ALARC Highlights – Spring 2016 Edition

What's happening at the USDA-Agricultural Research Service, Arid-Land Agricultural Research Center in Maricopa, AZ?

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FEATURED ACCOMPLISHMENT

Tools for precision irrigation management. Irrigated agriculture remains a primary user of fresh water both nationally and globally. Concerns about water scarcity, arising due to aridity, drought, desertification, and water shortage, have driven efforts to improve management of agricultural water resources. Scientists at the Arid-Land Agricultural Research Center (ALARC) in Maricopa, Arizona are developing and testing tools for improved irrigation management, including novel irrigation systems and algorithms for irrigation scheduling. Flood and furrow irrigation have traditionally been used in the central Arizona valley, but adoption of overhead sprinkler systems and buried drip systems is increasing. Regardless of the irrigation method, irrigation management can be improved through the development of appropriate control technology and management decision aids.

A new 6-span lateral move overhead sprinkler system equipped with a variable-rate irrigation (VRI) control system (Figure 1) was recently constructed at the Maricopa Agricultural Center (MAC). The system irrigates a 6.5 ha field site. It pumps 47 L s^{-1} and delivers water using low energy precision application (LEPA) technology. Nozzles are spaced 1.02 m apart, located 1.0 m above the ground, and positioned centrally between 1.02 m cotton rows. The VRI permits independent control of individual nozzles, using wireless technology to send irrigation rate instructions to electronic solenoid valves. Two global positioning system (GPS) receivers are used to locate the machine in the field, and the VRI system calculates irrigation rates based on real-time nozzle positions within a prescription irrigation map. The manufacturer provides software for developing irrigation rate maps for upload to the machine (Figure 2). The system permits field experiments with goals to 1) apply a range of irrigation rates to treatment plots based on a randomized complete block design or 2) apply spatially variable irrigation rates according to sensor-based measurements of variability in soil texture or plant stress. The irrigation system is comprised of novel, state-of-the-art irrigation technology, and no irrigation system with this capability has ever before been available for use in the arid, central Arizona environment.

Fig. 1. Water management research at the Arid-Land Agricultural Research Center includes A) a new 6-span lateral move overhead sprinkler system equipped with B) variable-rate irrigation technology that uses electronic solenoid valves (black part front left) controlled by wireless nodes (grey box back right).

Computer-based irrigation scheduling algorithms are important for efficient irrigation management. Such algorithms incorporate soil, weather, management, and plant growth information to calculate water budgets for the irrigated crop field. Two approaches for cotton irrigation scheduling were compared: one based on the FAO-56 water balance method and another based on the DSSAT Cropping System Model. The former used a

