Rice Technical Working Group

Arkansas California Florida Louisiana Mississippi Missouri Texas

PROCEEDINGS…

Fortieth Rice Technical Working Group

New Orleans, LA: February 17 – 20, 2025

Edited by: Kurt Guidry, Adam Famoso, and Jarrod Hardke

The Agricultural Experiment Stations and Agricultural Extension Services of Arkansas, California, Florida, Louisiana, Mississippi, Missouri, and Texas; and the Agricultural Research Service, the Economic Research Service, the National Institute of Food and Agriculture and other participating agencies of the U.S. Department of Agriculture; and cooperating rice industry agencies

40TH RTWG RICE TECHNICAL WORKING GROUP 2025

Louisiana State University Agricultural Center
Louisiana Agricultural Experiment Station

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PROCEEDINGS … FORTIETH
RICE TECHINCAL WORKING GROUP

RICE TECHINCAL WORKING GROUP

Organization and Purpose

The Rice Technical Working Group (RTWG) functions according to an informal memorandum of agreement among the State Agricultural Experiment Stations and the Agricultural Extension Services of Arkansas, California, Florida, Louisiana, Mississippi, Missouri, and Texas, and the Agricultural Research Service, the Economic Research Service, the National Institute of Food and Agriculture, and other agencies of the United States Department of Agriculture. Membership is composed of personnel in these and other cooperating public agencies and participating industry groups who are actively engaged in rice research and Extension. Since 1950, research scientists and administrators from the U.S. rice industry and from international agencies have participated in the biennial meetings.

Pursuant to the memorandum of agreement, the Association of Agricultural Experiment Station Directors appoints an administrative advisor who represents them on the Executive Committee and in other matters. The administrator of the USDA-ARS designates a representative to serve in a similar capacity. The Directors of Extension Service of the rice growing states designate an Extension Service Administrative Advisor. The Publication and Website Coordinators also are on the Executive Committee.

Other members of the Executive Committee are elected biennially by the membership of the RTWG; they include a general chair who has served the previous term as secretary, a secretary-program chair, a representative from each of the seven major rice-growing states (Arkansas, California, Florida, Louisiana, Mississippi, Missouri, and Texas), the immediate past chair, and an industry representative. The rice industry participants elect an Executive Committee member, on a rotational basis, from the following areas: (1) chemical, (2) seed, (3) milling, (4) brewing industries, (5) producers, or (6) consultants.

Several months prior to the biennial meeting, panel chairs solicit and receive titles and interpretative summaries of papers to be presented. They work with the secretary-program chair in developing the program, including joint sessions as desired. RTWG program development includes scheduling of papers and securing persons to preside at each panel session. Each panel chair is in charge of (1) election of a successor and (2) updating of the panel recommendations.

Committees, which are appointed by the incoming chair, include: Nominations and Location and Time of Next Meeting, Members of the Nominations and the Location and Time of Next Meeting Committees are usually selected to represent the different geographical areas.

The RTWG meets at least biennially to provide for continuous exchange of information, cooperative planning, and periodic review of all phases of rice research and Extension being carried on by the states, federal government, and cooperating agencies. It develops proposals for future work, which are suggested to the participating agencies for implementation.

Location and Time of the 2025 Meeting

The 40th RTWG meeting was hosted by Louisiana and held at the Hilton New Orleans Riverside in New Orleans, LA, from February 17 – 20, 2025. The Executive Committee, which coordinated the plans for the meeting, included Jarrod Hardke, Chair; Adam Famoso, Secretary; and Jason Bond, Immediate Past Chair. Geographic Representatives were Nick Bateman (Arkansas), Luis Espino (California), Matthew VanWeelden (Florida), Connor Webster (Louisiana), Tom Allen (Mississippi), Justin Chlapecka (Missouri), Ted Wilson (Texas), and Mallory Everett (Industry). Administrative Advisors were Michael Salassi

(Experiment Station), Steve Martin (Extension Service), and Michele Reba (USDA-ARS). Publication Coordinator was Kurt Guidry (Louisiana). The Industry Representative was Mallory Everett (Valent USA). The Local Arrangements Coordinators for Arkansas were Kurt Guidry (Chair), Brijesh Angira (Vice Chair), Manoch Kongchum, Ronnie Levy, and Kim Guidry.

Location and Time of the 2027 Meeting

The 2027 RTWG Meeting Location Committee recommended that the 41st RTWG meeting be held by the host state Texas. The meeting will be held in February 2027 in Texas.

2025 RTWG Awards

The Distinguished Rice Research and Education Award honors individuals achieving distinction in original basic or applied research, creative reasoning, and skill in obtaining significant advances in education programs, public relations, or administrative skills, which advance the science, motivate the progress, and promise technical advances in the rice industry. Only one individual and team award can be given at an RTWG meeting. The individual award was presented to Jason Norsworthy. The team award was presented to the Organic Rice Research Team of Fugen Dou, Xing-Gen Zhou, Lloyd "Ted" Wilson, Yubin Yang, Tanumoy Bera, Anna McClung, Mo Way, and Bradley Watkins.

The Distinguished Service Award honors individuals who have given distinguished long-term service to the rice industry in areas of research, education, international agriculture, administration, and industrial rice technology. This award usually requires a whole career to achieve, and thus, it can be argued that it is our toughest award to win. But, since more than one can be given at an RTWG meeting, it is our fairest award granted to all worthy of such distinction. This award was presented to Lee Tarpley.

Publication of Proceedings

The LSU AgCenter published the proceedings of the 40th RTWG meeting. Dr. Kurt Guidry of Louisiana served as the Publication Coordinator for the 2025 proceedings. The 2025 proceedings was edited by Kurt Guidry, Jarrod Hardke (Chair), and Adam Famoso (Secretary). They were assisted in the publication of these proceedings by the panel chairs.

Instructions to be closely followed in preparing abstracts for publication in the 41st RTWG (2027 meeting) proceedings are included in these proceedings.

Committees for 2027

Executive:

Chair:	Adam Famoso	Louisiana
Secretary:	Omar Samonte	Texas

Geographical Representation:

Camila Nicolli	Arkansas
Whitney Brim-Deforest	California
Matthew VanWeelden	Florida
Felipe Dalla Lana	Louisiana
Tom Allen	Mississippi
Chase Floyd	Missouri
Ted Wilson	Texas

Immediate Past Chair:

Jarrod Hardke	Arkansas

Administrative Advisors:

Michael Salassi	Experiment Station
Steve Martin	Extension Service
Michele Reba	USDA-ARS

Publication Coordinator:

Kurt Guidry	Louisiana

Web Page Coordinator:

Jarrod Hardke	Arkansas

Industry Representative:

Sunny Bottoms Hensley	Gowan USA

2027 Local Arrangements:

Shyamal K. Talukdar (Chair)	Texas
Brandy L. Morace	Texas
Darlene Sanchez	Texas
Lee Tarpley	Texas
Rebecca A. Pearson	Texas
Sam Rustom	Texas
Stanley Omar PB Samonte	Texas
Xin-Gen Zhou	Texas
Yubin Yang	Texas

Nominations:

Bob Scott	Arkansas
Sarah Marsh Janish	California
Matthew VanWeelden	Florida
Brijesh Angira	Louisiana
Tom Allen	Mississippi
Chase Floyd	Missouri
Fugen Dou	Texas
Sunny Bottoms Hensley	Gowan USA

Rice Crop Germplasm:

Georgia Eizenga (Chair)	USDA-ARS
Nick Bateman	Arkansas
Gretchen Zaunbrecher	California
Brijesh Angira	Louisiana
Will Eubank	Mississippi
Stanley (Omar) Samonte	Texas
Christian De Guzman	Arkansas
Xin-Gen (Shane) Zhou	Texas
Qiming Shao	Texas

Ex Officio:

Bishwo Adhikari	USDA-ARS
Harold Bockleman	USDA-ARS
Peter Bretting	USDA-ARS
Travis Huggins	USDA-ARS
Yulin Jia	USDA-ARS
Gary Kinard	USDA-ARS
Jack Okamuro	USDA-ARS
Xin-Gen (Shane) Zhou	Texas

National Germplasm Resources Laboratory:

Gary Kinard	USDA-ARS

Rice Variety Acreage:

Dustin Harrell (Chair)	California
Jarrod Hardke	Arkansas
Ronnie Levy	Louisiana
Will Eubank	Mississippi
Chase Floyd	Missouri
Ted Wilson	Texas
Matthew VanWeelden	Florida

2027 RTWG Panel Chairs:

Breeding, Genetics, and Genomics:
Shyamal K. Talukder — Texas

Economics:
To Be Determined

Plant Protection:
Xin-Gen Zhou — Texas

Postharvest Quality, Utilization, & Nutrition:
Yubin Yang — Texas

Rice Culture
Lee Tarpley — Texas

Weed Control & Growth Regulation:
Sam Rustom — Texas

Student Contest Panel:
Lina Bernanola — Texas

RESOLUTIONS
40^{th} RTWG – 2025

The 40^{th} meeting of the RTWG, held in New Orleans, Louisiana, February 17 to 20, 2025, provided an opportunity for information exchange among rice research and Extension scientists, rice growers, rice industry representatives, and users of rice products in the United States and abroad. Therefore, the Executive Committee, on behalf of the RTWG, expresses its appreciation to the listed individuals and organizations that contributed to the success of the 40^{th} meeting.

1. Jarrod Hardke, RTWG Chair, and all other members of the Executive Committee who organized and conducted this successful meeting. We recognize Adam Famoso and his cooperating staff for the timely completion of organizational details to include notification

correspondence, program preparation, specific paper presentation standards, and all other tasks involved with the RTWG.

2. The staff of the Hilton New Orleans Riverside Hotel, New Orleans, Louisiana, for their assistance in arranging lodging, services, and hospitality before and during the RTWG meeting.

3. The Local Arrangements Committee led by Kurt Guidry, Louisiana, for the site selection and overseeing arrangements.

4. The faculty and staff of the LSU AgCenter and the H. Rouse Caffey Rice Research Station for their time and assistance in conducting all aspects of pre-meeting and on-site logistics and other conference planning and operational details.

5. Luke Bullock, Andy Gonzalez, Roxanne Hare, and Marla Elsea, with the LSU AgCenter's department of Communication for designing and coordinating the conference's online registration and for designing and developing the conference program.

6. Karen Watts-DiCiccio, Gretchen Skinner, and their staffs at the University of Arkansas System Division of Agriculture Cooperative Extension Service departments of Information Technology and Communications who contributed time and effort for developing and maintaining the RTWG website.

7. Jeanette Davis, Katie Maher, and Jenni Bryant with the USA Rice Federation for their invaluable assistance with coordinating arrangements with the conference hotel and for their assistance in designing conference signage.

8. The Panel Chairs: Brijesh Angira, Manoch Kongchum, Blake Wilson, Connor Webster, and Griffiths Utungula, and moderators for planning, arranging, and supervising technical sessions. The Student Contest Chair, Felipe Dalla Lana, for planning, arranging, and supervising those special sessions.

9. The paper/poster presenters for sharing research results and new ideas.

10. The Symposia, General Session, and Industry Luncheon speakers, Mike Salassi, Bob Zeigler, Jackie Loewer, and Bobby Hanks, for sharing their knowledge and wisdom.

