TEXAS A&M AGRILIFE RESEARCH | EXTENSION

TEXAS A&M UNIVERSITY

# TEXAS A&M PLANT BREEDING BULLETIN

June 2015

**Our Mission:** **Educate and develop Plant Breeders worldwide**

**Our Vision:** **Alleviate hunger and poverty through genetic improvement of plants**

# Texas A&M University College of Agriculture and Life Sciences Grand Challenges – Feeding Our World Workshops

The College of Agriculture and Life Sciences (COALS) at Texas A&M University identified five grand challenges as top priorities for the future. The challenges, which include feeding our world, protecting our environment, improving our health, enriching our youth, and growing our economy, will be addressed through research, teaching, and outreach within the college. As part of this initiative, COALS recognized the need within the feeding our world challenge for transformational breakthroughs in plant breeding technology to propel improvements in agriculture productivity to meet the challenge of feeding, clothing, and sheltering the expected world population of nine billion people by 2050 and eleven billion by 2100. These technologies include gametic cycling, genome wide breeding, genome editing, and high-throughput plant phenotyping. In an effort to disseminate information and bring faculty together to discuss and plan research in these basic technologies, a series of workshops featuring some of the top researchers in these disciplines has been planned and is sponsored by the COALS Grand Challenges initiative. Researchers from across the nation and globe are encouraged to attend these high impact workshops either in person or via free webinars. Detailed information for each workshop is below.

For more information on how you can be involved with the COALS – Feeding Our World Grand Challenge: "Seminal Genetic Gain in Sustainable Crop Productivity", contact Wayne Smith at (979)845-3450 or cwsmith@tamu.edu

Feeding Our World Grand Challenge: "Seminal Genetic Gain in Sustainable Crop Productivity" – Coordinating Committee

*Project Director* – Dr. Wayne Smith, Soil and Crop Sciences
*Gametic Cycling Leader* – Dr. Seth Murray, Soil and Crop Sciences
*Genome Wide Breeding Leader* – Dr. Patricia Klein, Horticultural Sciences

*Genome Editing Leader* – Dr. Keerti Rathore, Soil and Crop Sciences
*High Throughput Phenotyping Leader* – Dr. Alex Thomasson, Biological and Agricultural Engineering

*Coordinating Committee Members*

Dr. William Rooney, Soil and Crop Sciences
Dr. Jackie Rudd, Soil and Crop Sciences, AgriLife Research–Amarillo
Dr. Gregory Sword, Entomology
Kari Hugi, Graduate Student, Soil and Crop Sciences
Mitchell Schumann, Graduate Student, Soil and Crop Sciences

## Upcoming Workshops and Dates

**High-Throughput Plant Phenotyping and Unmanned Aerial Vehicles in Agriculture Workshop -** August 17-18, 2015

**Symposium: The Use of R/qtl, MAGIC QTL Populations and Genomic Selection in Plant Breeding -** September 1, 3 & 11, 2015

**Workshops: The Use of R/qtl, MAGIC QTL Populations and Genomic Selection in Plant Breeding -** September 1-4, 2015

**Genome Editing Workshop** – September 28, 2015

## High-Throughput Plant Phenotyping and Unmanned Aerial Vehicles in Agriculture Workshop

August 17-18, 2015
8:00 AM – 4:30 PM

Memorial Student Center – Gates Ballroom – Room 2400
Texas A&M University, College Station, Texas

The High-Throughput Plant Phenotyping (HTPP) and Unmanned Aerial Vehicles (UAVs) in Agriculture Workshop will be held on August 17-18, 2015. The goal of this workshop is to provide attendees an expert overview and keen practical insights into these two related and timely research topics. Day 1 will feature speakers who are leaders in both fields and will focus on how UAVs and high-resolution remote sensing as well as automated sensor platforms can be used to efficiently measure phenotypic traits to facilitate advances in plant breeding and genetics. Day 2 will feature a UAV

demonstration at the Texas A&M AgriLife Research Farm (buses provided), as well as afternoon break-out sessions.

**Registration**

**Registration Deadline – July 31, 2015.**
**Register: https://agriliferegister.tamu.edu/HTPPUAV**
Registration is limited to the first 250 people, so register early to reserve your place at the workshop.

**Cost**

Registration cost includes lunch on August 17 and 18, the reception on August 17 and the field tour on August 18.

On or before July 31, 2015
$0 – Webinar Only
$20 – Graduate Students
$40 – Postdocs
$60 – All others
After July 31, 2015 all registration fees are increased by $100. No onsite registration is available.