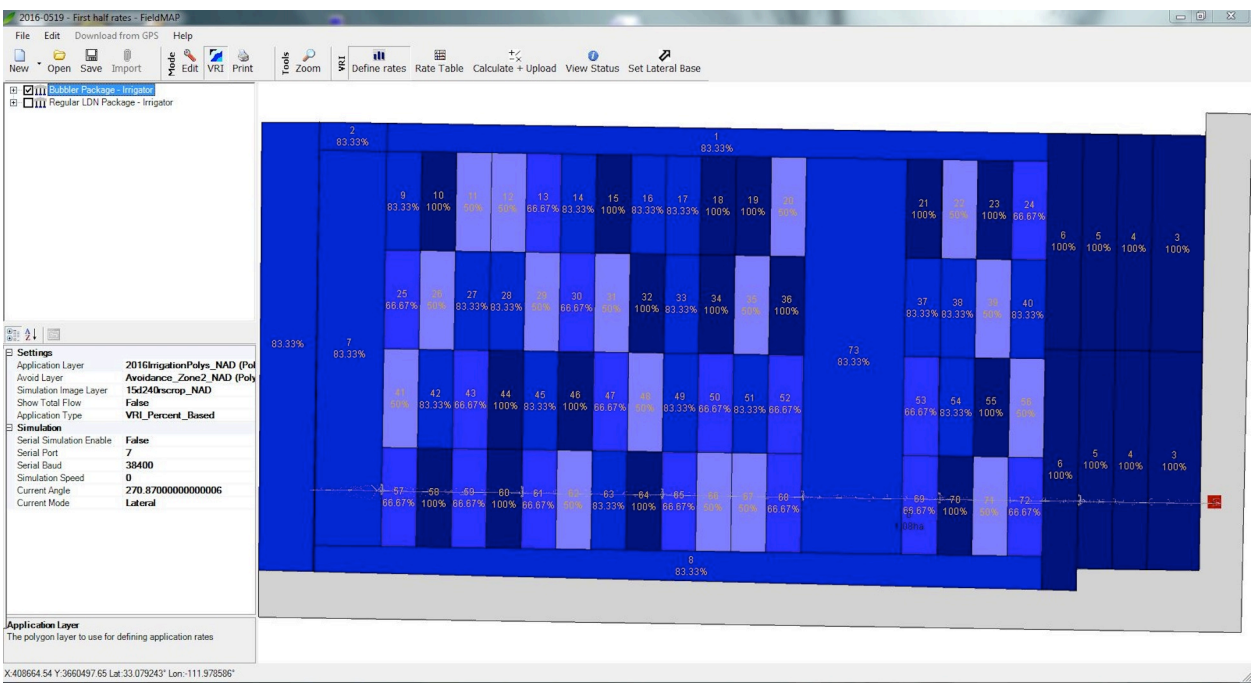


Fig. 2. Prescription maps for spatially variable irrigation control are created in the FieldMap software (developed by the manufacturer of the irrigation system).

trapezoidal crop coefficient curve as defined in the FAO-56 guidelines for crop water requirements. The latter calculated a dynamic crop coefficient curve based on simulated cotton development and growth. Both models were used to schedule irrigation for cotton

under the lateral move irrigation system in 2014 and 2015 (Table 1). In 2014, the total irrigation amount calculated by the two models was similar; however, the DSSAT model called for less irrigation in the early season and more in the late season. Cotton yield from plots managed by DSSAT was 25% higher than FAO-56, but sprinkler calibration may be a factor. Further modifications to the DSSAT model in the 2015 season led to more similar irrigation schedules between the two models, although the DSSAT model again called for less irrigation in the early season. Yields in 2015 were 8% higher using the DSSAT schedule. The study demonstrates that robust evapotranspiration calculation methods coupled with robust plant growth calculations can assist decision making for efficient irrigation management.

Table 1. Seasonal irrigation depth from planting to maturity and cotton yield using FAO-56 and DSSAT-CSM as an irrigation-scheduling algorithm in the 2014 and 2015 growing seasons.

	2014 Irrigation (mm)	2014 Yield (kg/ha)	2015 Irrigation (mm)	2015 Yield (kg/ha)
FAO-56	650	4440	805	6441
DSSAT-CSM	657	5531	795	6969

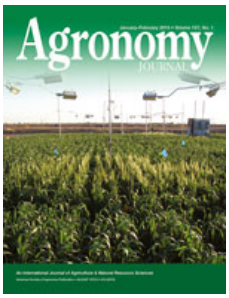
(Contact: Kelly.Thorp@ars.usda.gov)

Other Accomplishments

A novel chemical regulating mating in the western tarnished plant bug. During mating, the male of the Lygus bug transfers a chemical signal to the female that renders her temporarily unattractive to other males, as is known to occur in a number of insect species. In Lygus we found that the anti-mating chemical signal degrades over time to produce a new signal that enhances female attractiveness to potential mates. This phenomenon of competing chemical signals is unreported from other species. These results enhance understanding of plant bug chemical ecology and mating dynamics, and may lead to development of new methods of ecologically-based management. Contact: Colin.Brent@ars.usda.gov

Transgenic crops do not affect important arthropod parasitoids and predators. Bt transgenic crops are cultivated on millions of hectares globally, but there remain concerns about the risks these crops may impose on non-target organisms like arthropod natural enemies that supply important ecological services. An ALARC scientist cooperating with ARS-Ames, Iowa, Cornell University, and Agroscope in Switzerland, showed that the development and reproduction of a parasitic wasp, a predatory beetle, three predatory true bugs, a predatory mite and a predatory green lacewing were not affected by ingestion of prey that had fed on Bt plants over multiple generations. The prey used were either resistant to or not susceptible to the Bt proteins in the plants. This approach eliminates prey quality issues, allowing the direct effects of Bt proteins to be accurately assessed under realistic exposure scenarios. Results are valuable to governmental authorities responsible for regulating transgenic crops, scientists concerned with developing integrated pest management strategies for pest control, and a general public concerned about the environmental effects of biotechnology. Contact: Steve.Naranjo@ars.usda.gov