11. Kurt Guidry, H. Rouse Caffey Rice Research Station, LSU AgCenter, for editing and publishing the RTWG proceedings.

12. We gratefully recognize our many generous sponsors that made the 40th Rice Technical Working Group meeting successful.

2025 RTWG Conference Sponsorship

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Nichino America

Distinguished Rice Research and Education Award

Jason Norsworthy

Dr. Jason Norsworthy, Distinguished Professor and Elms Farming Chair of Weed Science at the University of Arkansas, is a nationally and internationally recognized leader in rice weed management. His research has profoundly shaped our understanding of herbicide resistance, weed ecology, and integrated weed management in rice systems. With three patents (including one directly related to rice) and 21 additional patent applications specific to rice technologies, Dr. Norsworthy has demonstrated exceptional innovation in the development of novel weed control strategies.

A central focus of Dr. Norsworthy's work has been the identification and management of new and evolving weed threats in rice, including white-margin sedge and rice cutgrass. His lab has elucidated multiple herbicide resistance mechanisms and pioneered the use of metabolic inhibitors to enhance herbicide efficacy. His research on seed treatments has improved crop safety in rice, enabling the use of newer herbicide chemistries. He has led the evaluation of over 20 experimental herbicides, contributing directly to the registration of Provisia, HighCard, Loyant, and Rogue—tools now critical to U.S. rice production.
A prolific scholar, Dr. Norsworthy's rice-related body of work includes 121 peer-reviewed articles, 121 research series reports, and over 300 abstracts, alongside significant contributions to extension literature and the popular press. His research has been cited over 12,650 times, reflecting its influence and utility in academic and applied contexts. His weed control guide (MP44) is distributed to over 10,000 stakeholders annually, further demonstrating the reach of his work.

Dr. Norsworthy has confirmed ten novel or unique cases of herbicide resistance in rice and screened more than 3,500 weed samples from growers' fields, directly supporting sustainable resistance management strategies. His academic outreach has been exemplary: he has delivered over 30 field day presentations, led 22 in-field training events, and organized the Roy J. Smith Barnyardgrass Symposium—one of the most comprehensive gatherings on rice weed management in recent years.

With a commitment to both scientific rigor and practical application, Dr. Norsworthy continues to shape the trajectory of rice weed science through his research, mentorship, and leadership in the academic community.

Distinguished Rice Research and Education Team Award

Fugen Dou, Xing-Gen Zhou, Lloyd "Ted" Wilson, Yubin Yang, Tanumoy Bera, Anna McClung, Mo Way, and Bradley Watkins

The U.S. organic rice industry has expanded significantly, with Texas and California leading in acreage, driven by high demand and benefitting from the efforts of a dedicated Organic Rice Team led by Texas A&M AgriLife Research. This team, composed of multidisciplinary experts, has worked for over 15 years on enhancing organic rice production by focusing on rice variety selection, and nutrient and pest management, which are critical for boosting yields and meeting market demand.

The team has led groundbreaking initiatives to address the critical needs of the U.S. organic rice industry. Supported primarily by $2.4 million in federal and stakeholder grants, the team established the first USDA NIFA Center of Excellence (COE) for organic rice research in the U.S. and conducted extensive research and outreach in Texas, Arkansas and South Carolina. This work has resulted in developing effective and sustainable strategies and tools for managing soil fertility, and controlling diseases, weeds, and insect pests. These efforts have enabled organic rice farmers to increase profitability, thereby supporting the sustainability of their farms and replacing the need for organic rice imports with domestic production.

The team determined that cultivar selection and seeding rates are key to optimizing yield, grain quality, and weed control, and identified specific cultivars showing high yield potential and disease resistance under organic management. Organic amendments and nitrogen rates were refined to balance rice productivity and input costs. For pest management, cover crops and organic soil amendments have proven effective controlling weeds and diseases, while seed treatments like BioEnsure and bio-fungicides like Badge X2 offer additional protection during the critical seedling emergence stage.

Economic studies highlighted the importance of establishing price premiums, organic certification, variety selection, and pest control methods to optimize profitability. Recommendations to prevent pesticide contamination in organic farms include using community-focused communication and equipment operation guidelines.

The team's environmental research revealed how organic nitrogen rates affect greenhouse gas emissions and microbial diversity in the soil, which are important issues for organic consumers and are critical for long-term sustainable practices. Their extensive efforts led to over 177 publications, including 19 peer-reviewed articles that have been cited 220 times, and culminated in the release of *Texas Organic Rice Production Guidelines*, the first publication of its kind in the U.S. Through extensive outreach, workshops, and online resources, the team has disseminated these results to a broad audience, reaching thousands domestically and internationally. Their training programs have equipped students and professionals with sustainable rice production skills, fostering the growth of leadership in organic agriculture.

Distinguished Service Award

Lee Tarpley

Dr. Lee Tarpley is Professor of Plant Physiology with a Research appointment at the Texas A&M AgriLife Research & Extension Center at Beaumont, where he started in 2001. He is faculty with the Texas A&M University Department of Soil & Crop Sciences. His research is primarily in the areas of rice yield physiology and crop response to environmental stresses.

In 2014, Dr. Tarpley became the Secretary for RTWG. In 2016, the 36th RTWG meeting was held in Galveston, Texas, and was attended by more than 430 participants, making it the largest RTWG meeting in recent memory. As program chair, Dr. Tarpley was responsible for all aspects of the meeting. In 2016, he became the Chair of the RTWG for the 2018 meeting held in Long Beach, California. Dr. Tarpley served on the Executive Committee for RTWG for 12 years in various capacities.

High night temperatures are a concern for rice production especially in the relatively humid growing areas along the U.S. Gulf Coast. Dr. Tarpley is a world leader in understanding how rice plants respond physiologically to high night temperature stress, and especially in using this information to suggest potential management and genetic solutions. He has also developed instrumentation suitable for studying the crop response to high night temperature stress. Dr. Tarpley has developed a modification of plant growth regulator technology to improve rice crop yield and profitability; this is in use by producers.

Dr. Tarpley has more than 500 publications, including more than 40 peer-reviewed journal articles focusing on rice research, along with others not on rice. The authors include 25 graduate students or post-graduate staff from Dr. Tarpley's program. Dr. Tarpley has provided more than 230 Research Outreach Publications and Public Reports and more than 140 Research Outreach Presentations; these are mostly on rice.

Dr. Tarpley is also active in other scientific societies, especially the Crop Science Society of America, of which he is Fellow.

MINUTES OF THE 39TH RTWG MEETING

Opening Executive Committee Meeting

In Attendance: Jarrod Harke, University of Arkansas System Division of Agriculture, Chair; Adam Famoso, LSU AgCenter, Secretary; Kurt Guidry, LSU AgCenter; Matthew VanWeelden, University of Florida; Luis Espino, UC Davis; Tom Allen, Mississippi State University; Chase Floyd, University of Missouri; Michele Reba, USDA-ARS; Felipe Dalla Lana, LSU AgCenter.

Hardke called meeting to order at 7:41 a.m., Monday, February 17., 2025.

Hardke and Famoso presented details about the most recent meetings in Orange Beach, and Hot Springs.

- Orange Beach: 280 attendees; 131 papers, 95 posters.
- Hot Springs: 330 attendees (preregistered); 128 papers, 103 posters.
- New Orleans: 333 pre-registrations, 320 attendees, 129 papers, 97 posters

Famoso and Hardke discussed financials. MOP states minimum of $6,000 should be transferred to next host. UADA transferred $20,000 to LSU AgCenter for 2025 meeting. Famoso indicated the financial situation should permit a transfer of $10,000 to Texas A&M for 2027 meeting.

Famoso reviewed minutes for the 39th RTWG Closing Executive Committee Meeting.

- Meeting scheduling conflicts continue between RTWG and other meetings.
- RTWG website now permanent as www.RTWG.org. All proceedings past and present will be placed on this website.
- Registration payments will be processed thru FormStack on the site for future meetings; universities not utilizing FormStack will have the option of funds transfers.

Point of Order by VanWeelden to close old business.

Bond read Necrology Report, which included Ida Wenefrida (March 27, 2023), Carl Johnson (April 17, 2023), Bill Webb (July 18, 2023), Gene Regan (December 14, 2023), J. Neil Rutger (June 6, 2024), and Ned French (June 18, 2024).

Hardke announced awards recipients.

The Rice Research and Education Award (Individual) winner was Jason Norsworthy.

The Rice Research and Education Team Award winner was the Organic Rice Research Team consisting of Fugen Dou, Xing-Gen Zhou, Lloyd "Ted" Wilson, Yubin Yang, Tanumoy Bera, Anna McClung, Mo Way, and Bradley Watkins.

Finally, the Distinguished Service Award winner as Lee Tarpley.

Due to the low number of award applications, the group discussed potential strategies to encourage greater participation. Key ideas included:

- Simplifying the application format by limiting submissions to a two-page summary instead of requiring a full curriculum vitae.
- Exploring existing templates—it was noted that the Biological Engineers Association has a template that could help define clear award application guidelines.
- Balancing brevity with completeness—while shortening the application packet could make the process easier, there was concern that it might not fully capture the qualifications of an individual or team. A compromise suggested was to limit the total application packet to five pages, with clearly defined key focus areas.

It was mentioned to remind all Panel Chairs that panel recommendations should be reviewed and modified. Panel chairs are asked to provide a brief synopsis of final recommendations at the closing business meeting.

Hardke gave a report of the nominations for the Nominations Committee and Geographical Representatives.

Other business.

There was discussion regarding the time and effort required to host the meeting. For host states with fewer personnel working in rice, this responsibility can become a significant burden. Utilizing an event planning service could help make the process more manageable. Louisiana, for example, was able to leverage personnel from the USA Rice Federation to assist with hotel arrangements and other logistics, which greatly eased the burden of hosting. It was also noted that some states are better positioned to host without outside assistance. As a result, it was suggested that each host state consider the option of using the USA Rice Federation or another event planning service if needed.

Wilson provided an update on the 41st RTWG. After considering three locations—Austin, San Antonio, and Galveston—Galveston was selected due to its cost advantages and scheduling flexibility. Two hotels have been identified along with the Convention Center. While the exact dates have not been finalized, the meeting is targeted for late February 2027.

Meeting was adjourned at 8:24 a.m.

Opening Business Meeting

Secretary Adam Famoso welcomed the membership to the 40th RTWG and to New Orleans, Louisiana.

Famoso recognized meeting sponsors. A presentation roll played throughout the business meeting displaying meeting sponsors and contribution levels.

Chair Jarrod Hardke called the meeting to order at 8:05 a.m. on February 18, 2025, at the Hilton Riverside, New Orleans, Louisiana.

Hardke asked Famoso to read the minutes from RTWG 2023. Tom Allen moved to dispense with the reading of the minutes.

Hardke gave highlights from Opening Executive Committee Meeting. Beginning in 2023, RTWG will be in odd years (e.g., 2023, 2025, 2027).

Hardke read Necrology Report, which included Ned French, Carl Johnson, Gene Reagan, Neil Rutger, Bill Webb, and Ida Wenefrida. Details were provided about the contributions of each to the U.S. rice industry and RTWG. A moment of silence was observed by the membership.

