TEXAS A&M AGRILIFE RESEARCH | EXTENSION

TEXAS A&M UNIVERSITY

TEXAS A&M PLANT BREEDING BULLETIN

March 2019

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

GLOBAL IMPACT OF DR. ENDANG SEPTININGSIH

This bulletin series featured Dr. Endang M. Septiningsih in November 2015 when she first arrived at Texas A&M. In that Plant Breeding Bulletin, we noted that Dr. Septiningsih had been an important component of the International Rice Research Institute's (IRRI) efforts in developing rice cultivars that would tolerate flooding conditions. Today, I want to follow up and share with you the success of this plant breeding and plant genetics effort.

Endang M. Septiningsih joined Texas A&M University as a faculty member in August 2015 after working at IRRI in the Philippines for the previous 10 years. Throughout her career, her research focus has been on understanding the genetic basis of abiotic stress tolerance and contribute to the development of improved cultivars, first with the IRRI breeding team and currently with the Texas A&M AgriLife Research rice breeders. While at IRRI, she

investigated various types of flooding stresses in rice, including flooding during germination (anaerobic germination), complete submergence during the vegetative growth stage (flash flooding), and flooding up to harvest (stagnant flooding). These flooding stresses are critical problems affecting more than 20 million hectares of rice fields worldwide.

Dr. Septiningsih joined IRRI as a Postdoctoral Fellow in 2005, working on marker-assisted backcrossing of the *Submergence 1* (*SUB1*) gene, with Dr. David Mackill, Senior Plant Breeder and Head of the Plant Breeding, Genetics and Biotechnology Division at IRRI. Dr. Septiningsih was promoted to Scientist in 2009 and Senior Scientist in 2013, and served as leader of the flooding tolerance genetics and breeding group from 2012 until she left IRRI in 2015. She was an integral part of the team that employed marker-assisted backcrossing to develop Sub1 rice cultivars that could withstand complete flooding (submergence of all foliage) for up to two weeks. This research was supported initially by the German Federal Ministry for Economic Cooperation and Development, and the Japan Ministry of Foreign Affairs. Eight Sub1 lines were developed by IRRI with collaboration of several national partners using the following mega-cultivars (popular varieties planted at least in one million ha): *Swarna, Samba Mahsuri, CR1009* or *Savitri* (from India); *IR64* and *PSB Rc18* (from Philippines), *BR11* (from Bangladesh), *TDK1* (from Laos), and *Ciherang* (from Indonesia) **[Neeraja C., R. Maghirang-Rodriguez, A. Pamplona, S. Heuer, B. Collard, E. Septiningsih, G. Vergara, D. Sanchez, K. Xu, A. Ismail, D. Mackill. 2007. A marker-assisted backcross approach for developing submergence-tolerant rice cultivars. Theoretical & Applied Genetics. 115: 767-776-----Septiningsih E.M., A.M. Pamplona, D.L. Sanchez, C.N. Neeraja, G.V. Vergara, S. Heuer, A.M. Ismail, D.J. Mackill. 2009. Development of submergence tolerant rice cultivars: the Sub1 locus and beyond. Annals of Botany103: 151-160----- Septiningsih, E.M., B.C.Y. Collard, S. Heuer, J. Bailey-Serres, A.M. Ismail, D.J. Mackill. 2013. Applying Genomics Tools for**

Breeding Submergence Tolerance in Rice. In: Varshney R.K., Tuberosa R., editors. Translational Genomics for Crop Breeding: Volume 2-Improvement for Abiotic Stress, Quality and Yield Improvement. Wiley-Blackwell. USA. p 9-30----- Septiningsih, E.M., N. Hidayatun, D.L. Sanchez, Y. Nugraha, J. Carandang, A.M. Pamplona, B.Y.C. Collard, A.M. Ismail, and D.J. Mackill. 2015. Accelerating the development of new submergence tolerant rice varieties: the case of Ciherang-Sub1 and PSB Rc18-Sub1. Euphytica 202:259-268].

The Bill and Melinda Gates Foundation played a major role in expanding the Sub1 project to include molecular genetics of salinity and drought stresses and dissemination of these molecular breeding products to farmers through a Gates' Initiative titled "Stress Tolerant Rice for Africa and South Asia" (STRASA), a collaborative effort between IRRI and Africa Rice from 2007 to 2019 (http://strasa.irri.org/). This project provided the opportunity for tremendous global impact.