**Texas A&M AgriLife Research On-Farm UAV Demonstration**

Demonstrations of multiple UAVs at the Texas A&M AgriLife Research Farm will be on Tuesday, August 18. Parking at the Research Farm is limited, so ALL conference participants should use the provided conference bus transportation. Arrive prior to 8:20 AM to load buses. Be sure to wear a hat, sunscreen, and insect repellent.

**Webinar**

A webinar of presentations on Monday, August 17 will be available at no charge for those unable to attend in person. On the registration page choose "Webinar Participant." A webinar link will be emailed to you prior to the conference.

**Parking**

Visitor parking is available in the University Center Garage (UCG) located on S. Houston St. Hourly rates apply. Maximum rate per day is $15.
Visitor Parking Map - http://transportmap.tamu.edu/parkingmap/tsmap.htm?map=vis

**Hotel**

Group rates are available at the following hotels. To qualify for the listed rates, hotels must be booked prior to Friday, July 17. **Use group name: "HTP/UAV Conference."**

**Hilton Garden Inn**
Phone: 979-703-7919
3081 University Drive East, Bryan, TX 77802
*Rate: $102 per night for King or Two Queen Room. Breakfast not included. Cancellation must be made prior to Sunday, August 2 for a full refund.*

**Staybridge Suites**
Phone: 979-485-2955
1405 University Drive East, College Station, TX 77840
*Rate: $129 per night for King Suite, $139 per night for Two Queen Suite. Breakfast included. Cancellations are accepted up to 72 hours prior to arrival without penalty.*

**Speakers**
The program will consist of around 15 speakers who are leaders in the field of HTPP and UAVs. Confirmed speakers include:

- *Dr. Pedro Andrade-Sanchez,* Assistant Specialist in Precision Agriculture, Assistant Professor, Maricopa Agricultural Center, University of Arizona
- *Dr. Andrew French*, Research Physical Scientist, USDA-ARS, Arid-land Agricultural Research Center
- *Dr. Mac McKee*, Director, Utah Water Research Laboratory, and Professor of Civil and Environmental Engineering, Utah State University
- *Dr. Duke Pauli*, Post-Doctoral Associate, Cornell University
- *Dr. Francisco Rovira-Más*, Director, Agricultural Robotics Laboratory, and Associate Professor, Polytechnic University of Valencia, Spain
- *Dr. Kelly R. Thorp*, Research Agricultural Engineer, USDA-ARS, Arid-Land Agricultural Research Center
- *Dr. John Valasek,* Director, Texas A&M Engineering Experiment Station – Center for Autonomous Vehicles and Sensor Systems (CANVASS), and Professor of Aerospace Engineering, Texas A&M University
- *Dr. Alex Thomasson,* Professor of Biological and Agricultural Engineering, Texas A&M University
- *Dr. Jeffrey White*, Research Plant Physiologist & Research Leader, USDA-ARS, Arid-Land Agricultural Research Center

**Tentative Schedule**
**Monday, August 17, 2015**

| | |
|---|---|
| 8:00 – 8:20 AM | Registration |
| 8:20 – 8:30 AM | Welcome |
| 8:30 AM – 12:00 PM | HTPP Speakers |
| 12:00 – 1:00 PM | Lunch |
| 1:00 – 4:30 PM | UAV Speakers |
| 4:30 PM | Adjourn |
| 5:30 - 7:00 PM | Reception – Café Eccell (4401 S. Texas Ave., Bryan) Hors d'oeuvres provided. Cash bar available. |

**Tuesday, August 18, 2015**

| | |
|---|---|
| 8:00 – 8:20 AM | Participant Arrival/Load Buses for Research Farm – Joe Routt St. beside the |

| | |
|---|---|
| | University Center Parking Garage |
| 8:30 AM | Buses Depart for Research Farm |
| 9:00 – 11:00 AM | Texas A&M AgriLife Research On-Farm UAV Demonstration |
| 11:30 AM | Buses Arrive Back on Campus |
| 11:45-1:00 PM | Lunch – MSC 2400 |
| 1:00 – 4:30 PM | Breakout Sessions |
| 4:30 PM | Adjourn |

**Contact Information**

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**Funding Provided By:**

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# Symposium: The Use of R/qtl, MAGIC QTL Populations and Genomic Selection in Plant Breeding

*Tuesday, September 1, 2015*
*Thursday, September 3, 2015*
1:00 – 5:30 PM
Rudder Tower, Room 301
401 Joe Routt Blvd.

