TEXAS A&M PLANT BREEDING BULLETIN

April 2016

Our Mission: **Educate and develop Plant Breeders worldwide**
Our Vision: **Alleviate hunger and poverty through genetic improvement of plants**

External Review of Plant Breeding at Texas A&M

We recently underwent a review of our plant breeding research and teaching programs at Texas A&M conducted by four outstanding scientists and faculty from sister institutions. I want to share (brag) with you first a few comments from our "self-assessment" of our programs and then a few comments from the external review team.

Our Self-Assessment:

The Plant Breeding Program of Texas A&M AgriLife Research and Texas A&M University is one of the largest programs among the Land-Grant institutions in the nation. It is an interdepartmental program, including Department of Soil and Crop Sciences and Department of Horticultural Sciences. The program currently has 32 faculty members, with 28 from the Department of Soil and Crop Sciences and four from the Department of Horticultural Sciences. Nineteen of these faculty members are located at College Station with the remainder located at eight of the 13 Texas A&M AgriLife Research and Extension Centers across the State of Texas, i.e., Amarillo (2), Beaumont (1), Dallas (1), Lubbock (4), Overton (2), Stephenville (1) and Weslaco (2). The program faculty pursue breeding and research in 20 or more species of food, feed (forage), fiber, vegetable, environmental (turfgrass and rose) and biofuel crops, including cotton, maize, wheat, sorghum, turfgrasses, forages, rice, peanut, soybean, sugarcane, energy cane, oat, barley, potato, tomato, pepper, and melon among others. Although field-based breeding research is a dominant focus of these plant breeding programs, extensive efforts are also made in research of crop genomics, genetics, molecular biology, systems biology, physiology and recently, phenomics to develop advanced knowledge, new technologies and toolkits for continued and enhanced plant improvement and breeding. The plant breeding research program and its affiliated graduate program benefit from the expertise of 26 adjunct

faculty members from USDA-ARS and other national or international institutions or private companies.

Members of the Plant Breeding faculty have dual roles, teaching and research. Teaching includes training the next generation of plant breeders as well as classroom instruction at both the graduate and undergraduate levels. Although the Center-based faculty have only research appointments with Texas A&M AgriLife Research, almost all are actively involved in plant breeding graduate student education and training. Graduate students actively participate in hands-on field and lab research and are educated formally in the classroom. The Plant Breeding faculty in Soil and Crop Sciences Department currently chair (or co-chair) 46 Plant Breeding majors on campus plus another 17 in our distance degree program. The Department of Horticultural Sciences faculty currently chair (or co-chair) 11 Hort majors with a plant breeding track on campus and three distance plant breeding majors. All plant breeding advanced degree majors have found employment primarily in private industry, especially PhD graduates, in academia, or remained in graduate school to pursue a PhD degree

Development of improved crop genetics and the discovery of new knowledge are the primary research roles of the plant breeding faculty. From 2009 to 2015, plant breeding faculty submitted proposals totaling over $491 million, of which, approximately $62 million were obtained, or about $9 million per year. In addition, more than $1 million in royalties were received from the research disclosures and patents of our faculty. In the past seven years, 136 improved plant germplasm lines, 70 new cultivars, and 129 disclosures or patents were developed and released from the plant breeding faculty. During this time period, 665 peer-reviewed research articles, 3 books and 36 book chapters were published by the program faculty and over 1,000 presentations were made from their research programs at national or international conferences.

Today, our plant breeding activities remain largely based on phenotypic performance of plants observed by breeders, a subjective and experience-based art aided with knowledge of genetics and statistics. It has been a consensus that continued and enhanced plant improvement will be contingent on the application of advanced scientific knowledge, new scientific discoveries and new technologies in plant genetic improvement and breeding. Today, Texas A&M breeding teams are exploring and ever-more relying on technologies such as marker-assisted selection (MAS), genome-wide or genomic selection (GS), genome modification or editing, genetic transformation, and gene-based breeding. Furthermore, high-throughput plant phenotyping (HTP) using in-canopy platforms and unmanned aerial vehicles (UAVs) is becoming a new initiative of plant breeding research and is expected to enhance crop genetic improvement and breeding.