New strategy for controlling infrared-heater warming experiments. Maintaining a constant crop canopy temperature increase of an infrared-heater warmed plot above that of an un-heated control plot is a commonly used strategy to simulate future global warming of



open-field plots. However, if the heater treatment significantly affects the physiology or growth of the vegetation in the heated plot over time, then an un-heated plot will not represent a proper experimental control. One dramatic example occurred when wheat heads in un-heated plots froze but those under infrared-heaters mostly survived. An ALARC collaborator derived theoretical equations to show that if additional measurements were made of canopy resistance to water loss, it should be possible to control the heater treatment without using an un-heated control plot. Applying the new control algorithm should result in more accurate estimates of effects of warming and reduce the costs of conducting experiments with heating. Contact: Bruce.Kimball@ars.usda.gov

Performance of a sorghum crop simulation for diverse genotypes, environments and management practices. Crop simulation models are widely used to analyze crop responses as affected by genetics, environment and management. The Crop Estimation through Resource and Environment Synthesis (CERES) Sorghum Cropping System Model was known to have problems related to simulation of flowering date and leaf number and also required modifications to enable the model to represent a wider diversity of sorghum types. An ALARC scientist in collaboration with Washington State University, University of Florida, and other institutions revised and tested the model for conditions including growth under well-managed conditions, responses to row-spacing, population, sowing date, irrigation, defoliation, and increased atmospheric carbon dioxide concentration, and a long-term sorghum-winter wheat rotation. Model accuracy was high for phenology, moderate for grain yields, and low for unit grain weight and leaf area index. The improved model will lead to more accurate projections of sorghum response to environment and management and should support farmers making more informed decisions in sorghum production. Contact: Jeff.White@ars.usda.gov

Variation in the content and composition of the waxy, protective layer on oilseed crops. *Brassica napus* is one of the most important oilseed crops in the world, but production regions are restricted to temperate climates because the crop is negatively impacted by heat and drought stress. One of the factors that influences plant tolerance to heat and drought stress is the plant cuticle, which forms the waxy, protective layer on the outer surface of leaves and stems. To determine whether this layer might be a target for improving heat and drought tolerance, ALARC scientists and collaborators from the University of Illinois, West Virginia University, Cornell University, and the Southwest University in Chongqing, China, determined the variability in wax content and composition amongst a diverse population of over 500 *B. napus* lines. There were substantial differences in the content and composition of the wax layer that was likely due to differences in the genetic makeup of the plants. Results are informative to crop breeders interested in improving the heat and drought tolerance, which could potentially expand geographic production. Contact: John.Dyer@ars.usda.gov

Human drugs on wheat irrigated with reclaimed waste water. Rising demands on fresh water has resulted in the need to increase water supplies by the reuse of municipal effluent for irrigation. Pharmaceuticals are frequently found in effluent due to limited removal during wastewater treatment. An ALARC scientist measured the uptake of four drugs (sulfamethoxazole, trimethoprim, ofloxacin and carbamazepine) by wheat plants irrigated with reclaimed water. Trimethoprim was found only on external surfaces, ofloxacin

was found externally and internally with higher concentrations in the straw and lower concentrations in the grain; carbamazepine and sulfamethoxazole were external and concentrated within the grain but at much lower concentrations than oflaxacin. The results will be used to safely increase water supplies by showing that drugs found in wastewater used for irrigation accumulate in the non-edible portions of wheat. Contact: Clinton.Williams@ars.usda.gov

Proximal hyperspectral sensing to characterize cotton plant health. Spectral reflectance data of crop canopies combined with physical or statistical models can provide information on cotton plant health and can lead to recommendations for management of irrigation and nitrogen fertilizer. ALARC scientists have developed hyperspectral data analysis approaches for estimating status of cotton leaf water content, specific leaf mass, leaf chlorophyll a+b content, and leaf area index. Methods were tested for seven Pima cotton cultivars during three cotton-growing seasons. The technology benefits cotton breeders who require rapid techniques to identify cotton cultivars that are resilient to water and nitrogen stress. The technologies can also assist the development of site-specific, variable-rate management plans for irrigation and nitrogen fertilizer, leading to reduced environmental impacts of cotton production and benefits cotton growers. Contact: Kelly.Thorp@ars.usda.gov