*Friday, September 11, 2015*
9:30 – 11:00 AM
The AgriLife Center
1538 John Kimbrough Blvd.

Texas A&M University, College Station, Texas

Innovative technologies must be utilized to increase crop productivity to meet the grand challenge of providing affordable food, feed, fiber, bioenergy, and greenspace for a global

population of nine billion. The vast availability of genomic resources and tools is leading to a new revolution in plant and animal breeding, facilitating the ability to connect a genotype with a corresponding phenotype, especially for complex traits. This symposium will focus on three current tools being utilized by breeders to make seminal gains in plant and animal breeding: 1) R/qtl for expediting the identification of markers linked to genes and QTL of interest; 2) R/mpMap for use with multi-parent advanced generation inter-cross (MAGIC) populations in QTL mapping; and 3) Genomic Selection (GS) for the estimation of breeding values for quantitative traits through whole genome genotyping. While the focus is on plants, there will be substantial overlap with tools of interest to animal breeders and geneticists.

**Registration**

**Registration Deadline – August 20, 2015**
**Register:** https://agriliferegister.tamu.edu/GenomicSelection
Registration is limited to the first 200 people, so register early to reserve your place at the symposium.

**Cost**

There is no cost to register but the registration deadline is August 20, 2015.

**Webinar**

A webinar of presentations will be available at no charge for those unable to attend in person. On the registration page choose "Webinar Participant." A webinar link for each day will be emailed to you prior to the conference.

**Parking**

Visitor parking is available in the University Center Garage (UCG) located on S. Houston St. for the sessions held in Rudder Tower and in West Campus Garage for the session held in The AgriLife Center. Hourly rates apply. Maximum rate per day is $15. Visitor Parking Map - http://transportmap.tamu.edu/parkingmap/tsmap.htm?map=vis

**Hotel**

A number of hotels are available in the Bryan/College Station area for those needing overnight accommodations.

**Speakers**

The program will consist of speakers who are leaders in the field of R/qtl, R/mpMap and Genomic Selection. Confirmed speakers include:

September 1

- *Dr. Karl Broman*, Professor, Department of Biostatistics & Medical Informatics, University of Wisconsin-Madison http://kbroman.org/
- *Dr. Emma Huang*, Senior Research Scientist, CSIRO https://www.linkedin.com/in/bemmahuang
- *Dr. Thomas Juenger*, Professor, Department of Integrative Biology, University of Texas at Austin https://sites.cns.utexas.edu/juenger_lab

September 3

- *Dr. Jeffrey Endelman*, Assistant Professor, Department of Horticulture, University of Wisconsin http://potatobreeding.cals.wisc.edu/
- *Dr. Dunia Pino Del Carpio,* Research Associate, Cornell University https://www.linkedin.com/pub/dunia-pino-del-carpio/49/1a7/733
- *Dr. Marnin Wolfe,* Postdoctoral Associate, Cornell University https://www.linkedin.com/pub/marnin-wolfe/90/60b/722

September 11

- *Dr. Mark Cooper*, Research Director, Pioneer Hi-Bred International

**Schedule**

**Tuesday, September 1, 2015,**
**Rudder Tower, Room 301**

| | |
|---|---|
| 1:30 PM | Welcome and Introductions |
| 2:00 PM | Karl Broman |
| 3:00 PM | Thomas Juenger |
| 4:00 PM | Emma Huang |
| 5:00 PM | Discussion |
| 5:30 – 6:30 PM | Reception |

**Thursday, September 3, 2015**
**Rudder Tower, Room 301**

| | |
|---|---|
| 1:30 PM | Welcome and Introductions |
| 2:00 – 5:00 PM | Genomic Selection Speakers |
| 5:00 PM | Discussion |
| 5:30 – 6:30 PM | Reception |

**Friday, September 11, 2015**
**The AgriLife Center**

| | |
|---|---|
| 9:30 AM | Mark Cooper |
| 10:30 AM | Coffee and Social |

**Contact Information**

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# Workshops: The Use of R/qtl, MAGIC QTL Populations and Genomic Selection in Plant Breeding

September 1-4, 2015
Heep Center – Room 440
Texas A&M University, College Station, Texas

**R is the ideal software for genetic mapping and genomic big data analysis. Three separate but interrelated workshops will be held in September to learn specific software packages and techniques for analysis in R.**