External Review Team Conclusions (restricted to Soil and Crop Sciences Department)

The plant breeding, genetics, and genomics group is one of the leading programs of its kind in the country. In terms of public cultivar development programs it is certainly among the top three. The department is breeding an impressive array of crop species and serving the diverse agriculture of the state. The genetics and genomics efforts are high quality and the integration with the breeders appears successful. The graduate program is also one the larger programs in the US and offers all the classic disciplinary courses as well as newer topics. There are very few programs around the country that still do this. The production in terms of referred publications is very good. Many faculty have national stature and have had significant national leadership roles. Given the strengths of the program it could attain even greater national and international stature if the department developed a plant breeding center as suggested in the last review. The program has great crop focused strengths, cotton, C-4 grasses, small grains, sorghum, maize, rice, forages, legumes, and turf. Each of these programs are well known and respected by workers in the same area, but the review team does not believe the program as a whole gets the recognition it deserves. We recommend that department develop an internationally known plant breeding and genomics center, this should include all breeders and genomicists from A&M departments. The greatest needs of this program are faculty hires in biostatistics, cereal chemistry, and bioinformatics. Each of these positions will interact with and increase the impact of numerous faculty members. Of course these positions and facilities would benefit not only the department but campus as a whole.

Review Team Recognized Strengths of Plant Breeding in Soil and Crop Sciences

- **Plant breeding group is one of strongest in country.**
- **Impressive number of cultivar and germplasm releases for major state crops and forages**
- **Lots of promising young faculty well balanced with senior faculty**
- **Teach all classic disciplinary courses for a complete graduate program**
- **Serving state in terms of germplasm, especially for crops without large seed industry**

Review Team Recommendations

- **Develop an internationally known Plant Breeding and Genomics Center, this should include all breeders and genomicists from A&M departments.**
- **"Reimagine" and "Strategically" plan to continue to elevate the plant breeding, genetics, and genomics group and to maintain and expand its position of national and global leadership.**

The annual meeting of the National Association of Plant Breeders will be held in Raleigh, NC, 15 – 18 August. More information can be found at https://www.plantbreeding.org/annual-meeting-2016.

Distance Plant Breeding Program and Continuing Education courses available for Summer and Fall 2016 (https://scsdistance.tamu.edu/available-courses

Continuing Education Available Courses

To fully participate in our continuing education courses, students should have:

- High speed internet connection and updated browsers, including Internet Explorer and either Chrome of Firefox
- Google Chrome or Mozilla Firefox
- Common plug-ins (e.g. Adobe Reader, Flash Player, Virus Protection, Java, etc.)
- Speakers and Webcam with microphone
- Skype
- Ability to either scan or fax course documents to the instructor

Summer 2016: May 23 – September 2

Plant Breeding Fundamentals – Full Course (3 Units) – Cost $679.65
May 23 – August 26, 2016

Introduction to the field of plant breeding for students without a plant breeding background. Includes common plant breeding terminology and introduction of concepts. Genetic improvement of crops by hybridization and selection; special breeding methods and techniques applicable to naturally self-pollinated, cross-pollinated and asexually reproduced plants. Course topics: Botany and genetics; Evaluation of Populations; Manipulation of Populations; and Plant Breeding Systems.

Basic Plant Breeding - Full Course (3 Units) - Cost - $679.65
May 23 – September 2, 2016

Basic Plant Breeding can be taken as an entire course (all three units) or each unit can be taken individually. For participants in our Professional Certificate in Plant Breeding and Genetics, completion of all three units is required.

Unit 1 - Introduction to Basic Plant Breeding *Cost - $226.55*
May 23 – June 24, 2016
Introduction to Basic Plant Breeding provides a review of plant reproduction, genetic variation, gene banks, germplasm preservation, gene segregation, the power of selection and its role in plant breeding, and an introduction to intellectual property and its role in the life of a plant breeder. This unit is designed to prepare the participant to explore the genetics and methodologies employed by plant breeders of self and cross pollinated crop species in units two and three of Basic Plant Breeding.

Unit 2 - Breeding Self Pollinated Crops *Cost - $226.55*
June 27 - July 29, 2016
The frequency of any specific heterozygous locus will be reduced by 50% for every generation of selfing, resulting in a mixture of homozygous lines within any natural population. Phenotypic selection within heterozygous generations will lead to homozygous or near homozygous germplasm lines or cultivars under self-pollination. This unit is designed to communicate plant breeding methodologies that take advantage of the genetic consequences of natural or forced self-pollination in agronomic crops. Topics will include: [1] the basics of segregation, [2] breeding methodologies, [3] the grain sorghum conversion program-an example of backcrossing in a different direction, [4] review of a commercial soybean cultivar development program, and [5] a review of the types of genetic releases from Texas A&M AgriLife Research.