Agave as a bioenergy feedstock on arid lands. *Agave americana* is a high-yielding plant recognized as a potential bioenergy crop for dry regions of the world. ALARC scientists and collaborators from Ohio University completed a three-year agave irrigation experiment in Maricopa that included four annual levels of irrigation (100—580 mm). This is the first field study to determine if *A. americana* can be grown productively as a bioenergy crop in desert regions of the Southwestern U.S. We found that the highest agave biomass yield and water use efficiency was obtained with only 330 mm of annual irrigation. Results suggest that agave could become a bioenergy feedstock in semi-arid and arid U.S. regions and has very low irrigation water requirements compared to the traditional crops grown in the region. This research will benefit potential Agave farmers in semi-arid and arid regions, water management agencies, and the biofuel industry. Contact: Doug.Hunsaker@ars.usda.gov

CURRENT GRANT AWARDS (*NEW)

*Genomics and Phenomics to Identify Yield and Drought Tolerance Alleles for Improvement of Camelina as a Biofuel Crop, USDA-NIFA. (PI **John Dyer**, Co-PIs **Hussein Abdel-Haleem**, Daniel Schachtman, Yufeng Ge, Toni Kutchan, Noah Fahlgren) 2016-2019

*Elucidating the Cellular Machinery for Lipid Storage in Plants, DOE-BES (PI Kent Chapman, CO-PIs **John Dyer**, Robert Mullen) 2016-2019

*Characterization of *Lygus hesperus* Salivary Gland Nucleases – Inhibiting the Inhibitors of RNAi, Cotton Incorporated (PIs **Colin Brent Joe Hull, Jeff Fabrick**) 2016.

*Applying Proximal Sensing to Enhance Upland Cotton Yield Trials, Cotton Incorporated (PI **Alison Thompson**) 2016

*Improving Nitrogen Fertilizer Management in Subsurface Drip-Irrigated Cotton, International Plant Nutrition Institute (PI **Kevin Bronson**) 2016

*Evaluation of the Cotton2K model for Arizona cotton production systems, Cotton Incorporated (PI **Kelly Thorp**) 2016.

*Energy Sorghum Reference Phenotyping System, DOE-ARPA-E (PI Todd Mockler, CO-PIs Noah Fahlgren, Erica Fishel, Stephen Kresovich, Jeremy Schmutrz, Jesse Poland, Geoff Morris, William Rooney, Pedro Andrade, Mike Ottman, **Jeff White**, David LeBauer, Robert Pless, Roman Garnett) 2015-2019

*Field Scale Movement of Pest & Beneficial Insets in Arizona Cotton, Arizona Cotton Growers Association (PI Ayman Mostafa, Co-PIs, Peter Ellsworth, **James Hagler, Steve Naranjo**) 2015-2016

*Improving Nitrogen Fertilizer Management and Fate of Nitrogen in Subsurface Drip-Irrigated Cotton, Cotton Incorporated (PI **Kevin Bronson**) 2016

Prospective Resistance Management: Empowering Growers to Partition Chemistry in Space and Time, USDA-NIFA (PI Peter Ellsworth, Co-PIs **Steve Castle**, Nilima Prabhaker (UC-Riverside), Yves Carrière, John Palumbo, Al Fournier, Wayne Dixon, Lydia Brown) 2014-2016

Prospective Resistance Management: Empowering Growers to Understand and Exploit Refugia (PI Peter Ellsworth, Co-PIs **Steve Castle**, Nilima Prabhaker, Yves Carrière, John Palumbo, Al Fournier, Wayne Dixon, Lydia Brown) 2015-2017

Selecting and Using Bt-Resistant Strains of Two Key Pests to Understand Resistance and Characterize Responses to Novel Toxins, CRADA Pioneer Hi-Bred International (PI **Jeff Fabrick**) 2013-2018.

Evaluating and Predicting H2O Consumption by Irrigated Agriculture in Israel and US: Inverse Biophysical Modeling Utilizing Spaceborne Imagery, Binational Agricultural Research and Development Fund (BARD) (PI **Andy French**) 2012-2016.