As acting Chair of the Nominations Committee, Famoso announced the following nominations for the 41st RTWG meeting:

Adam Famoso	Chair
Stanley (Omar) Samonte	Secretary
Jarrod Hardke	Past Chair

Geographical Representatives:

Camila Nicolli	Arkansas
Ted Wilson	Texas
Tom Allen	Mississippi
Whitney Brin-Deforest	California
Matthew VanWeelden	Florida
Felipe Dalla Lana	Louisiana
Chase Floyd	Missouri
Sunny Bottoms	Industry

Nominations Committee:

Bob Scott	Arkansas
Fugen Dou	Texas
Tom Allen	Mississippi
Sara Marsh Janish	California
Matthew VanWeelden	Florida
Brijesh Angira	Louisiana
Chase Floyd	Missouri
Sunny Bottoms	Industry

Famoso announced the location of the 2027 41st RTWG hosted by Texas A&M to be held in Galveston in either February 15 or February 22.

Meeting was adjourned at 8:30 a.m.

Closing Executive Committee Meeting

In attendance: Adam Famoso, LSU AgCenter, Chair; Omar Samonte, Texas A&M, secretary; Camila Nicolli, U of A Division of Agriculture; Ted Wilson, Texas A&M; Tom Allen, Mississippi State University; Whitney Brim-Deforest, UC Davis; Matthew VanWeelden, Florida; Felipe Dalla Lana, LSU AgCenter; Chase Floyd, University of

Missouri; Sunny Bottoms, Gowan USA; Michele Reba, USDA-ARS, Kurt Guidry, LSU AgCenter.. Jarrod Hardke, Chair called the meeting to order at 8:03 a.m. on Thursday, February 20, 2025.

Adam Famoso provided report on the program.

- They reported final meeting registration was 333 and final meeting attendance was 320.
- The program included:
  - 49 Student Oral Presentations
  - 42 Student Posters
  - 80 Panel Oral Presentations
  - 55 Panel Posters

Felipe Dalla Lana led a discussion on the student competition. He noted that the most significant challenge has been securing judges for the event. To address this, he suggested adding an option during meeting registration that allows participants to indicate their willingness to serve as a judge and specify the focus areas they feel comfortable evaluating. This would provide the student competition chair with a list of potential judges to contact. There was also discussion regarding students participating in both oral and poster competitions. While this is permissible, the presentations must cover different topics; students should not present the same research in both formats. Additionally, it was suggested that if a student registers to present research, it should be included in the student competition rather than a panel session.

There was discussion about participants leaving before the final day and strategies to encourage them to stay through the end of the meeting. Suggestions included:

- Scheduling higher profile talks later in the program
- Moving the student award presentations to an evening reception

Several ideas were discussed to enhance the upcoming meeting. One suggestion was to include a Quiz Bowl for students, structured as a bracket-style competition. This could feature an All-Star Team of industry personnel and allow students to sign up individually, with teams assigned rather than organized by university or state.

Another proposal was to host a Casino Night as a social event to attract more participants and encourage them to remain longer at the meeting.

Additionally, a Career Fair was suggested to provide students with opportunities to interact with industry professionals and university faculty, ask questions about career paths, and receive guidance.

The group also considered adding an Early Career Award to the existing awards program. This award would recognize individuals five to ten years into their careers or post-graduation, with criteria focused on their potential for long-term industry impact. Considerations would need to account for life circumstances that might affect productivity during this period. It was suggested that an Early Career award be limited in the number of recipients identified for each meeting, with perhaps 1 recipient from industry and one recipient from Research and/ or Extension.

There was further discussion on improving the current award process by shortening application packages, such as setting a maximum page limit, to encourage greater participation.

Logistical topics included requesting the host hotel to offer government rates for federal employees as part of the room block. It was noted that meeting economics are closely tied to participants staying at the host hotel to meet guaranteed room blocks. To support this, a tiered registration fee structure was suggested, offering a reduced rate for attendees who book accommodations at the host hotel.

Meeting was adjourned at 8:55 a.m.

Closing Business Meeting

Chair Jarrod Hardke called the meeting to order at 9:00 a.m. on February 20, 2025, at the Hilton New Orleans Riverside Hotel in New Orleans, LA.

Hardke asked for committee reports. There was no industry report.

Georgia Eizenga provided a written report for the Rice Germplasm Committee.

- Rice Germplasm Committee met Monday, February 17, 2025, at 9:00 a.m.
- Ten current members attended in person, three attended virtually, and four were unable to attend. In addition to the committee members, 16 guests attended in person and 2 attended virtually.
- National Small Grains Collection
    - Current Holdings:
    - 18,720 Oryza sativa accessions (110 countries) + 201 other Oryza species.
    - Recent Additions: 15 new PI assignments (4 U.S. varieties, 11 NERICA accessions).
    - Distribution: Since Feb 1, 2024: 980 seed packets for 74 requests.
- Committee membership approvals included Georgia Eizenga, Omar Samonte, Qiming Shao, and Shane Zhou to serve another six-year term ending in 2031. Will Eubank, agronomist at Mississippi State University Delta Branch Experiment Station (Stoneville, MS) to assume the position previously held by Ed Redoña for a six-year term. Georgia Eizenga re-elected to 2-year term as Committee Chair.
- Meeting adjourned at 12:30 p.m.

Dustin Harrell presented the report from the Rice Acreage Committee.

- Rice Acreage Committee met Monday, February 17, 2025, at 10:30 a.m.
- State reports were given by a representative from each of the seven states.
- Attendees reported on what cultivars were grown in each state in 2022, 2023, and 2024, how the data were collected, new cultivars in each state, and estimates of acreage for 2025.
- Meeting adjourned at 11:59 a.m.

Hardke gave a brief publication report indicating that older proceedings would continue to be added to the RTWG website. The biggest delay in getting additional proceedings posted was having to make them ADA compliant.

Hardke provided a summary of the discussion in the Executive Committee.

Hardke passed the gavel to Famoso as incoming RTWG Chair.

Famoso presented Hardke with a plaque acknowledging his dedication as Chair of the 40th RTWG meeting.

Meeting was adjourned at 9:30.

SPECIAL COMMITTEE REPORTS

Nominations Committee

The Nominations Committee proposed the following individuals for membership on the 2025 RTWG Executive Committee and Nominations Committee:

Executive Committee:

Adam Famoso	Chair
Stanley (Omar) Samonte	Secretary
Jarrod Hardke	Past Chair

Geographical Representatives:

Camila Nicolli	Arkansas
Ted Wilson	Texas
Tom Allen	Mississippi
Whitney Brin-Deforest	California
Matthew VanWeelden	Florida
Felipe Dalla Lana	Louisiana
Chase Floyd	Missouri
Sunny Bottoms	Industry

Nominations Committee:

Bob Scott	Arkansas
Fugen Dou	Texas
Tom Allen	Mississippi
Sara Marsh Janish	California
Matthew VanWeelden	Florida
Brijesh Angira	Louisiana
Chase Floyd	Missouri
Sunny Bottoms	Industry

Rice Crop Germplasm Committee

The 44th Rice Crop Germplasm Committee (CGC) meeting was held in a hybrid format on Monday, February 17, 2025. Members in attendance were Georgia Eizenga (Chair), Brijesh Angira, Stan De Guzman, Teresa De Leon, Yulin Jia, Jack Okamuro, Stanley (Omar) Samonte, Qiming Shao, Gretchen Zaunbrecher and Shane Zhou. Members attending virtually were Bishwo Adhikari, Trevis Huggins and Gary Kinard. Members Nick Bateman, Harold Bockelman, Neha Kothari and Ed Redoña were unable to attend. The 16 guests in attendance were John Carlin, Luis Espino, Will Eubank, Ford Frost, Dustin Harrell, Manoch Kongchum, Frank Maulana, Ann Noble, Kim Nyka Perdiguerra, Kimberly Ponce, Darlene Sanchez, Nirmal Sharma, Shyamal Talukder and Ted Wilson. Guests attending virtually were Melissa Jia and Jai Rohila.

Georgia Eizenga, Rice CGC chair, opened the meeting and noted that the minutes of the 43rd Rice CGC meeting held virtually, were approved via email on May 13, 2024. Of note, the minutes of the Rice CGC committee meetings (1984 to present) are now available at:

https://www.ars-grin.gov/CGC.

Jack Okamuro presented the USDA/ARS Office of National Programs report for Neha Kothari who was hired in November 2024 but unable to attend. He gave the presentation, "The National Plant Germplasm System (NPGS): 2025 Status, Prospects and Challenges". The mission of the NPGS is to support agricultural production by acquiring, conserving, evaluating and characterizing, documenting and distributing germplasm. The NPGS contains over 621,600 accessions with 476,000 available for distribution and represents 16,737 species. Because of the value of the accessions in the NPGS and the fact that the NPGS has been operating on a flat budget when adjusted for inflation, the 2018 Farm Bill directed USDA to develop and implement an assessment to address the significant backlogs in the NPGS. The "NPGS Plan", released in late 2023, is available at

https://www.ars-grin.gov/Pages/NPGS.

An Infographic listing the key elements of the plan and a diagrammatic summary with a 1 to 5-year and 6 to 10-year timeline for implementing the plan also is available on the same website. To promote funding for this NPGS Plan you are encouraged to submit success stories for rice highlighting the importance of rice accessions in the NPGS. Four rice stories are currently included (https://colostate.pressbooks.pub/pgrsuccessstories/). Lastly, the NPGS encourages collaborations/partnerships with the appropriate curator(s) to improve the quality and availability of the collections. When publishing state the "USDA National Plant Germplasm System" as the source of materials, when appropriate.

Gary Kinard, USDA/ARS National Germplasm Resources Laboratory (NGRL), which is comprised of three groups, the 1) Plant Exchange Office, facilitating domestic and international plant exploration and exchange; 2) Database Management Unit (DBMU), responsible for the GRIN-Global database; and 3) Plant Disease Research Unit, focused on pathogens affecting clonal crops. Of concern is the recent loss of IT specialists in the DBMU, going from seven to one IT specialist. Significant improvements and changes to GRIN-Global over the past year were: 1) the Standard Material Transfer Agreement (SMTA) acceptance is not required for non-propagative material as of Jan 1, 2025, 2) the user can exclude GEO (genetically engineered organism) material as part of the advanced search, 3) a GEO acceptance requirement has been added prior to submitting requests for GEO material, 4) the DOI (digital object identifier) field was added at the accession level (not currently used in NPGS but widely used internationally), and 5) the user can select accessions with images as one of the parameters in a descriptor search.

