TEXAS A&M PLANT BREEDING BULLETIN

May 2020

TEXAS A&M UNIVERSITY--EDUCATING AND DEVELOPING PLANT BREEDERS WORLDWIDE TO ALLEVIATE HUNGER AND POVERTY THROUGH GENETIC IMPROVEMENT OF PLANTS

Upcoming meetings that impact us as plant breeders and plant improvement scientists, entrepreneurs, seedsmen, industry representatives, etc. are stilled planned as of today.

The American Society of Horticultural Science 2020 annual conference is scheduled for August 9 through 13 in Orlando, FL. Additional information at https://ashs.org/.

The National Association of Plant Breeders will hold a virtual annual meeting during the week of 16 August (original meeting scheduled for 16-19 August at the University of Nebraska Lincoln). More information will be posted at https://www.plantbreeding.org.

The Agronomy Society of America / Crop Science Society of America / Soil Science Society of America will hold their annual trisocieties meeting November 8 - 11 in Phoenix, AZ and information can be found at https://www.acsmeetings.org/.

The format of these meetings are under constant review given the seriousness of the coronavirus pandemic that we are experiencing.

I had the opportunity recently to identify 20 outstanding improved germplasm lines, parental lines, and cultivars developed and released by Texas A&M AgriLife Research since its beginnings in 1887. Obviously this was a huge task and one that would by its limitation ignore some significant genetic improvements. Nonetheless, it was an interesting exercise and I thought that the recipients of this Plant Breeding Bulletin might enjoy seeing the releases I chose. Some of you

who are familiar with our breeding programs will disagree with my 20 selections. I would welcome anyone sending me the name of any variety or germplasm/line release that you think should have made the top 20. Perhaps one of us will have the opportunity to propose the top twenty again at some point. Note that the 20 are ordered chronologically.

1949: 'Westar' HRW wheat immediately became popular after its release in 1942 by Texas A&M AgriLife Research, being grown on more than 2 million acres in Texas and eight other states in 1949. It continued to be an important cultivar until about 1964. Westar exhibited excellent milling and baking quality. (Bayles, B.B., and J.A. Clark. 1954. Classification of Wheat Varieties Grown in the United States in 1949. USDA Tech. Bull. 1083.)

1955: A/B Tx3197 grain sorghum breeding lines were released by J.R. Quinby in 1955. These male sterile and restorer lines are the original A-line carrying cytoplasmic male sterility that was essential for the economic production of grain and forage sorghum hybrids. This cytoplasmic male sterility system is still in use today, 65 years after its introduction. These particular lines are less important than the cytoplasm trait itself which has been incorporated into many different seed parent lines. (Quinby, J.R. 1974. Sorghum Improvement and the Genetics of Growth. Texas A&M University Press, College Station, TX.)

1961: 'Starr' peanut was the first genetically improved spanish peanut that resulted from a controlled breeding program in the United States. It was developed by B. C. Langley and released in 1961. One parent of Starr was an introduction from Uruguay, PI 161317. By 1967, Starr accounted for 90% of the spanish peanut acres in Texas and 32 % of the spanish acreage in Georgia. (Langley, B. C. 1962. Star Spanish

Peanuts. L-562, Texas A&M Univ.-Texas Agr. Exp. Sta., College Station, Texas.)

1962: 'Gulf' annual ryegrass: The first annual ryegrass for the Gulf Coast region of the U.S. with crown rust (*Puccinia coronate* Pers. Cda.) resistance was developed by R. M. Weihing and released in 1962. With the release of Gulf, the acreage planted to ryegrass increased to over 1,000,000 acres in Texas alone. The source of the crown rust resistance is from the breeding line La Estanzuela 284, which was selected in Uruguay. This source of resistance remains effective today; an amazing 57 plus years. The cultivar Gulf is still grown and has been used as a breeding line for most popular cultivars released in the past 25 years. Gulf was not only important to Texas growers, but also to the Oregon seed industry, where almost all of the seeds are/were produced. Estimated value of Gulf to the seed industry is over $100,000,000 and to the cattle industry, perhaps, twice that figure. (Weihing, R. M. 1963. Registration of 'Gulf' Ryegrass. Crop Sci 3:366.)