**Workshop Sessions:**

- **R/qtl** is ideal for bi-parental linkage populations. However, it can be used for other linkage populations. This session will be taught by the developer of R/qtl, **Dr. Karl Broman** from the University of Wisconsin - Madison http://kbroman.org/
- **R/mpMap** is ideal for multi-parent linkage populations (MAGIC), a difficult problem but a very powerful resource beyond bi-parental populations. This session will be taught by the developer of R/mpMap **Dr. B. Emma Huang** from CSRIO https://www.linkedin.com/in/bemmahuang
- **Genomic selection** is a powerful new approach for using genomics in breeding and multiple R software packages will be covered by **Dr. Marnin Wolfe** and others who are at the cutting edge of using this technology, https://www.linkedin.com/pub/marnin-wolfe/90/60b/722

**Cost: $75 per participant for all three workshops – limited space available.** Preference will be given to those who will attend all workshops but some spots may be available for those interested in a single workshop. Some basic knowledge of R is expected, but not required.

**Registration:** This is an exciting and unique workshop. Because there are limited seats available please let us know if you would like to attend (and which sessions) by Monday, July 20th. If we have more applicants than seats available we plan to limit enrollment to one or two members per PI/laboratory; PI's may be contacted to determine applicant suitability. To be added to the applicant list, email LeAnn Hague at leann.hague@tamu.edu by July 20. **Graduate students**, please include the name of your PI, your research focus, and which session(s) you would like to attend.

**All workshops will be held in Heep Center, room 440.**

**No live webinar is available but recordings of the workshop will be available after it is concluded for those unable to attend.**

**Requirements:**

1. Laptop with the free "R" software loaded. For more information and to download the software - http://www.r-project.org/ . Participants unable to bring a laptop should contact LeAnn Hague (leann.hague@tamu) no later than August 1.
2. Laptops on the AgNet domain will require administrator access for "R" installation. Contact Scott Vajdak (svajdak@tamu.edu) for installation no later than August 1 if you do not have administrator access on your TAMU laptop.

**Workshop Schedule:** *(to be held in conjunction with The Use of R/qtl, MAGIC QTL Populations and Genomic Selection in Plant Breeding Symposium)*

**Day 1 – September 1**

| | |
|---|---|
| 8:00 AM – 12:00 PM | Review of "R" Software (Seth Murray tentative) |

**Day 2 – September 2**

| | |
|---|---|
| 8:00 AM – 12:00 PM | Karl Broman, R/qtl |
| 12:00 PM – 1:00 PM | Lunch (provided) |
| 1:00 PM – 3:00 PM | Karl Broman & Emma Huang (informal questions and discussion) |

**Day 3 – September 3**

| | |
|---|---|
| 8:00 AM – 12:00 PM | Emma Huang, R/mpMap |
| 12:00 PM – 1:00 PM | Lunch (provided) |

**Day 4 – September 4**

| | |
|---|---|
| 8:00 AM – 12:00 PM | Genomic Selection and "R"; Dr. Marnin Wolfe et al. |
| 12:00 PM – 1:00 PM | Lunch (provided) |
| 1:00 PM – 5:00 PM | Genomic Selection and "R" |

Funds for this workshop are provided by the Texas A&M University College of Agriculture and Life Sciences Grand Challenges – Feeding Our World initiative.

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## Genome Editing Workshop

*Monday, September 28, 2015*
*8:00 AM – 1:00 PM*
The AgriLife Center
1538 John Kimbrough Blvd.

Texas A&M University, College Station, Texas

Featuring Dr. Daniel Voytas – Professor, Director of the Center for Genome Engineering, University of Minnesota

Overview of Dr. Daniel Voytas' Research
(from http://www.cbs.umn.edu/research/research-cbs/faculty-labs/voytas)

The ability to modify the genome of an organism at a specific locus is an invaluable research tool and has the potential to be an amazing theraputic tool. The Voytas Lab specializes in two types of proteins that allow this kind of genome modification: Zinc Finger Nucleases (ZFNs) and Transcription Activator-Like Effector Nucleases (TALENs).

"The work of the Voytas Lab focuses on modifying plant genomes for basic research and for crop improvement. Toward this goal, we work with cassava, *arabidopsis thaliana*, rice, tobacco, soybean, and maize with the help of many collaborators. In addition, the Voytas Lab is involved in many projects in animal systems whose goals include curing lethal genetic diseases in humans and investigating the role of specific genes in addiction. These projects in animals are only possible with the help of close collaborators."