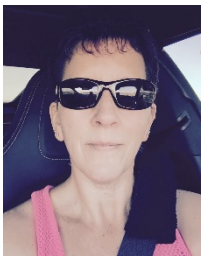
Accelerated Development of Commercial Hydrotreated Renewable Jet (HRJ) Fuel from Redesigned Oil Seed Feedstock Supply Chains, USDA-NIFA/DOE Biomass Research and Development Initiative (PI T. Isbell, Co-PIs **John Dyer,** Mike Gore, D. Long, D. Archer, S. Frey, D. Galloway, T. Tomlinson) 2012-2016.

Securing the Future of Natural Rubber – An American Tire and Bio-energy Platform from Guayule, USDA-NIFA/DOE Biomass Research and Development Initiative (PI H. Colvin, Co-PIs Mike Gore, C. McMahan, **John Dyer**, A. Halog, J. Mitchell, P. Zorner, Collaborator**, Doug Hunsaker**) 2012-2016.

Impact of Bioenergy Crops on Pests, Natural Enemies and Pollinators in Agricultural and Non-Crop Landscapes, USDA-NIFA-AFRI (Co-PI **James Hagler** with T. Kring and R. Weidenman, University of Arkansas; B. McCornack, Kansas State University; K. Giles, Oklahoma State University) 2011-2017

High-Throughput Phenotyping Using Portable LIDAR, Cotton Incorporated (PI **Andy French** with Co-PIs M. Gore, Cornell University and P. Andrade-Sanchez, University of Arizona) 2012-2016.

Recent Professional Awards and Recognition



Cheryl Borg was named the 2015 **Office Professional of the Year** for the Pacific West Area. The award recognizes Cheryl's outstanding service to the Office of the Center Director and for overseeing and participating in the system that provides direct service to the Center's research units and their research missions. Cheryl was recognized with a plaque and a cash award.

Joseph Garrett was named the 2015 **Location and Administrative Staff of the Year** for the Pacific West Area. This award recognizes Joseph's outstanding service as the Administrative Officer of the Center, where he manages the administrative team that provides critical support to our research mission. Joseph was recognized with a plaque and a cash award.

Robert LaMorte and the Customer Service Portal Core Team were selected to receive the **Abraham Lincoln Honor Award** for Innovative Customer Service. The team was recognized for implementation of a custom, broad-scale customer service platform for making service transparent, efficient, standardized, and trackable by customers and leadership. They were acknowledged at a ceremony in the Thomas Jefferson Auditorium of the USDA building in Washington, D.C. This same team was also awarded the **AFM Team of the Year** for ARS. Team members included (back row, left to right): **Robert LaMorte,** Scott Finke**,** Stephanie Gallison**,** Scott Davis, and Kari Deppe**;** (front row, left to right): Andrea Miller**,** Wendy Jones, USDA Deputy Secretary Krysta Harden**,** Jeffrey Van Houten**,** Heather Gossel, and Sandra Gutierrez. Team member Karen Brindle is not pictured.

Dr. James Hagler, an Entomologist with the Pest Management and Biological Control Research Unit was the 2015 recipient of the **Excellence in Integrated Pest Management (IPM) Award** from the Entomological Society of America. This award, sponsored by Syngenta Crop Protection, recognizes Dr. Hagler's work in advancing biological control and insect dispersal in IPM systems. He was honored at the annual meeting of the society, November 2015 in Minneapolis, MN.

Dr. Hagler was also named the 2015 **Outstanding Alumnus** from the Department of Entomology Plant Pathology and Weed Science, New Mexico State University in recognition of his scientific accomplishments. James was honored as a ceremony at the university in Las Cruces, NM.

Dr. Jeffrey White, a Plant Physiologist with the Plant Physiology and Genetics Research Unit was the 2015 recipient of the **L.R. Ahuja Ag Systems Modeling Award** from the Soil Science Society of America and the Agronomic Science Foundation. The award honors Dr. White for his efforts to fill knowledge gaps in crop simulation models and promote more effective application of models in research related to climate uncertainty. He was honored at the annual meeting of the society, November, 2015 in Minneapolis, MN.

Dr. Colin Brent, an Entomologist with the Pest Management and Biological Control Research Unit received the 2016 **Award in Physiology, Biochemistry, and Toxicology** from the Pacific Branch of the Entomological Society of America. The award recognizes an outstanding record of career-long accomplishments in Physiology, Biochemistry and/or Toxicology. Dr. Brent has made major advances in understanding the physiology and behavior of Lygus bugs, a serious pest of cotton and other crops in the west. Colin was honored at the annual meeting of the Pacific Branch ESA, April 2016 in Honolulu, HI.