1967: 'Sturdy' HRW wheat developed by I. M. Atkins was one of the first semi-dwarf hard red winter wheats developed in the United States and caused an explosion of acreage from 1967 to 1976. In 1976, Sturdy was grown on 1.9 million acres in TX, OK, and KS. The short stature, strong straw, and resistance to shattering made possible the practical utilization of high increments of fertilizer and irrigation water to produce maximum yields. (Atkins, I. M., K. B. Porter, and O. Merkle. 1967. Registration of 'Sturdy' Wheat. Crop Sci. 7:406.)

1971: 'Tamcot SP 21s' was developed by Luther Bird in what would become known as the Multiple Adversity Resistant (MAR) program. Beginning with Tamcot SP 21s in 1971, Luther developed and released seven short season, bacterial blight resistant cultivars by 1986. These

cultivars were the first upland cotton cultivars with immunity to bacterial blight and have served as a source of such resistance to the current date. From 1979 through 1986, Bird's cultivars were grown on at least 10% of the acreage in Texas, peaking in 1982 at approximately 1,000,000 acres. (Calhoun, D. S., D. T. Bowman, and O. L. May. 1994. Pedigrees of upland and pima cotton cultivars released between 1970 and 1990. MS Agri. and For. Experi. Stn. Bull. 1017.)

1972: 'LaBelle' was the earliest success of Charles Bollich's rice breeding program at the Beaumont Research and Extension Center. This cultivar was registered with Crop Science in 1972 and at its peak was grown on 95% of the acreage in Texas. (Bollich, C.N., and J.E. Scott. 1975. Past, present and future varieties of rice. *In* Six Decades of Rice Research in Texas. TX Agric. Exp. Stn. Res. Monogr. 4, College Station, TX, pp. 37-42.)

1980s?: 'TAM Mild Jalapeno-1' jalapeno pepper: Benigno Villalon developed a number of mild jalapeno pepper strains and TAM-1 Mild Jalapeno was obtained by the Pace company of San Antonio, TX in the 1980s and further selected for a consistent mild taste. Ben's genetics led to salsa becoming the number 1 food condiment in the U.S., surpassing ketchup in 1991. TAM Mild Jalapeno-1 was not officially released by Texas A&M AgriLife Research until 2005. (https://npgsweb.ars-grin.gov/gringlobal; PI 640584)

1983: 'Lemont' was developed by Charles Bollich at the Texas A&M AgriLife Research and Extension Center at Beaumont. It remained a mainstay of southeastern rice production from 1983 until the mid-1990s. During this time, rice yields in Texas increased by 29%, largely as a result of Lemont's direct use and as a parent. At its peak, over 1 million acres of rice in Texas, Louisiana, and Mississippi were planted

to Lemont. (Bollich, C. N., B. D. Webb, M. A. Marchetti, and J. E. Scott. 1985. Registration of 'Lemont' rice. Crop Sci. 25:883-885.)

1984: RTx 430 was developed by F.R. Miller and released in 1984 as a pollinator parent line (R Line) with excellent general and specific combining ability for developing grain sorghum hybrids. RTx 430 was one of the first R lines to utilize germplasm derived from the USDA-ARS Sorghum Conversion Program that both improved productivity and increased genetic diversity in sorghum germplasm. From the mid-1970s through the early 1990s, this pollinator parent was the primary grain sorghum R line across hybrids in the Americas and Australia, and is a parent in later derived pollinator lines. (Miller, F. R. 1984. Registration of Tx R430 sorghum parental line. Crop Sci. 24:216-217.)

1990s?: 'Texas Grano 1015' sweet onion: Named for its optimum planting date, October 15, the Texas 1015 super sweet onion has become the primary onion grown in Texas. Grown only in the Rio Grande Valley in South Texas, this large, prized onion was developed by Leonard Pike and associates. Onion is Texas' leading vegetable crop and the state produces mostly sweet onions. The sweet onion was adopted as Texas' official state onion in 1997. (https://npgsweb.ars-grin.gov/gringlobal; PVP 8200170) (Note that I could not find the release year)

1990: 'TAM 90' annual ryegrass was developed and released by Lloyd Nelson in 1990 based on improved cold tolerance, high forage yield and crown rust resistance. TAM 90 was released in 1990 and 83 million pounds of TAM 90 ryegrass seeds were sold by 2013. (Nelson, L. R. F. M. Rouquette, and G. W. Evers. 1992. Registration of 'TAM 90' annual ryegrass. Crop Sci. 32:828-828.)