Unit 3 - Breeding Cross Pollinated Crops *Cost - $226.55*
August 1 - September 2, 2016
Topics covered include: quantitative genetics and plant breeding, effects of selection on Hardy Weinberg Equilibrium, mating designs with cross pollinated crops, breeding methods for cross pollinated crops, deviations from Mendelian ratios, genetic male sterility and hybrid seed production, seed certification and types of release.

Recommended textbooks are “Breeding Field Crops” by J.M. Poehlman and D.A. Sleper, and “Principles of Cultivar Development” by W.F. Fehr. A final exam will allow the participant to assess their grasp of topics covered. Participants in the Plant Breeding and Genetic Certificate Program must score 70% on the final exam for each unit. This is a "self-paced" course and is available for viewing for a limited time. Time commitment is individual student driven. Few outside assignments are made. Students should view each lecture, review all previous lectures and be prepared to discuss any issues that are unclear. Each unit has a printable note set and most units have a set of review questions that can be used as a tool to check your comprehension and grasp of unit concepts. Feel free to contact the instructor, Dr. Wayne Smith, by e-mail (cwsmith@tamu.edu) or phone (979-845-3450) with any questions you have or if you need

Fall 2016: August 29 – December 16

Plant Breeding Fundamentals – Full Course (3 Units) – Cost $679.65
August 29 - December 16, 2016

Introduction to the field of plant breeding for students without a plant breeding background. Includes common plant breeding terminology and introduction of concepts. Genetic improvement of crops by hybridization and selection; special breeding methods and techniques applicable to naturally self-pollinated, cross-pollinated and asexually reproduced plants.

Basic Plant Breeding - Full Course (3 Units) - Cost - $679.65
August 29 - December 16, 2016

Basic Plant Breeding can be taken as an entire course (all three units) or each unit can be taken individually. For participants in our Professional Certificate in Plant Breeding and Genetics, completion of all three units is required.

Unit 1 - Introduction to Basic Plant Breeding *Cost - $226.55*
August 29 – September 30, 2016
Introduction to Basic Plant Breeding provides a review of plant reproduction, genetic variation, gene banks, germplasm preservation, gene segregation, the power of selection and its role in plant breeding, and an introduction to intellectual property and its role in the life of a plant breeder. This unit is designed to prepare the participant to explore the genetics and methodologies employed by plant breeders of self and cross pollinated crop species in units two and three of Basic Plant Breeding.

Unit 2 - Breeding Self Pollinated Crops *Cost - $226.55*
October 3 – November 4, 2016
The frequency of any specific heterozygous locus will be reduced by 50% for every generation of selfing, resulting in a mixture of homozygous lines within any natural population. Phenotypic selection within heterozygous generations will lead to homozygous or near homozygous germplasm lines or cultivars under self-pollination. This unit is designed to communicate plant breeding methodologies that take advantage of the genetic consequences of natural or forced self-pollination in agronomic crops. Topics will include: [1] the basics of segregation, [2] breeding methodologies, [3] the grain sorghum conversion program-an example of backcrossing in a different direction, [4] review of a commercial soybean cultivar development program, and [5] a review of the types of genetic releases from Texas A&M AgriLife Research.

Unit 3 - Breeding Cross Pollinated Crops *Cost - $226.55*
November 7 – December 16, 2016
Topics covered include: quantitative genetics and plant breeding, effects of selection on Hardy Weinberg Equilibrium, mating designs with cross pollinated crops, breeding methods for cross pollinated crops, deviations from Mendelian ratios, genetic male sterility and hybrid seed production, seed certification and types of release.

Recommended textbooks are “Breeding Field Crops” by J.M. Poehlman and D.A. Sleper, and “Principles of Cultivar Development” by W.F. Fehr. A final exam will allow the participant to assess their grasp of topics covered. Participants in the Plant Breeding and Genetic Certificate Program must score 70% on the final exam for each unit.

