

## **Educating the Future Plant Breeder**

M.R. Tuinstra, D.P. Cummings, and R.H. Mumm

Plant breeding is the science of applying genetic principles to improve plants for human use. All civilizations are greatly impacted by plant breeding in both rural and urban settings. The ongoing enhancement of corn yield is a clear example of the phenomenal achievements of plant breeders. Corn, the cultivated plant upon which the U.S. is most dependent, has increased in productivity from less than 30 bushels per acre in the 1920s to more than 150 bushels per acre in recent years. More than half of this 5-fold increase in productivity can be attributed to genetic improvements achieved through plant breeding. These improvements are the result of established plant breeding technologies combined with innovative advances in the application of molecular biology, such as marker-aided selection and development of transgenic traits including herbicide tolerance, insect resistance, and increased grain quality.

Today's plant breeders rely heavily on progressively more complex tools of science to create new and improved cultivars for increasingly sophisticated growers and end users in the U.S. and developed nations. This, in turn, provides additional benefits for small holder growers in developing nations, as technologies are developed and adapted globally. Rapid advancements in genomics and biotechnology promise to further accelerate the contributions of plant breeding. These improvements are critical, since the yields of our primary crops need to double by 2030 in order to meet rapidly growing needs of increasing global populations!

The Master of Science and Doctoral degrees required for scientific leadership roles in plant breeding are conferred under a number of different scientific disciplines including plant breeding, genetics, crop science, plant science, horticulture, forestry, agronomy, pathology ... etc. Most graduate programs in plant breeding emphasize the multi-disciplinary nature of the science through a curriculum that includes coursework in genetics, statistics, plant production and protection, biology, and biochemistry, along with practical field experimentation. Training in bioinformatics, molecular biology, and genomics is now essential. At least 47 universities offer undergraduate or graduate degrees in plant breeding; however, programs vary in ability to provide the critical mass of faculty and facilities needed to conduct highly effective graduate research, education, and experiential training required for employment by leading industries. Over the past three decades, advances in basic genetic research have diverted funding away from the applied genetics of plant breeding in academic programs, leading to a loss of faculty positions in plant breeding. This trend resulted in a critical decline in the number of students pursuing graduate degrees in plant breeding. These losses jeopardize a key U.S. and global competency and threaten our very ability to meet the important challenges in continuously improving our cultivated plants.

The 21<sup>st</sup> Century is predicted to be the Era of the Genetic Revolution. Plant breeding bridges fundamental research with plant producers and end-users. Rewarding professional opportunities in plant breeding and related sciences have never been more abundant.

Several issues must be addressed to increase the number of graduates and improve the quality of education to prepare new professionals for productive careers in plant improvement:

- Federal and state funding for hiring/retaining new plant breeding faculty at land grant institutions
- Increased broad-based support for graduate scholarships to attract outstanding students
- More opportunities for graduate students for experiential learning in industry settings
- Regional technology centers to support public research in genomic applications in plant breeding
- Additional funding in support of public breeding operations.