1997: Grain Sorghum Conversion Program: While this entry is not a specific germplasm line, cultivar, or hybrid, the program is one of the most successful programs of its kind and was a joint effort of USDA-ARS and Texas A&M AgriLife Research. This program was a systematic approach to increase the genetic diversity available for sorghum breeding programs in temperate environments. Over a period of 45 years, this program released over 700 fully converted lines, some of which have been extremely important in sorghum improvement for biotic and abiotic stress resistance, quality, yield and adaptation. Since the mid-1970s, essentially all grain sorghum hybrids have some converted germplasm in their pedigree. (Example release publication: Rosenow, D.T., J.A. Dahlberg, G.C. Peterson, L.E. Clark, F.R. Miller, A. Sotomayor-Rios, A. Quiles-Belen, P. Madera, and C.A. Woodfin. 1997. Registration of 50 converted sorghums from the sorghum conversion program. Crop Sci. 37:1397-1398.)

1998: 'Palisades' zoysiagrass, released by Milt Engelke in 1998, continues as an industry standard [based on the National Turfgrass Evaluation Program (NTEP)] for drought resistance, moderate resistance to tropical sod web-worm, zoysiagrass mites, tawny mole cricket, and its fast rate of establishment. As of 2019, Palisades was licensed and in production in at least ten states in the south and southeastern United States. (Engelke, M. C., R. White, P. F. Colbaugh, and J. A. Reinert. 2002. Registration of 'Palisades' zoysiagrass. Crop Sci. 42:305-306.)

1999: 'Coan' runner peanut cultivar was the first root knot nematode resistant peanut cultivar in the world. Coan was developed by Charles Simpson and Jim Starr by introgressing resistance from a wild peanut species. Since its release in 1999, Coan has been used in other peanut breeding programs to introduce resistance to root knot nematode.

(Simpson, C. E., and J. L. Starr. 2001. Registration of 'COAN' peanut. Crop Sci. 41:918.)

1999: Texas Russett Norkotah potato strains were developed by Creighton Miller. Unique properties of these strains include high yield, attractiveness, drought/heat tolerance, and wide adaptability. By 2009, virtually all of the russet potatoes grown in Texas were from the Texas Russet Norkotah strains. Since the inception of the program, the farm-gate value of the potato crop in Texas has grown from less than $20 million per year to approximately $117 million. In 2018, the three Texas Russet Norkotah strains 112, 278, and 296 collectively, ranked third nationally in certified seed potato production, behind only Russet Burbank (a traditional variety) and Frito Lay cultivars (collectively). (Miller, J. C. 1999. Selection, evaluation, and identification of improved Russet Norkotah strains. Amer. J. Potato Res. 70:161-167.)

2000: 'Texas Maroon' bluebonnet (later to be marketed as 'Alamo Fire') was the culmination of a lengthy bluebonnet selection effort led by Jerry Parsons, the original goal of which was to enable the planting of the Texas state flag in red, white, and blue bluebonnets. This selection was officially released in 2000 by Texas A&M AgriLife Research. (Mackay, W. A., S. George, J. M. Parsons, G. Grant, T. D. Davis, and L. Stein. 2000. 'Texas Maroon' bluebonnet. Hort. Sci. 35:313.)

2004: 'Apache' arrowleaf clover was developed by Gerald Smith at the Overton Research and Extension Center. Released in 2004, Apache is resistant to bean yellow mosaic virus (BYMV) lethal wilt and is tolerant to other symptoms of BYMV such as stunting, yellowing and leaf deformation. Fifteen years of seed sales of Apache arrowleaf total 1.5 million pounds at a seed value of about $3.0 million. (Smith, G. R., F. M.