This effort is one of the most successful examples of marker-assisted selection of any crop, reaching millions of rice farmers in South and Southeast Asia and routinely providing double the yield of non-Sub1 cultivars after flash flood events. After the first wave of Sub1 cultivars were released in 2009 and 2010 in India, Bangladesh, Philippines and Indonesia, they were rapidly disseminated and adopted by farmers, reaching 3.8 million farmers by the end of 2012. STRASA reached over 10 million farmers in South Asia alone by the end of the second phase in 2014 and trained thousands of young scientists, extension workers, and farmers (https://www.youtube.com/watch?v=1ML3vVwqOBk). Sub1 cultivars have been released in multiple countries and additional ones have been developed by a number of national partner institutes using the elite Sub1 cultivars developed at IRRI [Septiningsih, E.M., and D.J. Mackill. 2018. Genetics and breeding of flooding tolerance in rice. In: Sasaki, T., Ashikari, M. (eds.). New Waves in Rice Genomics, Genetics, and Breeding. Springer, Singapore, pp. 275-295]. Sub1 rice is transforming the lives of smallholder rice farmers living in flood-prone

areas and is a landmark success story for Dr. Septiningsih and her team, IRRI, and the project donor, the Bill and Melinda Gates.

Dr. Septiningsih was involved in STRASA since the project launched. The peak of her involvement was from the end of 2012 until 2015, when she became the Objective Leader for the submergence team. In addition to Sub1 cultivars, she also developed a number of genetic stocks and flood-tolerant lines that have been impactful for both breeding and genetic studies at national and international research institutions around the world. Dr. Septiningsih published numerous papers on various aspects of flooding tolerant rice, and was the lead author or corresponding author of several of them. She was the lead PI and corresponding author for the cover article of the September 2015 issue of *Nature Plants* in cloning of *trehalose-6-phospate phosphatase* (*OsTPP7*) as the gene underlying tolerance to anaerobic germination in rice. This novel finding has made a significant impact not only by highlighting the roles of sugar metabolism and signaling in anaerobic germination but also by providing the foundation for future advances in direct-seeded rice production, which can lead to improved food security and stability of subsistence rice farmers around the world. Our hats are off in honor of Dr. Septiningsih and the team of scientists at IRRI in this significant accomplishment.

At Texas A&M, Dr. Septiningsih research is focused on the use of genetics and genomics tools to make an impact by improving the yield stability and quality of rice and other important crops in Texas, the southern US, and worldwide. She was recently awarded a grant from USDA-NIFA as the lead PI under an AFRI program to investigate the mechanisms of a novel QTL for submergence tolerant rice, alongside Dr. Julia Bailey-Serres from UC Riverside. Dr. Septiningsih is active in

training the next generation scientists through her graduate students and her teaching at Texas A&M University.

Meetings of Interest

National Association of Plant Breeders, NAPB will hold their annual meeting at the University of Georgia, August 25-29, 2019. More information will be available soon at https://www.plantbreeding.org.

American Society of Agronomy-Crop Science Society of America-Soil Science Society of America will hold their annual meeting November 10 – 13, 2019 in San Antonio, Texas. More information available at https://www.acsmeetings.org/.

Distance Plant Breeding at Texas

A&M – Continuing Education

Available Courses

Spring Courses: January 14 – May 10, 2019

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**
- **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**

Spring 2019

Plant Breeding Fundamentals – Full Course (3 Units) – Cost $679.65

January 14 – May 10, 2019

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

January 14—May 10, 2019

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
January 14 – February 15, 2019
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 18 – March 29, 2019
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 1 – May 10, 2019
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.

Analysis of Complex Genomes – Full Course (3 Units) – Cost - $679.65

January 14 – May 10, 2019

Genome structure, organization and function of model organisms and higher eukaryotes; theory and methodology of genetic and physical mapping, comparative genomics, sequencing, sequence analysis and annotation; emphasis on understanding the function of complex genomes, genome-wide expression analysis, genetic and epigenetic mechanisms; X-inactivation, imprinting, gene silencing, transposons, genome duplication and evaluation. Requires an in-depth and working knowledge of basic and advanced plant breeding concepts.

Unit 1 – DNA Marker Technology and Genetic Mapping ***Cost - $226.55***
January 14 – February 15, 2019

Unit 2 – Recombinant DNA and Cloning ***Cost - $226.55***
February 18 – March 29, 2019

Unit 3 – Sequencing Genomes and Other Genomic Tools ***Cost - $226.55***
April 1 – May 10, 2019

Quantitative Genetics and Plant Breeding - Full Course (3 Units) - Cost - $679.65

January 14 – May 10, 2019

Applied aspects of quantitative genetics in plant breeding; examination of methodologies to analyze quantitative variation in crop species; genetic phenomena (inbreeding, heterosis and epistasis); quantitative trait loci (QTL) mapping and marker-assisted selection (MAS); genotype by environment interaction, heritability multiple traits and selection theory with implications in plant breeding. Requires an in-depth and working knowledge of basic and advanced plant breeding concepts.

Introduction to Host Plant Resistance (1 Unit) - Cost - $226.55

January 14 – February 15, 2019

Refresher course in host plant resistance breeding and selections.

Other Academic and Continuing Education courses in plant breeding and related disciplines that will be available during other semesters include Advanced Plant Breeding; Crop Production; Selection Theory.

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 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.