Bishwo Adhikari, USDA/APHIS Plant Germplasm Quarantine Program (PGQP), Team Lead for the *Poaceae* Quarantine Program reported the purpose of the team is to ensure safe importation of rice seeds to prevent exotic fungal and bacterial pathogens from being imported and monitoring the importation of *Oryza* species identified as noxious weeds. In Bishwo's lab, the imported rice seeds are planted in the spring and released to the requestor in the fall or early winter. Tissue from all accessions being imported is sequenced using High-Throughput Sequencing (HTS) for possible pathogen detection. Three people, that were recently hired in Bishwo's group, were affected by the latest "down-sizing" efforts of the new administration. Of the 390 Heat-MAGIC lines imported from the International Rice Research Institute (IRRI) in 2024, 150 lines were grown and tested by Bishwo's team in 2024 and 145 were released to Trevis Huggins. The remaining five lines are being tested further. In 2025, Bishwo's team will plant an additional 75 rice lines in the spring of 2025 and test for any pathogens present. The remaining 75 rice lines were sent to Brandon Wodka, at the University of Arkansas Rosen Center in Fayetteville, AR for grow-out and testing. As on update on endornaviruses, there was additional validation of the RT-PCR test developed a few years ago and it was noted that the endornavirus titer is different at different growth stages. Unlike many other plants, mature rice plants have higher viral titer. To date, there has been no evidence of any plant endornaviruses being pathogenic and a study focused on the functional characterization of the viruses using infectious particles of these viruses was proposed to observe potential disease symptoms.

Shane Zhou briefly shared that the White leaf disease of rice or *Hoja blanca* disease (HBD) caused by the White leaf rice virus or the Rice *Hoja blanca* tenuivirus (RHBV), which affects the leaves of the rice plant by stunting the growth of the plant or killing it altogether was found in the rice ratoon crop in Louisiana and Texas in 2024. The RHBV is found in South America, Mexico, Central America and the Caribbean region. The short discussion focused on the fact that RHBV is seed transmitted, in the late 1950s to 1960s, RHBV was reported in Louisiana and Florida, and a killing frost during the winter months will decrease the incident of HBD.

The report prepared by Harold Bockelman, Curator (retired) for the National Small Grains Collection (NSGC) was presented by Trevis Huggins, USDA/ARS Dale Bumpers National Rice Research Center (DBNRRC). Harold reported there are currently 18,720 *Oryza sativa* accessions originating from 110 countries, not including the USA, available for distribution and 201 other *Oryza* species accessions. In the past year, 15 new PI assignments were made for four recently released varieties developed by Louisiana (3) and Texas (1), and 11 NERICA (New Rice for Africa) accessions imported from AfricaRice (Cote D'Ivoire). Since Feb. 1, 2024, NSGC has distributed 980 seed packets (accessions) as part of 74 separate seed requests.

Trevis Huggins, USDA/ARS Dale Bumpers National Rice Research Center (DBNRRC) reported that the Genetic Stocks-*Oryza* (GSOR) collection currently holds 32,177 accessions. The Nipponbare TILLING mutants of (approx. 6,000 accessions) were returned to the donor because their inventory was exhausted. The *Tropical japonica* core (TRJ Core) collection of approximately 530 accessions will be available in late 2025. (Currently, the publication is being drafted.) Four new germplasm lines were donated to GSOR, Eclipse, a semi-dwarf, medium-grain Calrose with low amylose content and blast resistance and three lines selected from a Cybonnet x Saber RIL population with blast resistance and quality like the parents. From 2024 to present, GSOR shipped 7,688 seed packets to fulfill 82 requests with 64 being shipped to U.S. requestors.

The "Rice Crop Vulnerability" slide was shared with the committee for review. No updates were suggested at the meeting. It will be circulated again when these minutes are sent for approval. (This was done and there were a few revisions which Georgia incorporated).

Votes regarding committee membership included:

1) A motion by Gretchen Zaunbrecher to have Georgia Eizenga, Omar Samonte, Qiming Shao and Shane Zhou serve another six-year term, ending in 2031, was seconded by Teresa De Leon and Stan De Guzman and supported by the committee membership.

2) A motion by Stan De Guzman to have Will Eubank, agronomist at the Mississippi State Univ. Delta Branch Experiment Station in Stoneville, MS, assume the vice Ed Redoña position on the committee for a six-year term, was seconded by Qiming Shao and supported by the committee membership.

3) A motion by Teresa De Leon for Georgia to serve a 2-year term as committee chair. This was seconded by Omar Samonte and Bishwo Adhikari which was subsequently supported by the committee membership.

A motion by Georgia to adjourn the 44th Rice Crop Germplasm Committee meeting. This motion was seconded by Trevis Huggins and supported by the committee membership. The meeting adjourned at 10:35 am.

Rice Germplasm Committee members as of February 17, 2025 business meeting with year term ends in parenthesis

Dr. Georgia Eizenga, Chair (2031)
USDA-ARS Dale Bumpers National Rice Research Center
2890 Hwy 130 E
Stuttgart, AR 72160
Georgia.Eizenga@usda.gov

Dr. Nick Bateman (2029)
Rice Research and Extension Center
University of Arkansas
2900 Hwy 130 E
Stuttgart, AR 72160
nbateman@uaex.edu

Dr. Teresa De Leon (2027)
California Cooperative Rice Research Foundation
P. O. Box 306
955 Butte City Highway (Hwy. 162)
Biggs, CA 95917-0306
tdeleon@crrf.org

Dr. Stanley (Omar) Samonte (2031)
Texas A&M AgriLife Research Center
1509 Aggie Drive
Beaumont, TX 77713
stanley.samonte@ag.tamu.edu

Dr. Gretchen Zaunbrecher (2029)
California Cooperative Rice Research Foundation
P. O. Box 306
955 Butte City Highway (Hwy. 162)
Biggs, CA 95917-0306
gzaunbrecher@ccrf.org

Dr. Brijesh Angira (2029)
H. Rouse Caffey Rice Research Station
Louisiana State University Agricultural Center
1373 Caffey Road
Rayne, LA 70578
bangira@agcenter.lsu.edu

Dr. Christian (Stan) De Guzman (2027)
Rice Research and Extension Center
University of Arkansas
2900 Hwy. 130 E
Stuttgart, AR 72160
deguzma@uark.edu

Dr. Will Eubank (2031)
Delta Branch Experiment Station
Mississippi State University
82 Stoneville Rd.
P.O. Box 197
Stoneville, MS 38776
twe34@msstate.edu

Dr. Qiming Shao (2031)
Nutrien Ag Solutions
676 County Rd. 324
El Campo, TX 77437
qiming.shao@nutrien.com

Dr. Xin-Gen (Shane) Zhou (2031)
Texas A&M AgriLife Research Center
1509 Aggie Drive
Beaumont, TX 77713
xzhou@aesrg.tamu.edu

Dr. Bishwo Adhikari, Ex-officio
Lead Plant Pathologist & Program Manager
Poacceae Quarantine Program
USDA-APHIS
Plant Germplasm Quarantine Program
Bldg. 580, BARC-East
Beltville, MD 20705
bishwo.n.adhikari@usda.gov

Dr. Harold Bockelman, Ex-officio
Curator (Retired), NSGC
USDA-ARS
1691 S 2700 W
Aberdeen, ID 83210
harold.bockelman@usda.gov

Dr. Trevis D. Huggins, Ex-officio
Curator GSOR
USDA-ARS Dale Bumpers National Rice Research Center
2890 Hwy 130 E
Stuttgart, AR 72160
trevis.huggins@usda.gov

Dr. Yulin Jia, Ex-officio
Research Leader/Center Director
USDA-ARS Dale Bumpers National Rice Research Center
2890 Hwy 130 E
Stuttgart, AR 72160
yulin.jia@usda.gov

Dr. Gary Kinard, Ex-officio
Research Leader
USDA-ARS
National Germplasm Resources Laboratory
10300 Baltimore Avenue
Beltsville, MD 20705
gary.kinard@usda.gov

Dr. Neha Kothari, Ex-officio
USDA-ARS, NPS
National Program Leader, Plant Genetic Resources, Genomics, & Genetic Improvement
1111 South Mason St.
Fort Collins, CO 80521
neha.kothari@usda.gov

Dr. Jack Okamuro, Ex-officio
USDA-ARS, NPS
National Program Leader, Plant Biology
5601 Sunnyside Avenue
Beltsville, MD 20705-5139
jack.okamura@usda.gov

Publication Coordinator /Panel Chair Committee

Publication Coordinator Kurt Guidry communicated by email with the panel chairs before the 2025 RTWG meeting concerning publication of panel attendance, recommendations, and abstracts in the RTWG proceedings. Timely submissions, editorial review by chairs, and quality of abstracts were stressed for the proceedings. All changes in operating procedures will be incorporated in the RTWG guidelines for preparation of abstracts in the 2027 proceedings. Proceedings will be made available in electronic format on the RTWG web page when finalized.

Submitted by
Kurt Guidry

Rice Variety Acreage Committee

The 43rd meeting of the Rice Technical Working Group (RTWG) Acreage Committee was called to order by Dustin Harrell at 10:30 p.m. on February 17, 2025, in the Warwick Room of the New Orleans Riverside Hilton in New Orleans, Louisiana.

In attendance were committee members: Jarrod Hardke, University of Arkansas; Dustin Harrell of California Cooperative Rice Research Foundation; Ron Levy of Louisiana State University AgCenter; Will Eubank of Mississippi State University; Ted Wilson of Texas A&M Agrilife, Matthew Van Weelden of University of Florida, and Chase Floyd of University of Missouri. Guests in attendance included Justin Chlapecka of UADA, Steve Linscombe of USA Rice, Manoch Kongchum of LSU AgCenter, Adam Famoso of LSU AgCenter, Randy Ouzts of Nutrien Ag, Ford Frost (Rice Farmer in Texas), Luis Espino with UC Cooperative Extension, and John Goldberg with USA Rice.

Harrell distributed and presented the minutes of the February 20, 2023, Acreage Committee meeting and asked for a motion to accept. The motion was moved by Ron Levy and seconded by Jarrod Hardke. The motion carried.

The Arkansas report for rice acres in 2023 and 2024 was given by Jarrod Hardke. Rice acres in Arkansas generally cycle from low acres one year to increased acres the next year. However, in 2023 and 2024 acres increased in both years. In 2023 three hybrids made up the bulk of the year with XP753 representing 12% of the total acreage. The medium grain Titan represented 5.8% of the acreage. DG263L represented the highest acreage of conventional long grains. In 2024, FullPage hybrids represented 25% of the state-wide acreage. Total hybrid acreage for the state generally represents about 65% of the Arkansas rice market however, due to limited seed availability, hybrid acreage ran about 58% over the last two years and is expected to be even lower in 2025. Acreage in 2025 is predicted to be between 1.2 to 1.4 million acres. Furrow irrigated rice now represents about 15-20% of all Arkansas rice acres. The newest medium grain release in Arkansas is CLM05 and a new Provisia variety is expected to be released in 2026.

The Louisiana report for 2023 and 2024 was given by Ron Levy. Rice acreage determinations in Louisia are compiled by taking AgCenter County Agent surveys and information provided by seed sales. Rice acres in 2023 and 2024 were approximately 461,371 and 459,690, respectively. In 2023, PVL03 represented 25% of the total acreage followed by Jupiter (10%), RT7321 FP (6%), Cheniere (6%), DG263L (6%), XP753 (5%), and Titan (5%). In 2024, the highes acreage rice varieties and hybrids included PVL03 (31.6%), CLL19 (12.1%), DG263L (7.8%), Avant (7.4%), and Titan (5.4%). Notable trends observed in the last couple years included Dermacor X100 losing some efficacy for rice water weevils in Louisiana, smut becoming more prevalent and causing yield losses of 15-20%, increased incidence of Cercospora, 80-90% ratooning in the south, and crawfish acres increasing over 400,000. New varieties include Fitzgerald (Jasmine type), CLHA03, and Venus (medium grain).