Rouquette, and I. J. Pemberton. 2004. Registration of 'Apache' arrowleaf clover. Crop Sci. 44:1018.)

2006: 'Axcella 2' annual ryegrass was selected by L.R. Nelson for its dwarf growth characteristics, thus providing beautiful turfgrass during the winter months. Axcella 2 maintains growth and green color during the winter and withstands freezing temperatures to about 12 F. It should be over seeded in the late fall and will transition out (die) in May. The early transition results in a huge advantage over perennial ryegrass, which grows into mid-summer and thus may damage warm season turfgrass. Axcella 2 is grown on sports fields, mainly soccer and football fields, but also on some golf courses, and home lawns. Axcella 2 is grown internationally and was used on Olympic soccer fields in South Africa and Brazil. (Nelson, L. R., J. Crowder, and D. R. Chalmers. 2007. Registration of 'Axcella 2' Annual Ryegrass. J. Plt. Reg. 1:20-21.)

2018: Cordon Bleu™, Bleu Brulee™, and Brandy Bleu™ winter hardy hibiscus cultivars, developed by Dariusz Malinowski, were commercialized in spring 2018 as a part of the Summer Spice Hibiscus™ collection and received two Medal of Excellence Breeding Awards at the Cultivate'18 Expo in Columbus, OH. These three cultivars were developed from 'Blue Angel' which was bred by Dr. Malinowski and became the parent of numerous breeding lines and cultivars with blue flower color. Regular sales started in spring 2019 nationwide by Home Depot, Calloway's, and several major mail order nurseries. "Blue Angel" is the source of genes responsible for the novel blue pigment in all blue-flower winter-hardy hibiscus. (Malinowski, D. P., and W. E. Pinchak. 2012. Blue Angel winter-hardy hibiscus (Hibiscus x moscheutos L.) HortScience 47:289-290.)

Publications by Soil & Crop Sciences Plant Breeding Faculty

First Quarter, 2020

Chandra: Ambika Chandra, Anthony D. Genovesi, Meghyn Meeks, Ying Wu, Milt C. Engelke, Kevin Kenworthy, Brian Schwartz. 2020. Registration of 'DALZ 1308' zoysiagrass. *Journal of Plant Registrations* https://doi.org/10.1002/plr2.20016

da Silva: Kennedy M. Fernandes, Roberto A. Tenenbaum, Edwin B. M. Meza, João Batista L. da Silva, Diego N. Brandão. 2020. Use of the Luus-Jaakola optimization method to minimize water and energy consumption in scheduling irrigation with center pivot systems. *Irrigation Science* https://doi.org/10.1007/s00271-020-00663-6.

Dever & Smith: Linghe Zeng, Deborah L. Boykin, Jinfa Zhang, Efrem Bechere, Jane K. Dever, B. Todd Campbell, Tyson B. Raper, Calvin Meeks, Wayne Smith, Gerald O. Myers, and Fred M. Bourland. 2019. Analysis of Testing Locations in Regional High-Quality Tests for Cotton Fiber Quality Traits. *The Journal of Cotton Science* 23:284-291.

Dever: Ruvini W. Mathangaderra, Eric F. Hequet, Brendan Kelly, Jane K. Dever, Carol M. Kelly. 2020. Importance of cotton fiber elongation in fiber processing. *Industrial Crops and Products* https://doi.org/10.1016/j.indcrop.2020.112217

Dever: Jane Dever, Carol Kelly, Addissu Ayele, John Zwonitzer, Paxton Payton, Don Jones. 2020. Registration of CA 4007 cotton germplasm line for water-limited production. *Journal of Plant Registrations* https://doi.org/10.1002/plr2.20034

Dever: Abdelraheem Abdelraheem, David D. Fang, Jane Dever, Jinfa Zhang. QTL analysis of agronomic, fiber quality, and abiotic stress tolerance traits in a recombinant inbred population of pima cotton (*Gossypium barbadence* L.). *Crop Science* https://doi.org/10.1002/csc2.20153.