Dr. Steven Naranjo, Director of the Center in Maricopa was elected as a **Fellow of the Entomological Society of America**. Dr. Naranjo was recognized for his research in integrated pest management (IPM), insect sampling and decision aids, conservation biological control and environmental risk assessment of transgenic crops, and for his leadership accomplishments in USDA-ARS. He was honored at the annual meeting of the society, November 2015 in Minneapolis, MN.

The Center's internship program, conducted in partnership with South Mountain Community College and Central Arizona College, was presented the **Innovation Award in Business** by the COX Connect2STEM program. The program recognizes people and institutions that engage in activities to promote education and outreach in STEM (Science, Technology, Engineering and Math). [Link] [Link]

Employee Engagement

The Plant Physiology and Genetics Unit recently unveiled their Employee Engagement Zone poster at the Center. The interactive poster provides summaries of the units research programs and staff and also provides a way for unit members to communicate thoughts and ideas through sections like Cool Science, Nerd Corner and a white-board.

The Safety Committee sponsored a **Safety Poster Contest** as a fun way to highlight the importance of safety in the workplace. We had 14 entries and employees voted to determine the winners. All the posters are hanging in the laboratory building. ***Special thanks*** *to Brenda Singleton, Lynn Jech, Sharette Rockholt and Rodney Gaither for organizing the contest.*

1st Place
(Erica &Alison)

2nd Place
(Colin)

3rd Place
(Laura)

3rd Place
(Sharette)

Andy French is the Center's representative on the **PWA Employee Engagement Committee**. The goal of the committee is to report engagement activities that can be featured on AXON, ARS' intranet, and to generate and share employee engagement ideas that could potentially be implemented at the Location, Area or even Agency level.

ALARC in the News

Guayule Rubber for Tires: The Center's cooperative USDA-DOE funded project team met in August 2015 to discuss recent progress in the goal to produce tires using rubber from the native scrub, guayule [Link]

Biological Control in Cotton IPM: A cooperative project with the University of Arizona is developing a strategy to utilize the abundance and activity of arthropod predators in cotton

fields to help make better decision about the need to spray insecticides for control of whiteflies. [Link]

Field Scanalyzer at UA-MAC: The U.S. Department of Energy TERRA (Transportation Energy Resources from Renewable Agriculture) program has funded an $8M grant to develop a reference phenotying system for energy sorghum. Scientists at the Center are cooperating on the project [Link] [Link]

Technology for Crop Improvement. The use of proximal sensing for assessing crop responses to heat and drought are contributing to faster crop improvements. [Link]

ARS Targets Next Generation of Arizona Cotton Irrigation. The use of overhead sprinkler and underground drip systems could save significant amounts of water in cotton production.[Link]

U.S. Department of Energy (DOE) Invests Millions in Cutting-Edge Arizona Crop Scanner. The DOE funded field scanalyzer has the potential to transform the way we conduct crop improvement. [Link]

Recent Events and Outreach

June 2015, Our annual student intern program got underway. We hosted 14 students from high schools in the Phoenix area as part of Undergraduate Bioscience Engagement Track (UBET) program with South Mountain Community College. During the summer the students completed a research project of their own while earning college level credits. They presented posters on their work at ALARC and the College in July. We will host 20 students this summer.

June 2015, ALARC hosted the Summer Ag Institute, a group of K-12 teachers who embark on a week-long tour throughout Arizona. This adventure is designed to teach them about food and fiber production, and help to incorporate that knowledge in the classroom curriculum. This experience is a great opportunity for the teachers to see the vital role agriculture plays in rural communities and the importance of the research in agriculture. Tours were provided by scientist and technicians from all three units.

June 2015, ALARC hosted a visit from Dr. Sarah Porter, the Director of the Kyle Center for Water Policy at Arizona State University. Dr. Porter toured the Center and learned about many of the research projects being conducted in each Research Unit. The tour was followed by a small discussion group with the scientific staff of the Water Management and Conservation Unit.

June 2015, the Equal Employment Opportunity committee celebrated Lesbian, Gay, Bisexual, Transgender Pride Month by hosting a Movie/Lunch session for employees. There were three movies shown by *Yoruba Richen*, What the gay rights movement learned from the civil rights movement. *Morgan Bailey*, The danger of hiding who you are and *Norman Spack*, How I help transgender teens become who they want to be.