The California report was presented by Dustin Harrell. He reported that the California estimates are based on foundation seed sales and acres enrolled in the California Crop Improvement Association's registered and certified seed production program. In 2023, approximately 514,000 acres were planted. Medium grain accounted for 485,000 acres, short grain 18,000 acres, and long grain 11,000 acres. M-206 and M-211 were the two most widely grown varieties. In 2024, approximately 488,000 acres were grown. Medium grain accounted for 460,000 acres, short grain 20,000 acres, and long grain 8,000 acres. M-206 and M-211 were the most widely grown varieties. New varieties include the release of M-521 in 2023 which is the first ROXY medium grain variety and Calhikari-203 a new premium quality short grain. In 2025, AM-201, an aromatic Calrose type medium grain variety and Calamore-201, an arborio type rice, was released. It was noted that M-211 is the highest yielding Calrose variety and is increasing in acreage quickly while M-26 is acreage is declining quickly. M-211 is more susceptible to poor milling when harvested at low grain moisture. The hope is to replace M-211 in the next few years with a more stable milling variety that has a similar yield potential.

The Missouri report was presented by Chase Floyd. Rice acreage in Missouri was approximately 149,000 and 200,000 acres in 2023 and 2024, respectively. Approximately 65 percent of the acreage was hybrids. Long grains represented 97 percent of the total acreage. The most commonly grown varieties and hybrids were 7521, 7421, 7321, Ozark and CLL18.

The Texas report was presented by Ted Wilson. Data was determined by a survey respondents and USDA-FSA certified acres. Texas planted rice acres for 2023 and 2024 were approximately 145,606 and 144,722 acres, respectively. The lower acreage over the last couple years were due to drought and water availability. Approximately 42 to 60 percent of the rice acres planted in Texas were hybrids over the last couple years. There was approximately 25,000 acres of hybrid seed rice production in 2024 and approximately 40,000 acres of hybrid seed production expected in 2025.

The Mississippi report was given by Will Eubank. The rice acres were approximately 120,724 and 152,028 in 2023 and 2024, respectively. The rice acreage in 2025 is projected to increase to around 200,000. Approximately 80 percent of the planted rice each year were hybrids. Approximately 30 percent of the acreage is grown using furrow irrigation.

The Florida report was given by Matthew Van Weelden. Crop consultants with the Florida Crystals provided the estimates. 2023 and 2024 acres were approximately 19,279 and 24,454, respectively. The variety Diamond represented 42 percent of the acreage. Hybrids represented approximately 8 percent of the acreage in 2023 and 2% in 2024.

Following the state reports, a discussion on grain quality was led by Dr. Steve Linscombe. It was pointed out that one major area that contributes to reduced quality is the co-mingling of over 30 rice varieties and hybrids into southern long grain contributes to the problem since many of the cultivars are not consistent with their physical, chemical, and cooking characteristics.

There being no further business, a motion to adjourn was passed and the meeting was adjourned at 11:59 a.m.

Submitted by
Dustin Harrell

Industry Committee

The Rice Technical Working Group (RTWG) Industry Committee hosted a successful luncheon during the 40th RTWG meeting in New Orleans, Louisiana, on Tuesday, February 18, 2025. The purpose of the Industry Committee luncheon is to enhance the meeting experience in several ways. First, it strengthens the cohesiveness of the committee by allowing members to become better acquainted with one another. Since the luncheon is open to all RTWG attendees, it naturally encourages interaction between industry representatives and public-sector researchers. Additionally, it provides an opportunity for an invited speaker to share timely insights with the RTWG membership.

The 2025 Industry luncheon met all these goals. Approximately 270 guests attended and heard Mr. Bobby Hanks, CEO of Supreme Rice LLC, speak on “Challenges in International Rice Trade.” Mr. Hanks discussed factors affecting the competitiveness of U.S. rice in international markets and explained how imports and exports influence domestic rice prices. His presentation offered a perspective on rice competitiveness and profitability that many involved in rice research and education may not typically encounter. Having current and future rice researchers in attendance for Mr. Hanks’ talk was a rewarding experience for all.

The Industry Committee extends its gratitude to Dr. Jarrod Hardke and Dr. Adam Famoso for their assistance in coordinating the luncheon. The committee looks forward to hosting the next luncheon at the 41st RTWG meeting, which will be held in Texas in 2027.

Submitted by
Mallory Scott

2023 Arkansas Harvested[1] Rice Acreage Summary

			MEDIUM GRAIN			LONG GRAIN						
COUNTY/PARISH	**2022 Acreage**	**2023 Acreage**	**Jupiter**	**Titan**	**Others[2]**	**CLL16**	**DG263L**	**RT 7321 FP**	**RT 7421 FP**	**RT 7521 FP**	**RT XP753**	**Others[2]**
Arkansas	65,448	70,789	1,050	158	1,590	2,863	4,064	9,590	9,778	25,059	6,761	9,876
Ashley	4,563	8,305	0	0	0	0	0	4,146	0	4,160	0	0
Chicot	18,186	27,299	305	305	0	0	611	106	0	909	13,684	11,379
Clay	62,298	71,081	3,790	1,555	0	7,307	6,148	11,809	5,006	10,878	13,567	11,020
Craighead	50,276	62,733	9,437	0	0	2,944	13,123	11,683	394	6,520	8,876	9,755
Crittenden	29,139	41,762	0	0	2,719	1,639	8,533	4,524	2,904	5,008	12,427	4,008
Cross	54,413	90,053	11,325	7,908	9,192	1,370	2,176	15,989	2,768	25,917	7,001	6,407
Desha	18,447	27,513	0	2,378	0	11	390	7,532	0	3,948	1,286	11,968
Drew	10,267	13,380	523	523	0	0	0	805	0	8,123	1,770	1,636
Greene	55,281	67,612	1,399	3,964	0	7,424	5,023	3,768	0	4,075	6,279	35,679
Independence	8,904	12,396	224	448	2,395	2,352	0	2,138	0	540	1,557	2,741
Jackson	84,101	112,566	5,614	8,450	17,395	4,308	3,658	19,301	5,573	18,106	8,066	22,096
Jefferson	54,861	67,254	1,238	3,376	0	4,084	10,238	18,466	0	13,731	17	16,104
Lafayette	5,439	5,552	0	0	0	389	389	0	0	1,665	333	2,776
Lawrence	75,582	104,302	2,864	20,121	823	1,377	4,474	9,877	0	7,391	32,836	24,538
Lee	12,749	18,938	463	1,251	0	0	2,666	4,738	450	5,452	2,056	1,863
Lincoln	20,060	30,112	5,682	0	0	0	1,245	7,771	1,176	11,788	1,960	490
Lonoke	84,168	86,562	7,393	0	2,856	2,959	508	0	16,722	30,354	10,307	15,462
Miller	6,216	8,225	1,295	1,295	0	394	394	0	0	1,690	338	2,817
Mississippi	43,194	64,865	702	702	0	1,490	3,368	18,118	8,942	16,623	13,650	1,269
Monroe	40,834	53,611	0	0	7,878	3,989	7,326	2,321	6,674	11,725	6,932	6,765
Phillips	19,955	33,306	0	2,632	0	0	6,489	7,626	0	10,885	0	5,674
Poinsett	81,464	107,482	1,265	8,466	11,560	11,920	13,099	7,870	2,509	20,412	2,864	27,517
Prairie	50,771	56,930	794	1,309	1,011	1,682	5,730	11,487	8,265	14,844	6,971	4,837
Randolph	28,629	40,153	0	10,697	1,465	0	2,739	4,454	1,073	2,388	7,001	10,335
St. Francis	26,630	34,553	373	1,395	13	399	5,745	7,577	90	7,772	4,042	7,147
White	6,086	8,303	245	0	0	230	0	3,234	0	3,403	851	340
Woodruff	46,662	65,229	1,806	3,612	0	0	5,297	11,509	12,807	24,449	0	5,749
Others[3]	17,871	20,810	1,243	1,243	0	1,273	1,340	827	438	3,250	2,482	8,715
Unaccounted[4]	1,505	5,327										5,327
2023 Total		1,417,000	59,028	81,787	58,897	60,404	114,775	207,266	85,571	301,065	173,915	274,291
2023 Percent		100.00	4.17	5.77	4.16	4.26	8.10	14.63	6.04	21.25	12.27	19.36
2022 Total	1,084,000		49,146	29,702	11,088	53,560	117,623	158,421	0	322,737	193,247	148,476
2022 Percent	100.00		4.53	2.74	1.02	4.94	10.85	14.61	0.0	29.77	17.83	13.70

[1] Harvested acreage. Source: USDA – NASS, 2024.

[2] Other varieties: AddiJo, ARoma17, ARoma22, CLL17, CLL18, CLM04, Diamond, Lynx, Ozark, ProGold1, ProGold2, PVL03, RTv7231MA, RT7301, RT7302, RT7331MA, RT7401, RT7801, Taurus

[3] Other counties: Clark, Conway, Faulkner, Franklin, Hot Springs, Johnson, Little Rive, Logan, Perry, Pope, Pulaski, and Yell.

[4] Unaccounted for acres is the total difference between USDA-NASS harvested acreage estimates and estimates obtained from each county FSA.