Ibrahim: Sat Pal Sharma, Daniel I. Leskovar, Kevin M. Crosby, A. M. H. Ibrahim. 2020 GGE Biplot Analysis of Genotype-by-environment Interactions for Melon Fruit Yield and Quality Traits. *HortScience* https://doi.org/10.21273/HORTSCI14760-19

Murray: Bridget A. McFarland, Naser AlKhalifah, Martin Bohn, Jessica Bubert, Edward S. Bucklet, Ignacio Ciampitti, Jode Edwards, David Ertl, Joseph L. Gage, Celeste M. Falcon, Sherry Flint-Garcia, Michael A. Gore, Christopher Graham, Candice N. Hirsch, James B. Holland, Elizabeth Hood, David Hooker, Diego Jarquin, Shawn M. Kaeppler, Joseph Knoll, Greg Kruger, Nick Lauter, Elizabeth C. Lee, Dayane C. Lima, Aaron Lorenz, Jonathan P. Lynch, John McKay, Nathan D. Miller, Stephen P. Moose, Seth C. Murray, Rebecca Nelson, Christina Poudyal, Torbert Rocheford, Oscar Rodriguez, Maria Cinta Romay, James C. Schnable, Patrick S. Schnable, Brian Scully, Rajandeep Sekhon, Kevin Silberstein, Maninder Singh, Margaret Smith, Edgar P. Spalding, Nathan Springer, Kurt Thelen, Peter Thomison, Mitchell Tuinstra, Jason Wallace, Ramona Walls, David Wlls, Randall J. Wisser, Wenwei Ex, Cheng-Ting Yeh, & Natalia de Leon. 2020. Maize genomes to fields (G2F) 2014-2017 field seasons: genotype, phenotype, climatic, soil, and inbred ear image datasets. *BMC Research Notes* 13:71.

Murray: Tyler L. Foster, Heather D. Baldi, Xiaoqing Shen, Byron L. Burson, Robert R. Klein, Seth C. Murray, and Russell W. Jessup. 2020. Development of Novel Perennial *Sorghum bicolor* x *S. propinquum* Hybrids. *Crop Science* https://doi.org/10.1002/csc2.20136

Murray: Steven L. Anderson II and Seth C. Murray. 2020. R/UAStools::plotshpcreate: Create Multi-Polygon Shapefiles for Extraction of Research Plot Scale Agriculture Remote Sensing Data. *BioRxiv* https://doi.org/10.1101/2020.02.21.960203

Muray: Simone Scalabrin, Lucile Tonuitti, Gabriele Dr Gaspero, Davide Scaglione, Gabrile Magris, Michele Vidotto, Sara Pinosio, Federica Cattonaro, Federica Magni, Irena Jurman, Mario Cerutti, Furio Siggi Liverani, Luciano Navarini, Lorenzo Del Terra, Gloria Pellegrino, Manuela Rossana Ruosi, Nicola Vitulo, Giorgio Valle, Alberto Pallavicini, Giorgino Graziosi, Patricia E. Klein, Nolan Bentley, Seth Murray, William Solano, Amil Al Hakimi, Timothy Schilling, Christophe Montagnon, Michele Morgante & Benoit Bertrand. 2020. A single polyploidization event at the origin of the tetraploid genome of *Coffea arabica* is responsible for the extremely low genetic variation in wild and cultivated germplasm. *Scientific Reports* 10:4642.

Rooney: Henrique D. R. Carvalho, James L. Heilman, Kevin J. McInnes, William L. Rooney, Katie L. Lewis. 2020. Epicuticular wax and its effect on canopy temperature and water use of Sorghum. *Agricultural and Forest Meteorology* https://doi.org/10.1016/j.agrformet.2019.107893.

Rooney: Francisco E. Gomez, John E. Mullet, Anastasia H. Muliana, Karl J. Niklas, William L. Rooney. 2020. The genetic architecture of biomechanical traits in sorghum. *Crop Science* https://doi.org/10.1002/csc2.20049.

Septiningish: Satyen Mondal, M. Iqbal R. Khan, Shalabh Dixit, Pompe C. Sta. Cruz. Endang M. Septiningsih, Abdelbagi M. Ismail. 2020. Growth, productivity and grain quality of AG1 and AG2 QTLs introgression lines under flooding in direct-seeded rice system. *Field Crop Research* https://doi.org/10.1016/j.fcr.2019.107713.