August 2015 employees remembered Gail Dahlquist, a Research Technician who touched everyone's hearts with her amazing personality. She was diagnosed with Lou Gehrig's disease, which took her way too early. During her last months after being confined

to a wheelchair, she would wear very colorful socks to keep her spirits up. The tradition lives on as we celebrate our individuality and zest for life with Crazy Sock Day on Gail's birthday August 1st.

October 2015, The ALARC Seminar Series kicked-off. The series brought in a wide diversity of speakers in entomology, plant sciences, water conservation and beyond. The seminars provide the agricultural community, as well as ALARC employees and visiting scientists with a forum to keep abreast of current research developments.

October 2015, The ALARC Equal Employment Opportunity Committee hosted a viewing of the PBS documentary *Pedro E. Guerrera: A Photographer's Journey*, to celebrate Hispanic Heritage Month. The documentary explores the life and work of Pedro E. Guerrero, a Mexican-American photographer born in and raised in Casa Grande and Mesa, AZ. Pedro collaborated with iconic American artists of the 20th century, including Frank Lloyd Wright and sculptors Alexander Calder and Louise Nevelson – and became one of the most sought-after photographers of the Mad Men era. Viewers enjoyed the movie with chips & homemade salsa

November 2015, Dr. Malcom Gillies, Joseph Foley, and Alison McCarthy, scientist's from the National Center for Engineering in Agriculture at the University of Southern Queensland visited scientist in the Water Management and Conservation Research Unit at the ALARC, AZ. The visit was a great opportunity to share and discuss research of mutual interest in surface irrigation modelling, spatial variability in irrigated systems, remote sensing, and crop modeling.

November 2015, Scientist's from the ALARC judged posters and helped staff a USDA-ARS booth at the Annual American Indian Science Engineering Society (AISES) National Conference held in Phoenix, AZ. The Annual AISES National Conference is a one-of-kind, three-day event focusing on educational, professional and workforce development. Attendees included American Indian high school and college students, educators, professionals, tribal nations and tribal enterprises, universities, corporations, and government agencies.

(*Pictured L to R*) *Mrs. Jessica Loggins, USDA-ARS, Athens, GA, Dr. John Dyer, Mr. Jeff Petersen, and Dr. Hussein Abdel-Haleem from ALARC and Dr. Deborah Brennan, USDA-ARS, Stoneville, MS, and Mrs. Velinda Woriax, University of North Carolina at Pembroke*

November 2015, ALARC employees from the all three units and the Admin Office harvested cotton that was part of the Regional Breeders Testing Network (RBTN) and part of experiments being conducted to compare irrigation strategies. The RBTN program tests advanced breeding lines from cotton breeders across the U.S. ALARCs contribution was to test for heat and drought tolerance, as well as using this material for High through-put phenotyping and remote sensing work by the plant and water units.

December 2015, the ALARC Equal Employment Opportunity committee hosted an event to help celebrate Native American Heritage Month. Our guest speaker was Mr. Frank Koerner from the Heard Museum in Phoenix, AZ. The mission of the museum is to educate visitors and promote greater public understanding of the arts, heritage and ways of the indigenous peoples of the Americas, with an emphasis on American Indian tribes and other cultures of the Southwest. He presented "*Native Foods*", where he discussed foods that were and are part of the Native American culture.

December 2015, Undergraduate students and faculty from the Irrigation Engineering program at the University of Chapingo, Mexico, made their yearly visit to ALARC. Drs. Eduardo Bautista, Andrew French and Kevin Bronson discussed ongoing research at ALARC in the areas of irrigation modeling, irrigation management, and remote sensing in irrigated agriculture.

December 2015, ALARC employees gathered together to *Stuff Holiday Stockings* for our troops serving at Bagram Air Force Base in Afghanistan. This project was coordinated in an effort to bring a little Peace, Joy, Comfort, and Holiday Cheer from our desert to theirs. Over 75 stockings were hand made/or purchased and stuffed with lots of goodies. ***Special thanks*** *to Evelyn Bull, Alice Wyland, Barbara Olsen, Sharon Sumner, and Dr. Alison Thompson for coordinating, cutting, piecing the fabric toghether, and sewing the stockings*.