2024 Arkansas Harvested[1] Rice Acreage Summary

			MEDIUM GRAIN			LONG GRAIN						
COUNTY/PARISH	2023 Acreage	2024 Acreage	Taurus	Titan	Others[2]	DG263L	Ozark	RT 7302	RT 7421 FP	RT 7521 FP	RT XP753	Others[2]
Arkansas	70,789	83,436	1,621	194	1,351	8,729	5,408	8,244	7,387	35,694	5,544	9,264
Ashley	8,305	13,338	0	3,230	0	38	3,778	302	2,569	2,516	0	907
Chicot	27,299	26,923	141	422	0	1,578	1,038	4,398	0	4,259	1,076	14,012
Clay	71,081	71,377	0	4,172	0	19,979	0	1,075	7,931	14,967	5,388	17,865
Craighead	62,733	60,253	2,382	0	2,447	7,202	4,511	780	5,933	8,477	5,436	23,085
Crittenden	41,762	50,022	0	0	2,105	9,025	1,301	5,003	1,403	8,812	15,844	6,529
Cross	90,053	81,004	2,924	7,629	1,246	3,566	9,652	2,173	5,068	28,207	4,830	15,710
Desha	27,513	34,176	0	150	0	3,505	4,926	1,117	9,197	6,854	4	8,423
Drew	13,380	10,231	0	0	0	205	307	2,169	935	4,147	1,335	1,134
Greene	67,612	71,868	0	1,407	1,103	3,022	6,021	11,874	4,924	0	15,804	27,713
Independence	12,396	13,638	504	504	432	0	3,337	506	4,810	0	0	3,546
Jackson	112,566	113,757	7,670	4,214	8,055	5,876	5,556	3,259	8,343	26,844	5,826	38,113
Jefferson	67,254	72,224	533	355	889	8,928	3,434	8,931	2,077	33,273	2,522	11,282
Lafayette	5,552	6,020	0	0	0	963	60	421	482	1,264	1,505	1,324
Lawrence	104,302	101,044	10,503	3,458	2,690	18,589	6,776	5,842	9,879	4,160	17,306	21,840
Lee	18,938	22,006	0	0	397	6,582	160	2,225	224	10,634	902	882
Lincoln	30,112	27,858	2,093	449	598	1,456	2,700	291	0	6,235	0	14,036
Lonoke	86,562	82,547	899	0	3,101	13,228	0	7,977	6,384	28,160	9,887	12,912
Miller	8,225	9,448	0	0	0	1,512	94	661	756	1,984	2,362	2,079
Mississippi	64,865	63,107	63	0	303	2,453	1,521	875	12,488	23,950	10,651	10,803
Monroe	53,611	47,693	0	0	1,224	7,922	3,340	4,450	4,070	12,685	4,450	9,553
Phillips	33,306	39,990	0	0	100	10,421	4,463	4,152	8,990	4,743	1,349	5,771
Poinsett	107,482	111,959	7,991	537	2,722	7,391	11,395	396	7,938	19,730	5,455	48,405
Prairie	56,930	58,192	484	801	238	9,144	1,792	5,187	4,027	18,196	6,807	11,517
Randolph	40,153	39,098	5,724	3,650	420	4,109	179	11,099	402	1,072	5,427	7,017
St. Francis	34,553	38,808	570	0	0	6,160	2,847	561	1,308	14,505	5,580	7,277
White	8,303	6,856	120	0	0	0	0	0	848	4,687	848	353
Woodruff	65,229	56,048	407	0	1,057	5,787	0	0	10,437	29,130	3,160	6,071
Others[3]	20,810	17,275	0	0	385	1,424	6,450	153	229	1,670	1,653	5,311
Unaccounted[4]	5,327	1,804										1,804
2024 Total		1,432,000	44,630	31,171	30,863	168,791	91,046	94,119	129,038	356,855	140,950	344,536
2024 Percent		100.00	3.12	2.18	2.16	11.79	6.36	6.57	9.01	24.92	9.84	24.06
2023 Total	1,417,000		1,524	81,787	116,402	114,775	10,883	10,840	85,571	301,065	173,915	520,238
2023 Percent	100.00		0.11	5.77	8.21	8.10	0.77	0.77	6.04	21.25	12.27	36.71

[1] Harvested acreage. Source: USDA – NASS, 2025.

[2] Other varieties: AddiJo, ARoma17, ARoma22, CLL16, CLM04, Diamond, ProGold1, ProGold2, PVL03, PVL04, RTv7231MA, RTv7303, RT7301, RT7331MA, RT7401, RT7801, RT7801

[3] Other counties: Clark, Conway, Faulkner, Franklin, Hot Springs, Johnson, Little Rive, Logan, Perry, Pope, Pulaski, and Yell.

[4] Unaccounted for acres is the total difference between USDA-NASS harvested acreage estimates and estimates obtained from each county FSA.

2023 and 2024 California Rice Acreage Summary

	2023			2024		
Variety	Seed Acres[1]	Percentage	Estimated Acres[2]	Seed Acres[1]	Percentage	Estimated Acres[2]
Medium Grain						
M-105	3,162	13	63,416	3,492	17	76,544
M-206	7,634	32	153,102	5,583	27	122,436
M-209	3,670	15	73,596	3,431	16	75,197
M-210	2,851	12	57,184	3,003	14	65,820
M-211	4,553	19	91,306	3,980	19	87,233
M-401	1,366	6	27,396	885	4	19,394
M-521	12	0	530	8	<0.1	124
Total RES-Medium	23,248	96	466,249	20,381	97	446,747
Non-RES Medium	935	4	18,751	605	3	13,253
Total Medium Grain	24,183	100	485,000	20,986	100	460,000
Short Grain						
Calamylow-201	78	3	471	68	3	577
Calhikari-201	51	2	305	66	3	562
Calhikari-202	280	9	1,687	206	9	1,742
Calhikari-203	87	3	524	95	4	804
Calmochi-101	188	6	1,131	17	1	143
Calmochi-203	919	31	5,531	896	38	7,582
S-102	238	8	1,436	238	10	2,015
S-202	18	1	107	-	-	-
Total RES -Short	1,859	62	11,190	1,586	67	13,424
Non-RES Short	1,131	38	6,810	777	33	6,576
Total Short Grain	2,990	100	18,000	2,363	100	20,000
Long Grain						
A-201	78	12	1,329	37	6	455
A-202	133	21	2,272	229	35	2,819
Calaroma-201	219	34	3,735	233	36	2,865
Calmati-202	-	-	-	20	3	241
L-205	62	10	1,057	-	-	-
L-207	89	14	1,514	87	13	1,074
L-208	19	3	328	19	3	228
Total RES -Long	600	93	10,235	625	96	7,683
Non-RES Long	45	7	765	26	4	317
Total Long Grain	645	100	11,000	651	100	8,000
USDA-NASS Acres						
Medium			485,000			460,000
Short			18,000			20,000
Long			11,000			8,000
TOTAL			514,000			488,000

[1] Seed acres represent the number of approved seed acres in the California Crop Improvement seed certification seed program.

[2] Estimated acres were determined by using the percent acres in seed production and the total reported USDA-NASS acres

2023 and 2024 Florida Rice Acreage Summary

	2023		2024	
Variety	Acreage	Percentage	Acreage	Percentage
Medium Grain				
Titan	1,387	7	1,816	7
Total Medium Grain	1,387	7	1,816	7
Long Grain				
Cheniere	1,760	9	1,048	4
DG263L	330	2	658	3
Diamond	6,115	32	10,363	42
Jewel	8,140	42	10,178	42
RT7323	137	1	108	<1
RT7401	34	<1	108	<1
XP754	1,376	7	175	1
Total Long Grain	17,892	93	22,638	93
TOTAL	19,279		24,454	

2023 and 2024 Louisiana Rice Acreage Summary

2023				2024		
Variety	Acres	Percentage		Variety	Acres	Percentage
Long Grain				Long Grain		
Addi Jo	372	0.08%		Addi Jo	185	0.04%
Avant	5,071	1.10%		Avant	34,022	7.42%
Cheinere	29,558	6.41%		Cheinere	19,481	4.25%
DG 263L	29,192	6.33%		DG 263L	35,990	7.85%
Diamond	490	0.11%		Diamond	0	0.00%
Mermentau	16,154	3.50%		Mermentau	5,463	1.19%
CL 151	5,028	1.09%		CL 151	0	0.00%
CL111	5,897	1.28%		CL111	4,926	1.07%
CL153	2,442	0.53%		CL153	0	0.00%
CLL16	12,750	2.76%		CLL16	5,715	1.25%
CLL17	8,299	1.80%		CLL17	0	0.00%
CLL18	490	0.11%		CLL18	3,982	0.87%
CLL19	155	0.03%		CLL19	55,546	12.11%
PVL03	114,587	24.84%		PVL03	145,070	31.63%
CLJ01	12,040	2.61%		CLJ01	1,955	0.43%
Della2	11	0.00%		Della2	0	0.00%
Jazzman	5,944	1.29%		Jazzman	1,075	0.23%
RT7301	4,601	1.00%		RT7301	787	0.17%
RT7321	29,783	6.46%		RT7321	12,443	2.71%
RT7331 MA	6,715	1.46%		RT7331 MA	3,631	0.79%
RT7401	8,940	1.94%		RT7401	911	0.20%
RT7421	9,099	1.97%		RT7421	14,305	3.12%
RT7501	640	0.14%		RT7501	316	0.07%
RT7521	21,601	4.68%		RT7521	23,751	5.18%
RT7523	22,619	4.90%		RT7523	11,027	2.40%
RTv7231 MA	3,847	0.83%		RTv7231 MA	8,580	1.87%
XP753	23,453	5.08%		XP753	15,482	3.38%
Any Other LG	6,475	1.40%		Any Other LG	11,518	2.51%
Total Long Grain	386,253	83.72%		Total Long Grain	416,161	90.74%
Medium Grain				Medium Grain		
CLM04	5,334	1.16%		CLM04	5,706	1.24%
Jupiter	46,215	10.02%		Jupiter	13,175	2.87%
Titan	23,571	5.11%		Titan	23,571	5.14%
Total Medium Grain	75,120	16.28%		Total Medium Grain	42,452	9.26%
Total Rice	461,373	100.00%		Total Rice	458,613	100.00%

2023 and 2024 Mississippi Rice Acreage Summary

Rice Acreage by County

County	2023	2024
Bolivar	25,100	38,318
Coahoma	9,440	9,144
Desoto	1,887	3,052
Grenada	623	400
Holmes	417	850
Humphreys	2,821	4,600
Issaquena	0	563
Leflore	6,750	9,256
Panola	6289	7445
Quitman	9,736	13,567
Sunflower	12,100	15,408
Tallahatchie	6,460	9247
Tate	801	839
Tunica	31,807	28,610
Washington	4,470	8296
Yazoo	0	409
Total	120,724	152,028

Rice Acreage by Variety

Variety	2023	2024	Proj. 2025
RiceTec			
Conventional	35,000	41,000	48,000
XP 753	24,500	28,400	
RT 7501	7,900	8,200	
RT 7401	2,600	4,400	
Hybrids	55,000	58,000	67,000
RT 7521 FP	38,500	40,000	
RT 7321 FP	12,350	9,600	
RT 7421 FP	3,850	4,300	
RT 7523 FP	1,000	3,100	
MaxAce	5,000	2,000	1,500
RT 7331 MA	3,750	1,500	
RTv 7231 MA	1,250	500	
Dynagro	13,000	32600	55,000
DG263L	13,000	22,000	
DG245L	-	8,000	
Other	-	3,600	
Horizon	12,000	20,000	28,000
CLL18	7,800	9,500	
CLL16	3,650	6,250	
CLL19	-	3,250	
Others	550	1,000	

2023 and 2024 Missouri Rice Acreage Summary

	2023		2024	
Variety	**Percentage**	**Acres**	**Percentage**	**Acres**
Long Grain	96.8	194,113	97.7	213,963
Hybrids	68.0	136,313	65.0	142,350
Conventional				
XP753	16.3	32,715	13.1	28,689
RT7401	3.4	6,816	1.0	2,190
RT7301	1.4	2,726	1.4	2,978
RT7302	0.7		5.4	11,826
FullPage				
RT7221 FP	0.7	1,363	0.7	1,489
RT7321 FP	21.1	42,257	6.1	13,359
RT7421 FP	12.2	24,536	13.9	30,441
RT7521 FP	9.5	19,084	20.1	44,019
RT7523 FP	1.4	2,726	1.4	2,978
MaxAce				
RT7331 MA	0.7	1,363	1.2	2,628
Varieties	28.8	57,733	32.7	71,613
Conventional	18.9	37,933	23.4	51,183
DG263L	17.0	34,118	15.6	34,118
Diamond	1.4	2,800	0.9	2,000
Ozark			3.4	7,446
Others	0.5	1,015	3.5	7,619
Clearfield	6.5	12,984	5.9	12,984
CLL15	-	-	-	-
CLL16	5.3	10,655	2.1	10,655
CLL17	0.3	537	0.3	537
CLL18	0.7	1,401	3.9	1,401
CL111	0.1	129	0.1	129
CL151	0.1	262	0.1	262
CL153	-	-	-	-
CL163	-	-	-	-
CLHA02	-	-	-	-
Provisia/MA	1.5	3,007	1.5	3,285
PVL02	-	-	-	-
PVL03	0.6	1,228	0.6	1,228
RTv7231 MA	0.9	1,779	0.9	2,057
Specialty	1.9	3,809	1.9	4,161
Jazzman-2	1.8	3,671	2.0	4,023
CLJ01	0.1	138	0.1	138
Medium Grain	3.2	6,344	2.3	5,000
Jupiter	1.8	3,608	0.9	1,971
CLM04	0.7	1,354	0.5	1,200
Titan	0.6	1,162	0.2	500
DG353M	0.1	220	0.1	220
Taurus			0.5	1,009
Total Acreage	100.0	194,000	100.0	149,000