Septiningish: Shamistha Ghosal, Fergie Ann Quilloy, Carlos Casal Jr., Endang M. Septiningsih, Merlyn S. Mendioro, & Shalabh Dixit. 2020. Trait-based mapping to identify the genetic factors underlying anaerobic germination of rice: Phenotyping, GXE, and QTL mapping. *BMC Genetics* 21:6.

Smith & Hague: C. Wayne Smith, Ben Beyer, E. F. Hequet, S. Hague, D. Jones. 2020. TAM BB-2139 ELSU extra long staple upland germplasm. *Journal of Plant Registrations* https://doi.org/10.1002/plr2.20024.

Smith: Efrem Bechere, Dick L. Auld, C. Wayne Smith, Roy G. Cantrell, Eric F. Hequet, Glen L. Ritchie, Irish L. B. Pabuayon, Depika Mishra, Braile R. Hendon, Nino Brown, Branden R. Kelly. Registration of six upland cotton germplasm lines with improved fiber quality through ethyl methane sulfonate treatments and selection. 2020. *Journal of Plant Registrations* https://doi.org/10.1002/plr2.20005.

Stelly: Corrinne E. Grover, Mengqiao Pan, Daojun Yuan, Mark A. Arick II, Guanjing Hu, Logan Brase, David M. Stelly, Zefu Lu, Robert J. Schmitz, Daniel G. Peterson, Joathan D. Wendel, Joshua A. Udall. 2020. The *Gossypium longicalyx* genome as a resource for cotton breeding and evolution. *BioRxiv* https://doi.org/10.1101/2020.01.08.898908.

Distance Plant Breeding at Texas A&M Graduate Degrees

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.

Distance Plant Breeding at Texas

A&M – Continuing Education

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.

Continuing Education Available Courses
Fall Courses: August 24 – December 11, 2020

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.

Fall 2020

Plant Breeding Fundamentals – Full Course (3 Units) – Cost $679.65
August 24 - December 11, 2020
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 24 - December 11, 2020
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 24– September 25, 2020

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
September 28 – October 30, 2020
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 2– December 11, 2020
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 24 - December 11, 2020
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 24– September 25, 2020
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
September 28 – October 30, 2020
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 2– December 11, 2020
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 26 - December 13, 2019
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 24– September 25, 2020
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
September 28 – October 30, 2020

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 2– December 11, 2020
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.

Intellectual Properties in the Plant Sciences - Full Course (3 Units) - Cost - $679.65
August 26 - December 13, 2019
This course introduces the major foci of intellectual property (IP) impacting plant sciences, including: 1) traditional vs. emerging knowledge economies, 2) governing U.S. statutes and international treaties, 3) forms of IP protection, and 4) IP asset identification, valuation, capture, and deployment towards an understanding of best practices for the development of effective IP strategies and management of IP portfolios.

Unit I - Introduction to Intellectual Property, International Treaties and Patents Cost - $226.55
August 24– September 25, 2020
Unit I of the Intellectual Properties in the Plant Sciences Course. Topics covered include: IP Culture and the Knowledge Economy, Traditional Knowledge vs. Biopiracy, Sui generis Systems, International Treaties, Overview of Patentability, Utility Patents, and Plant Variety Patents.

Unit II - Intellectual Property Documentation Cost - $226.55
September 28 – October 30, 2020
Unit II of the Intellectual Properties in the Plant Sciences Course. Topics covered include: Trademarks, Copyrights, & Trade Secrets; USPTO; Inventorship, Ownership, Compensation, IP Training; Confidential Information; IP Audit; IP Value; Competitive Intelligence; Cyberspace – IP and IT Cooperation.

Unit III - Intellectual Property Transfer and Enforcement Cost - $226.55
November 2– December 11, 2020

Unit III of the Intellectual Properties in the Plant Sciences Course. Topics covered include: Intellectual Property Transfer and Enforcement, IP Case Studies, IP Portfolio, IP Strategy and Leveraging IP Value.