

How a New Wheat Cultivar is Developed

- Year 1:** Make between 600 to 900 crosses at Lincoln in the greenhouse. This is F₁ seed.
- Year 2:** Grow the F₁ seed in the Lincoln greenhouses or in Arizona to avoid losses due to winterkilling if the seed was grown in the field. Harvest F₂ seed.
- Year 3:** Plant F₂ seed in bulk populations at Mead, NE. Mead is the most severe winter site. Infect plants with stem rust. Hence wintertender and stem rust susceptible plants will be severely injured or killed.
- Year 4:** Plant F₃ seed in bulk populations at Mead, NE. Infect plants with stem rust. Hence wintertender and stem rust susceptible plants will be severely injured or killed. Send 30 populations to the USDA-ARS to select Hessian fly resistant material. Select 45,000 heads from F₃ bulks.
- Year 5:** Plant 45,000 F₄ head rows at Mead, NE. Infect plants with stem rust. Wintertender and stem rust susceptible plants will be severely injured or killed. On the basis of plant type and disease resistance, harvest 1,800 head rows. Evaluate harvested seed and select 1,500 - 1800 lines for advancement.
- Year 6:** Plant 1,500 - 1800 observation F₅ plots at Lincoln, NE. All lines are screened in the greenhouse for stem rust. On the basis of plant type, yield, and disease resistance, harvest 400-450 plots. Evaluate harvested seed using microquality analyses (flour protein and Mixograph) in the Nebraska Wheat Quality Laboratory and select 285 lines for advancement that have acceptable end-use quality.
- Year 7:** Plant 285 F₆ lines and 15 checks (total of 300 lines) in single replication trials at seven Nebraska locations (Mead, Lincoln, Clay Center, Sidney, and Alliance). On the basis of plant type, yield, disease resistance, and end-use quality select about 56 lines for advancement. Evaluate harvested seed using a full milling and baking procedure at the Nebraska Wheat Quality Laboratory.
- Year 8:** Plant 56 F₇ lines and 4 checks (total of 60 lines) in replicated and observation trials at eight Nebraska locations (Mead, Lincoln, Clay Center, North Platte, Sidney, and Alliance). Send seed to USDA-ARS Cereal Rust Laboratory for stem rust testing and USDA-ARS for Hessian fly testing. On the basis of plant type, yield, end-use quality, and disease resistance, select about 25 lines for advancement. Evaluate harvested seed using a full milling and baking procedure at the Nebraska Wheat Quality Laboratory.
- Year 9:** Plant 60 F₈ to F₁₂ lines in replicated and observation trials at eight Nebraska locations (Mead, Lincoln, Clay Center, North Platte, Sidney, and Alliance). The 60 lines include 10 to 15 check lines, 25 lines retained from the previous year's trials and the 25 newly advanced lines. Send seed to USDA-ARS for Hessian fly testing. Test for wheat streak mosaic virus tolerance. On the basis of plant type, yield, end-use quality, and disease resistance, select 35-40 lines (including checks) for retention. Evaluate harvested seed using a full milling and baking procedure at the Nebraska Wheat Quality Laboratory. Increase seed of 10 lines for advancement to regional

nurseries.

Year 10: Plant 60 F₈ to F₁₂ lines in replicated and observation trials at eight Nebraska locations (Mead, Lincoln, Clay Center, North Platte, Sidney, and Alliance). The 60 lines include 10 to 15 check lines, 25 lines retained from the previous year's trials and the 25 newly advanced lines. Send seed to USDA-ARS for Hessian fly testing. Test for wheat streak mosaic virus tolerance. On the basis of plant type, yield, end-use quality, and disease resistance, select 35-40 lines (including checks) for retention. Evaluate harvested seed using a full milling and baking procedure at the Nebraska Wheat Quality Laboratory. Submit 8-10 to regional nurseries and receive regional data. Retain 6 lines for second year testing in regional nurseries. Submit 4 lines to state cultivar testing.

Year 11: Plant 60 F₈ to F₁₂ lines in replicated and observation trials at eight Nebraska locations (Mead, Lincoln, Clay Center, North Platte, Sidney, and Alliance). The 60 lines include 10 to 15 check lines, 25 lines retained from the previous year's trials and the 25 newly advanced lines. Send seed to USDA-ARS for Hessian fly testing. Test for wheat streak mosaic virus tolerance. On the basis of plant type, yield, end-use quality, and disease resistance, select 35-40 lines (including checks) for retention. Evaluate harvested seed using a full milling and baking procedure at the Nebraska Wheat Quality Laboratory. Submit 8-10 to regional nurseries and receive regional data. Retain 6 lines for second year testing in regional nurseries. Submit 4 lines to state cultivar testing. Begin Foundation Seed production of advanced lines.

Year 12: Plant 60 F₈ to F₁₂ lines in replicated and observation trials at eight Nebraska locations (Mead, Lincoln, Clay Center, North Platte, Sidney, and Alliance). The 60 lines include 10 to 15 check lines, 25 lines retained from the previous year's trials and the 25 newly advanced lines. Send seed to USDA-ARS for Hessian fly testing. Test for wheat streak mosaic virus tolerance. On the basis of plant type, yield, end-use quality, and disease resistance, select 35-40 lines (including checks) for retention. Evaluate harvested seed using a full milling and baking procedure at the Nebraska Wheat Quality Laboratory. Submit 8-10 to regional nurseries and receive regional data. Retain 6 lines for second year testing in regional nurseries. Submit 4 lines to state cultivar testing. Continue Foundation Seed increase of advanced lines. If performance warrants release, release one line as a new cultivar.

A breeding program is a continuum; hence lines are constantly added and dropped from consideration. Of the 25 lines advanced in year 8, only 10-15 will be retained in year 9, 5-10 will be retained in year 10, 5 will be retained in year 11, and one or two in year 12. On average, over 100,000 lines will be looked at to find a cultivar. Over 12,000 yield plots will be harvested each year. A cultivar will be tested in over 100 location-years before we know enough to release it. It takes a minimum of 12 years to create a new wheat cultivar.