2023 Texas Rice Acreage by Variety Summary

COUNTY	2022 Acreage	2023 Acreage[1]	Acreage Change	% MC Ratooned	RT7321 FP	XL723	CL153	RT7523 FP	Cheniere	CLL17	XL753	RT7521 FP	RT7421 FP	CL151
					LONG GRAIN									
East Zone														
Brazoria	16,172	14,063	-13.00%											
Chambers	27,514	25,510	-7.30%	0							11		11	
Galveston	1,653	856	-48.20%											
Hardin	642	471	-26.60%											
Jefferson	26,916	22,028	-18.20%	10				24.7	39.8	23.3				
Liberty	7,510	6,740	-10.30%	58	65								10	
Orange														
East Total	80,407	69,668	-13.40%	11	8.1			10	16.2	9.5	5.2		6.4	
Northwest Zone														
Austin	1,341	1,449	8.10%	50			100							
Colorado	36,990	23,137	-37.50%	62	50.4	15		20.2				12.6		
Fort Bend	1,995	2,141	7.30%	70	100									
Harris	73	73	0.00%											
Lavaca	3,668	3,625	-1.20%	41		23.4	34.4							
Robertson														
Waller	3,808	3,578	-6.00%	92	30.4		5.9	7.4			30.1	2.7		
Wharton	39,176	23,516	-40.00%	80	25.2		30.1	5.9			2.7	7.2		18.9
Lanar														
Brazos	58	46	-20.70%											
Northwest Total	87,109	57,565	-33.90%	70	36.3	7.5	17.4	11			3	8.2		7.7
Southwest Zone														
Calhoun	4,220	4,338	2.80%											
Jackson	8,902	9,583	7.60%	83		68.3	22.3							
Matagorda	9,643	2,390	-75.20%	20					100					
Victoria	1,272	1,255	-1.30%	100										
Cameron		2												
Southwest Total	24,038	17,568	-26.90%	73		58.5	19.1		3.2					
Northeast Zone														
Bowie	95	804	746.30%	0										
Hopkins														
Red River														
Northeast Total	95	804	746.30%	0										
State Total	191,648	145,606	-24.00%	44	18.2	10	9.2	9.2	8.1	4.5	3.6	3.2	3.1	3.1

[1] Acreage Source: USDA/CFSA Certified Acreage

Source: Wilson, L.T., B. Morace, J. Wang, K. Leon, J.L. Korenek, and Y. Yang, 2024, Texas Rice Crop Survey (http://beaumont.tamu.edu/CropSurvey)

2023 Texas Rice Acreage by Variety Summary (Continued)

	LONG GRAIN										MEDIUM GRAIN	
COUNTY	**PVL03**	**Presidio**	**Jazzman**	**XL7401**	**RTLG**	**RT7331 MA**	**CLM04**	**DG263L**	**RTv7231 MA**	**Ozark**	**Jupiter**	**Other**
East Zone												
Brazoria												
Chambers			6.4								71.6	
Galveston												
Hardin												
Jefferson	12.1											
Liberty							10				15	
Orange												
East Total	4.9		3				1.2				35.5	
Northwest Zone												
Austin												
Colorado				1.8								
Fort Bend												
Harris												
Lavaca					42.2							
Robertson												
Waller						21.2			2.3			
Wharton	2.7			3.5		1.4						2.4
Lanar												
Brazos												
Northwest Total	1.1			2.2	2.7	1.9			0.1			1
Southwest Zone												
Calhoun												
Jackson		4.7		4.6								
Matagorda												
Victoria		100										
Cameron												
Southwest Total		15.3		3.9								
Northeast Zone												
Bowie								90.3		9.7		
Hopkins												
Red River												
Northeast Total								90.3		9.7		
State Total	2.8	1.8	1.4	1.3	1.1	0.7	0.6	0.5	0.1	0.1	17	0.4

Source: Wilson, L.T., B. Morace, J. Wang, K. Leon, J.L. Korenek, and Y. Yang, 2024, Texas Rice Crop Survey (http://beaumont.tamu.edu/CropSurvey)

2023 Texas Main Crop Combined Yields by Variety

		2023						2022					
Variety	Variety Type	Number of Fields Reported	Reported Acreage	Yield lbs./Acre	Milling Yield (%H)	Milling Yield (%T)	Grade	Number of Fields Reported	Reported Acreage	Yield lbs./Acre	Milling Yield (%H)	Milling Yield (%T)	Grade
RT7321FP	Hybrid	99	10,277	8,860	49.6	70.1	2.0	120	13,125	8,405	53.0	70.7	2.0
CL153	Inbred	53	5,118	7,402	55.8	69.3	2.0	43	3,981	7,234	57.3	69.7	2.1
XP753	Hybrid	48	3,371	8,833	52.1	70.8	2.0	64	7,123	7,371	54.0	70.4	2.0
RT7331MA	Hybrid	27	2,519	9,612	56.2	70.6	2.0	6	354	9,118	57.0	72.0	2.0
RT7523FP	Hybrid	23	1,516	8,774	50.5	69.6	2.1	5	583	8,466	50.8	70.1	2.0
CL151	Inbred	15	1,449	8,142	48.0	69.7	2.0	14	1,299	7,710	55.2	70.0	2.0
RT7521FP	Hybrid	14	1,380	9,226	50.6	70.1	2.0	16	1,203	8,461	49.9	68.6	2.2
XL723	Hybrid	12	824	8,618	58.5	70.8	2.0	102	8,697	4,439	51.7	69.0	2.4
Texmati	Inbred	3	405	3,910	40.0	65.5	2.0						
RT7301	Hybrid	4	380	8,532	57.6	69.9	2.0	3	245	8,198	46.9	69.2	2.4
XL7301	Hybrid	4	258	7,303	52.5	68.6	2.0						
PVL03	Inbred	3	256	5,935	58.3	69.7	2.0	3	285	6,498	58.6	70.8	2.0
RT7421 FP	Hybrid	3	245	7,314	48.0	67.6	2.0						
CLL17	Inbred	3	194	8,230	59.6	69.0	2.0	5	645	7,206	56.5	68.4	2.0
Jupiter	Inbred	1	185	4,874	53.0	67.0	2.0						
DG263L	Inbred	2	150	7,251	51.0	68.5	2.0	8	535	8,276	58.6	68.4	2.0
RT7302	Hybrid	1	144	9,081	56.0	70.0	2.0						
RT7421FP	Hybrid	2	137	9,351	46.1	70.7	2.0						
CLL16	Inbred	2	130	9,194	50.2	68.1	2.0	2	130	7,655	50.6	67.5	2.0
CLXL745	Hybrid	1	101	9,290	52.0	71.0	2.0	27	2,803	8,016	59.7	72.9	2.0
Maxa	Inbred	1	89	9,607	55.0	70.0	2.0						
RTv7231MA	Inbred	1	74	7,198	45.0	68.0	2.0	10	529	6,685	52.7	70.2	2.0
RT7401	Hybrid							9	824	5,779	50.5	69.4	2.3
Cheniere	Inbred							5	400	4,948	61.0	71.3	2.7
Gemini 214CL	Hybrid							4	260	6,312	53.5	69.3	2.0
Presidio	Inbred							1	110	6,334	35.0	69.0	2.0
Trinity	Inbred							1	100	7,797	63.0	70.0	2.0
TOTAL		322	29,202	8,478	52.0	70.0	2.0	448	43,230	7,133	53.8	70.1	2.1

Source: Wilson, L.T., B. Morace, J. Wang, K. Leon, J.L. Korenek, and Y. Yang, 2024, Texas Rice Crop Survey (http://beaumont.tamu.edu/CropSurvey)

2024 Texas Rice Acreage by Variety Summary

Percent Variety by County

					LONG GRAIN									
COUNTY	2023 Acreage	2024 Acreage[1]	Acreage Change	% MC Ratooned	RT7302	Texmati	RT7521 FP	Presidio	RT7421 FP	XL723	RT7321 FP	Cheniere	XL7521	DG263L
East Zone														
Brazoria	14,063	17,017	21.00%	10		100								
Chambers	25,510	24,242	-5.00%	22	52.2					22.4			11.2	
Galveston	856	1,337	56.20%	0										
Hardin	471	571	21.20%											
Jefferson	22,028	20,810	-5.50%	10										
Liberty	6,740	6,505	-3.50%	45	30.4					3.8				40
Orange														
East Total	69,668	70,482	1.20%	17	29.8	34.7				11.5			5.5	5.3
Northwest Zone														
Austin	1,449	1,417	-2.20%	67	100									
Colorado	23,137	23,821	3.00%	20	38.6		21.8	23.2			15			
Fort Bend	2,141	1,940	-9.40%	69	5							85		
Harris	73													
Lavaca	3,625	3,651	0.70%	20			24.6				15			
Robertson														
Waller	3,578	3,260	-8.90%	91	11.2			5		8		19		
Wharton	23,516	26,847	14.20%	82	1.5	23	23.6	14.7			2.7	12.1		
Lanar														
Brazos	46													
Northwest Total	57,565	60,935	5.90%	54	18.8	10.1	20.4	15.8		0.4	8	9		
Southwest Zone														
Calhoun	4,338													
Jackson	9,583	8,479	-11.50%	74	5.8		15.8		67.4		4.1			
Matagorda	2,390	2,599	8.70%	5							100			
Victoria	1,255	1,235	-1.60%	100					100					
Cameron	2													
Southwest Total	17,568	12,312	-29.90%	62	4.8		13.2		68.8		7.3			
Northeast Zone														
Bowie	804	992	23.40%	0										
Hopkins														
Red River														
Northeast Total	804	992	23.40%	0										
State Total	145,606	144,722	-0.60%	36	22.9	21.1	9.7	6.7	5.9	5.8	4	3.8	2.7	2.6

[1] Acreage Source: USDA/CFSA Certified Acreage

Source: Wilson, L.T., B. Morace, J. Wang, K. Leon, J.L. Korenek, and Y. Yang, 2024, Texas Rice Crop Survey (http://beaumont.tamu.edu/CropSurvey)