February 2016, ALARC scientists hosted visitors from the National Corn Growers Association (NCGA). The group visited/toured ALARC to learn about our high-throughput phenotyping activities. The visit was part of a large effort led by NCGA to build a broad coalition of commodity groups to champion development of a national initiative on high-throughput phenotyping. Presentations and demonstrations from scientists/technicians and leadership at the Center, as well as the University of Arizona, Maricopa Agricultural Center covered the state of the art in field-based phenotyping systems, the challenges associated with big data management and analysis, and the great potential for phenomics-based research to enhance crop performance and increase crop yields.

February 2016, scientists from the Plant Physiology & Genetics Research Unit, and the Pest Management & Biocontrol Research Unit hosted a tour for a Biology teacher and 6 students from McClintock High School. They were given tours of labs at the center, as well as discussing research activities from all three units. They also toured the greenhouses, where they saw and learned about the guayule and brassica plants, which are non-food crops used for production biofuels and specialty chemicals such as natural rubber. It was a great opportunity to share our research and the love of science with young people.

February 2016, Employees from ALARC and the University of Arizona, Maricopa Agricultural Center (MAC) hosted Farm Science Day, An Arizona SciTech Festival Signature Event. This event brought in local vendors, farmers, and families from throughout the community to learn about agriculture and how it affects their communities. Activities included an insect zoo, cotton 101, auto-steer tractor-ride along, hayrides, farm village and

cotton gin at MAC, cricket spitting, face painting, vintage tractors, and live music by ALARC musicians. ALARC scientists and technician's put together displays on Biofuel crops, Entomology, Photosynthesis, Irrigation, Remote sensing, and Natural Rubber from guayule. We were joined by the Pinal County Master Gardeners, Arizona Farm Bureau, Future Farmers of America, AZ Dept. Water Quality, Wild at Heart and Central Arizona College. The event was attended by about 700 people.

March 2016, the ALARC EEO committee hosted *Women in Science: Challenges and Opportunities* to celebrate Womens History Month. Debra Baluch, President of the Arizona Chapter of the Association for Women in Science (AWIS) and Olga Yurchenko made presentations. Following the presentation, there was an open discussion focusing on *Women in Science Today*, as well as networking among employees from ALARC, Central Arizona College, Arizona State University, and Tempe High School District. Some of the key points discussed were under-representation of women in science, challenges for women in science, and opportunities for women in science. The event concluded with lunch and networking. ***Special thanks*** *to Olga Yurchenko, Sharette Rockholt and Kathy Johnson for organizing the event.*

March 2016, ALARC hosted the 2016 PWA Leadership Conference in Maricopa. As part of the three day meeting PWA Research Leaders, Administrative Officers and ARS Leadership from Beltsville were provided a tour of the ALARC facility by scientists and technicians. The day before the conference the ARS Administrator Dr. Chavonda Jacobs-Young, ARS chief of staff Dr. Sharon Drumm, Associate Administrator Dr. Simon Liu, Budget Director Michael Arnold, OCIO Chief Paul Gibson and the PWA Area and Associate Area Directors Drs. Andy Hammond, Tom Shanower and Charles Onwulata visited ALARC for an all-hands meeting and a tour of the facility.

April 2016, ALARC hosted its annual Stakeholder Advisory Group meeting. The diverse group is comprised of producers, industry, university and other federal agency representatives. Research Leaders presented summaries of on-going and future research followed by discussions to gain feedback on the relevance and importance of the research to our stakeholders and to expand insight into additional stakeholder needs that can be achieved by ALARC or other ARS locations. The meeting included lunch and a tour of the facility.

June 2016, ALARC scientists participated in a special event at UA-MAC to inaugurate the Advanced Research Projects Agency-Energy (ARPA-E) Transportation Energy Resources from Renewable Agriculture (TERRA) program. The event was jointly hosted by the UA College of Agriculture & Life Sciences and the U.S. Department of Energys (DOE). The ARPA-E Field Scanalyzer at MAC is the largest field crop analytics robot in the world. It incorporates cameras and sensors that measure and record crop growth and development at high resolution. The TERRA programs goal is to develop and integrate remote sensing platforms, complex data-analytics tools, and advanced plant-breeding technologies to enable crop production advances. ALARC staff displayed and discussed our phenomics platforms, technologies and programs at the event.

Recent Journal Publications

Plant Science

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