Plant breeders are always on a quest to develop new and improved crop and forage varieties that can outperform the existing ones. Here at the Noble Research Institute, plant breeders work on behalf of agricultural producers to develop improved varieties that could have higher biomass, grain yield, or forage quality; greater heat tolerance and better performance in drought; stronger pest and disease resistance; and other traits that help meet the needs of producers in the Southern Great Plains.

THE PROCESS OF PLANT BREEDING

Plant breeding is an old science and is sometimes considered an art. Historically, plant breeders have depended on natural mutations, or variations, to develop improved cultivars. Plants naturally mutate and select for their survival in changing environments or to adapt to pressures, like pests and diseases. Genetic variation in a species (plant
or animal) occurs due to processes called recombination and mutation. These processes occur naturally and can also be artificially induced to create useful variations that a breeder can use for selection.

Breeding for an improved variety always starts with identifying individual plants with properties or traits that allow them to perform better than other plants in the group. This is a very slow, laborious and expensive process, especially considering we are trying to meet the demands of changing global needs. The development process may take anywhere from 10 to 15 years or more, depending on the trait, its heritability (ease of passing the trait to the next generation), the amount of genetic variation present for that trait, etc.

Once better-performing plants are found, they are selected and crossed with other better-performing plants to create new populations or experimental varieties. These experimental varieties are evaluated for multiple years across different environments to test and compare their performance against existing varieties. The better-performing varieties are then released as improved cultivars or varieties.

**ABOUT GENOME EDITING**

Advances in biotechnology and genetic engineering have created new and promising techniques that complement a plant breeder’s existing toolbox.

One such technology is genome editing, which can create variations in plants by editing DNA sequences in a very precise and targeted manner.

Genome editing differs from conventional genetic engineering, which is used to develop genetically modified organisms, or GMOs, as the resulting plant does not include genes or DNA from unrelated or cross-incompatible species. Genome editing is doing the work that could naturally occur in plants, just with much more efficiency and precision.

With genome editing, the variation is created in the exact trait that the breeder wants to improve. Therefore, a plant breeder does not have to wait for a natural mutation to occur, make hundreds of crosses to create a perfect recombination, or screen hundreds of thousands of plants to select for that one good plant. Such precise editing of DNA is possible by using enzymes called nucleases. There are many different nucleases used in this technology, including meganucleases, zinc finger nucleases and TALENs. CRISPR-Cas9 is the latest innovation and the primary genome editing tool used today.

**A VALUABLE TOOL**

Genome editing technology is currently used in major crops like corn, soybeans, wheat, rice, barley, alfalfa, sunflower, tomato, etc. The technique could yield better tasting, higher yielding crops that are more resistant to pests and diseases and are more tolerant of drought. Given the ease with which this technology can be used by plant breeders, there is great potential in this new breeding method.

As technologies continue to build new capacities for plant breeders, the hope is to identify and build varieties that help address common forage and crop needs through available, affordable and more resilient plants.