Registration and webinar information coming soon.

Funds for this workshop are provided by the Texas A&M University College of Agriculture and Life Sciences Grand Challenges – Feeding Our World initiative.

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## Continuing and Distance Education in Plant Breeding at Texas A&M

**Continuing education course modules in plant breeding and genetics, and related disciplines are available from Texas A&M University to clientele interested in gaining new information in plant breeding or simply seeking refresher courses. This program is designed for individuals employed in private industry, CGIAR centers, government agencies, non-government organizations, and other agriculture professionals who need and**

**desire additional knowledge and training in plant breeding but who are not interested in an additional academic degree. A professional certificate can be a part of this program. No campus visit is required. Course modules available for January through May 2015 are (**https://scsdistance.tamu.edu/purchase/**):**

## SUMMER 2015

### Introduction to Plant Breeding Fundamentals – Full Course ) – Cost $679.65
**May 18 – August 28, 2015**

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
**May 18 – August 28, 2015**

*Unit 1 - Introduction to Basic Plant Breeding Cost - $226.55*
*January 20 – February 20, 2015*
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*
*February 23 – April 3, 2015*
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*
*April 6 – May 13, 2015*
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.

## FALL 2015

### Introduction to Plant Breeding Fundamentals – Cost $679.65
**August 31- December 18, 2015**

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 31- December 18, 2015**

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 31 – October 2, 2015*
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 5 – November 5, 2015*
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 9 – December 18, 2015*
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 31- December 18, 2015**

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 31 – October 2, 2015*
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 5 – November 5, 2015*
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 9 – December 18, 2015*
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 31- December 18, 2015

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 31 – October 2, 2015*

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 5 – November 5, 2015*
Topics covered include: Split-plot and split-split plot designs, nested designs, variance analyses, interactions with years and locations, comparisions 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 9 – December 18, 2015*

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.

## **Soil Fertility** - Full Course (3 Units) - Cost - $679.65
## August 31- December 18, 2015

Chemical and biological reactions in soils that influence nutrient availability to plants; environmental aspects associated with nutrient availability and fertilization, especially for nitrogen (N) and phosphorus (P). Topic covered include: introduction and historical background; plant essential nutrients, soil plant relations, calculations in soil fertility, soil acidity, soil nitrogen, soil phosphorus, potassium, calcium, magnesium, sulfur and the micronutrient elements.

*Topic 1 – Introduction and Historical Background*

Major contributions to soil chemistry and fertility. Introduction to soils and climate of Texas.

*Topic 2 – Plant Essential Nutrients, Soil-Plant Relations*

Plant available forms of nutrients, functions of nutrients in plants, types of soils where deficiencies might be anticipated, relative quantities required by plants.

*Topic 3 – Calculations in Soil Fertility*

Chemical notations, mole on a weight basis, mole on a charge basis, equivalents, ppm, concentrations of solutions, lbs/acre, kg/ha, lbs/1000 ft2, etc.

*Topic 4 – Soil Acidity*

Measurement and causes, active and reserve acidity, effects on nutrient availability and chemical properties, influence on plant grown, correction of, exchangeable Al, Al hydroxyl polymers, effective CEC

*Topic 5 – Soil Nitrogen*

Reactions of N in soils, N cycle, N gains and losses, biological N2 fixations, factors influencing availability, mineralization-immobilization, nitrification, NO-3 movement and groundwater contamination, eutrophication, NH4+ fixation, NH3 volatilization, denitrification, nitrification inhibitors, production of N fertilizers, acidification from NH4+ fertilizers, selection of N source potential environmental effects

*Topic 6 – Soil Phosphorus*

Phosphorus cycle, low uptake efficiencies – reversion in acid and alkaline soils, solubility product constants of reversion precipitates, solubility diagrams, influence of soil pH on P availability, method of application, production of P fertilizers, potential environmental consequences, eutrophication

*Topic 7 – Potassium, Calcium, Magnesium*

Potassium cycle, available forms, soil reactions, K+ fixation, mineral sources, factors influencing plant availability, fertilizer sources

*Topic 8 – Sulfur and the Micronutrient Elements*

Reactions of S in soils, S cycle, sources of S fertilizers, anticipated crop responses, reactions influencing availability of micronutrients in soils, pH effect chelates, extent of micronutrient deficiencies, correction of deficiencies.

**Other Continuing Education courses in plant breeding and related disciplines that will be available during other semesters include Host Plant Resistance; 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.**