final F_1 will be randomly intercrossed twice to ensure full dispersal of the genes before the onset of RMS.

Implementation of recurrent mass selection

The base population will be subjected to RMS. Male fertile plants will be inbred and F_3-derived F_4 rows will be selected in the field to obtain male parents (F_5) for the next crossing cycle. An accelerated single seed descent (SSD) inbreeding strategy will be used with the ultimate aim to achieve two to three generations of winter wheat per year. To do this, plants will be stressed during growth (small soil volume, extended daylight hours, elevated temperature); prematurely harvested and the seed dried and stored at higher temperatures to break seed dormancy.

F_1: From previous year – Pre-select seedlings for cold-hardiness & sort into:

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New F_1 produced in January

Next cycle

F_3-derived F_5 ♂parents selected from F_1 grown 3 years earlier

F_2:

Greenhouse

Opportunity for marker-aided selection & seedling resistance screening

Single seed descent (continuous light, stressed plants)

F_4:

Grow in the field. Select (July; year 3)

Select among/ within field-planted rows

Selected **F_3**-derived plants are used for pollination in January, year 4

Female cycle = 1 year
Male cycle = 3 years