This is a "self-paced" course and is available for viewing for a limited time. Time commitment is individual student driven. Few outside assignments are made. Students should view each lecture, review all previous lectures and be prepared to discuss any issues that are unclear. Each unit has a printable note set and most units have a set of review questions that can be used as a tool to check your comprehension and grasp of unit concepts. Feel free to contact the instructor, Dr. Wayne Smith, by e-mail (cwsmith@tamu.edu) or phone (979-845-3450) with any questions you have or if you need additional information.

Advanced Plant Breeding - Full Course (3 Units) - Cost - $679.65
August 29 - December 16, 2016

Expectations of genetic improvement for different plant breeding methods; relative efficiency for crops of different reproductive mechanisms; genetic variances, covariances and genotype-environment interaction components of variance used in planning selection procedures. Advanced Plant Breeding can be taken as an entire course (all three units) or each unit can be taken individually. For participants in our Professional Certificate in Plant Breeding and Genetics, completion of all three units is required.

Unit 1 - Advanced Genetic Principles in Plant Breeding
August 29 – September 30, 2016
Topics covered include: Hardy Weinberg, means and variances, covariances and heritability, mating designs, genetic diversity.
Cost - $226.55

Unit 2 - Selection: Theory and Practice in Advanced Plant Breeding
October 3 – November 4, 2016
Topics covered include: recurrent selection, inbred line selection and testcrossing, selection environments, indirect selection, multiple trait selection, QTL MAS, heterosis and hybrid prediction.
Cost - $226.55

Unit 3 - Statistical Tools in Advanced Plant Breeding
November 7 – December 16, 2016
Topics covered include: statistical concepts review, expected mean squares and combined analysis, GxE interactions and stability analysis, polyploidy.
Cost - $226.55

Experimental Designs in Agronomic Research - Full Course (3 Units) - Cost - $679.65 August 29 - December 16, 2016

Teaches fundamental principles and procedures of experimental designs in agricultural sciences. Emphasis includes factorial designs, predicting outputs, use of covariance, and balanced and unbalanced experimental designs as related to common agricultural research projects under field, greenhouse or growth chamber culture. Students will become familiarized with computer programming of common statistical software. Experimental Designs in Agronomic Research can be taken as an entire course (all three units) or each unit can be taken individually. For participants in our Professional Certificate in Plant Breeding and Genetics, completion of all three units is required.

Unit 1 - Factorial Experimental Designs in Agronomic Research
August 29 – September 30, 2016
Topics covered include: Fundamentals of agricultural research methodology and methodology, basic statistical concepts for testing of hypothesis, introduction to simple computer statistical software programs and applications, complete randomized design, randomized complete block design, and Latin square design.
Cost - $226.55

Unit 2 - Factorial and Unbalanced Designs in Agronomic Research
October 3 – November 4, 2016
Topics covered include: Split-plot and split-split plot designs, nested designs, variance analyses, interactions with years and locations, comparisons of paired and grouped mean, estimation of missing values, the general linear model, and planned incomplete block design.
Cost - $226.55

Unit 3 - Correlation, Regression, Covariance, and Biplot Analysis in Agronomic Research
November 7 – December 16, 2016
Topics covered include: Correlation, regression, path coefficient analysis, covariance analysis, nearest neighbor analysis, augmented designs and moving means and analysis, database management, biplot analyses.
Cost - $226.55

This is a "self-paced" course and is available for viewing for a limited time. Time commitment is individual student driven. Students should view each lecture, review all previous lectures and be prepared to discuss any issues that are unclear. Each unit has a printable note set and voiced over PowerPoint video lectures

Other Academic and Continuing Education courses in plant breeding and related disciplines that will be available during other semesters include Host Plant Resistance; Crop Production; Selection Theory; Marker Assisted Selection; Genomic Analysis; Field Crop Diseases; Field Insects; Essential Nutrients in Crop Growth; and others. For more information visit https://scsdistance.tamu.edu/ or contact LeAnn Hague, Distance Education Coordinator in Soil and Crop Sciences at leann.hague@tamu.edu or (979)845-6148.

Distance Plant Breeding

M.S. and Ph.D. degree programs at Texas A&M.

Visit https://scsdistance.tamu.edu/plant-breeding-distance-education/ for details.

Please direct comments concerning this bulletin to Wayne Smith, cwsmith@tamu.edu or 979.845.3450.