2024 Texas Rice Acreage by Variety Summary (Continued)

Percent Variety by County

	LONG GRAIN													
COUNTY	**PVL03**	**XL753**	**CLL19**	**XL7401**	**RT7331 MA**	**CLL17**	**RT7523 FP**	**Dixiebelle**	**Trinity**	**DG245L**	**CLHA03**	**CLJ01**	**ARoma40**	**Other**
East Zone														
Brazoria														
Chambers	3.4					3.4								
Galveston		16.8		83.2										
Hardin														
Jefferson														
Liberty	18.3				7.6									
Orange														
East Total	4.1	0.5		2.3	1	1.7								
Northwest Zone														
Austin														
Colorado										1.5				
Fort Bend					5.2			4.8						
Harris														
Lavaca			3.2						15					42.2
Robertson														
Waller	9.4	9.1			15.1		16.9					4.9	1.3	
Wharton	0.8	6.6	3.9				1.4	1.9			0.7			7.1
Lanar														
Brazos														
Northwest Total	0.9	3.4	1.9		1		1.5	1	0.9	0.6	0.3	0.3	0.1	5.6
Southwest Zone														
Calhoun														
Jackson			6.9											
Matagorda														
Victoria														
Cameron														
Southwest Total			5.8											
Northeast Zone														
Bowie														
Hopkins														
Red River														
Northeast Total														
State Total	2.3	1.6	1.3	1.1	0.9	0.8	0.6	0.4	0.4	0.2	0.1	0.1	0	2.4

Source: Wilson, L.T., B. Morace, J. Wang, K. Leon, J.L. Korenek, and Y. Yang, 2024, Texas Rice Crop Survey (http://beaumont.tamu.edu/CropSurvey)

2024 Texas Main Crop Combined Yields by Variety

		2023						2022					
Variety	Variety Type	Number of Fields Reported	Reported Acreage	Yield lbs./Acre	Milling Yield (%H)	Milling Yield (%T)	Grade	Number of Fields Reported	Reported Acreage	Yield lbs./Acre	Milling Yield (%H)	Milling Yield (%T)	Grade
CL153	Inbred	65	5,551	6,372	55.5	69.1	2.0	53	5,118	7,402	55.8	69.3	2.0
RT7521FP	Hybrid	48	4,029	7,779	50.9	69.5	2.0	14	1,380	9,226	50.6	70.1	2.0
RT7302	Hybrid	38	2,865	7,844	51.0	70.8	2.0	1	144	9,081	56.0	70.0	2.0
RT7321FP	Hybrid	20	2,004	7,688	55.3	71.8	2.0	99	10,277	8,860	49.6	70.1	2.0
RT7331MA	Hybrid	21	1,656	8,220	58.7	72.2	2.0	27	2,519	9,612	56.2	70.6	2.0
XP753	Hybrid	17	1,576	6,863	47.0	69.7	2.0	48	3,371	8,833	52.1	70.8	2.0
CLL19	Inbred	18	1,431	6,806	54.7	69.2	2.0						
Texmati	Inbred	15	1,397	3,365	41.5	64.7	2.0	3	405	3,910	40.0	65.5	2.0
XL723	Hybrid	18	1,369	7,451	50.2	70.2	2.0	12	824	8,618	58.5	70.8	2.0
RT7523FP	Hybrid	9	999	9,096	57.8	72.3	2.0	23	1,516	8,774	50.5	69.6	2.1
PVL03	Inbred	10	903	7,005	60.5	72.6	2.0	3	256	5,935	58.3	69.7	2.0
CL151	Inbred	9	749	6,759	55.5	69.6	2.2	15	1,449	8,142	48.0	69.7	2.0
CLJ01	Inbred	4	398	6,083	61.8	69.9	2.0						
Dixiebelle	Inbred	3	320	5,114	49.7	69.5	2.0						
Presidio	Inbred	4	290	5,416	62.1	70.0	2.0						
RT7301	Hybrid	2	200	3,806	61.0	72.0	2.0	4	380	8,532	57.6	69.9	2.0
RT7421FP	Hybrid	3	142	8,495	56.5	72.0	2.0	2	137	9,351	46.1	70.7	2.0
RTv7231MA	Inbred	1	117	5,986	53.0	70.0	3.0	1	74	7,198	45.0	68.0	2.0
CLL18	Inbred	2	114	5,761	52.0	70.0	2.0						
DG263L	Inbred	1	100	6,957	57.0	69.0	2.0	2	150	7,251	51.0	68.5	2.0
Trinity	Inbred	2	90	3,349	60.0	70.0	2.0						
RT7401	Hybrid	1	70	8,876	56.0	72.0	2.0						
RT7303	Hybrid	1	11	8,341	54.0	68.0	2.0						
XL7301	Hybrid							4	258	7,303	52.5	68.6	2.0
RT7421 FP	Hybrid							3	245	7,314	48.0	67.6	2.0
CLL17	Inbred							3	194	8,230	59.6	69.0	2.0
Jupiter	Inbred							1	185	4,874	53.0	67.0	2.0
CLL16	Inbred							2	130	9,194	50.2	68.1	2.0
CLXL745	Hybrid							1	101	9,290	52.0	71.0	2.0
Maxa	Inbred							1	89	9,607	55.0	70.0	2.0
TOTAL		312	26,381	7,005	53.2	70.0	2.0	322	29,202	8,478	52.0	70.0	2.0

Source: Wilson, L.T., B. Morace, J. Wang, K. Leon, J.L. Korenek, and Y. Yang, 2024, Texas Rice Crop Survey (http://beaumont.tamu.edu/CropSurvey

RECOMMENDATIONS OF THE PANELS

BREEDING, GENETICS, AND CYTOGENETICS

Chair: Brijesh Angira

Moderators: Christian Torres De Guzman, Teresa De Leon, Shyamal Talukder, Adam Famoso, Xueyan Sha, and Brijesh Angira

Participants: Huggins, T.D., Edwards, J.E., Manigbas, N.L., Borges, K.L.R., Talukder S.K., Richards, J.K., Angira, B., Punzalan, J., Subudhi, P.K., Jia, M.H., Samonte, S.O.Pb., De Guzman, C., Sha, X., De Leon, T.B., Sanchez, D.L., Thomas, J., Baisakh, N., Thomson, M.J., Jia, Y., Septiningsih, E.M., Gu, X.-Y., Maulana, F., Hanlin, D., and Singh, G.

Issues/Recommendations:

1) CRISPR technology holds a significant promise for targeting and knocking down undesirable genes in high-yielding rice lines. Dr. Michael Thomson from Texas A&M highlighted the importance of this technology and its potential to drive future advancements in rice breeding. The panel recommends prioritizing the use of CRISPR technology to support the development of improved rice varieties. Additionally, it is suggested that further discussions on this topic take place in upcoming RTWG meetings to explore its full potential.

2) The rice community in the U.S. is relatively small compared to other cereal crop industries, and securing funding has always been a challenge. The breeding panel recommends fostering collaboration with other breeding programs to reduce operational costs and increase efficiency across the board.

3) Genotyping for marker-assisted selection, genomic selection, and line purification is a critical step, especially as the cost of genotyping has decreased. However, for smaller breeding programs, the expense of genotyping and developing marker panels remains a significant challenge. To address this, the panel recommends collaborative efforts in genotyping job submissions and marker panel development. to reduce per-unit costs and make these essential tools more accessible to all breeding programs.

4) New genomic and AI technologies have become more accessible to rice breeders, offering significant potential for improving breeding accuracy and efficiency. However, integrating these technologies into applied breeding programs remains a considerable challenge. Successful implementation requires careful planning and consideration of logistics to ensure these tools deliver value. To overcome this hurdle, the panel recommends enhancing knowledge sharing and collaboration between breeding programs to facilitate the effective adoption of these advanced technologies.

5) The Puerto Rico winter nursery plays a vital role in advancing Southern U.S. rice breeding programs by accelerating generation progress, rapidly increasing seed stocks, and ensuring the purity of new variety releases. However, reduced discretionary funding—driven by declining rice acreage and the subsequent drop in check-off funds—combined with rising costs due to inflation poses a challenge. To sustain these essential operations, the panel recommends securing long-term funding and preserving open access to the winter nursery facilities in Puerto Rico.

6) The attendees recommended to change the name of the panel from “Breeding, Genetics, and Cytogenetics Panel Breakout” to “Breeding, Genetics, and Genomics Panel Breakout”.

ECONOMICS AND MARKETING

Chair: Michael Deliberto

Supply/Production Research

- Explore the economic viability of alternative irrigation strategies (AWD and Row Rice). Specifically look at the water use efficiency per kg of rice produced. As alternative irrigation strategies are marketed as potentially GHG reducing its pertinent to look at the economic tradeoffs.

- Economic investigation of arsenic and/or other heavy metals in rice production.

- Identify factors accounting for differences in cost of production by state and region.

- Develop and expand Extension efforts to help disseminate information regarding AWD and Row Rice with regards to returns and the economic risks associated with non-traditional irrigation methods.

- Develop and expand Extension efforts to help disseminate information regarding organic rice production. Possibly produce production budgets for organic rice.

- Analyze the economic and environmental impacts of new technology in rice production.

- Analyze the feasibility of U.S. rice producers to adopt varieties of rice that are imported.

- Explore the impact of lost premium due to losing identity preservation.

Policy, Trade, Demand, & Marketing Research

- Analyze Chinese rice policies. Current Chinese stocks are the equivalent of India's annual consumption. As such, if these stocks are released there could be market movements. Look at possible outcomes in changes in Chinese rice policy.

- Analyze the evolution of the competitiveness of U.S. rice in the Western Hemisphere. As rice quality becomes more of an issue in U.S. exports look to see how Western Hemisphere markets will react in terms of import substitution.

- Analyze consumer preferences for different rice attributes and investigate any potential price premium that can be supported by the market.

- Analyze the impacts of expanding consumption and production of large rice importing countries in West Africa.

- Identify expansion/contraction of U.S. exports markets with regards to rice quality issues.

- Explore how evolving environmental regulations/ policies could change the economic landscape of rice production.

- Evaluate potential impacts of international trade agreements on global rice trade and the competitiveness of the U.S. rice industry.

- Evaluate potential impacts of alternative farm safety net programs on U.S. rice producers and consumers.

PLANT PROTECTION

Chair: Blake Wilson

The main recommendations for each of the groups that comprise the plant protection panel (entomology (insects and other animal pests) and plant pathology (diseases) are listed below by discipline. In addition, a single statement was made by the entirety of the group regarding the future of our combined disciplines.

Diseases

The principal objectives of basic and applied rice disease research in the United States include a more comprehensive understanding of the biology and epidemiology of diseases and the molecular mechanisms involved in the host pathogen relationship, determining specifics regarding pathogenesis within each pathogen system, and host resistance to rice pathogens. In addition, continuing to monitor for fungicide resistance as well as developing new management strategies in those areas where resistance is detected. Consequently, an effective and integrated disease management program relying on disease-resistant germplasm, cultural practices, and chemical control based on cooperative research with scientists in agronomy, entomology, weed science, and molecular biology should be the main goal of the group. If advances are made in the understanding and application in biological, microbiome manipulation, or molecular-genetic control aspects, these factors should be developed and incorporated into the program.

Major yield and quality reducing diseases occurring in the U.S. causing damage to the rice crop on an annual basis currently includes sheath blight, caused by *Rhizoctonia solani* AG1; rice blast, caused by *Magnaporthe oryzae*; Cercospora (narrow brown leaf spot, Cercospora net blotch and Cercospora panicle blight), caused by *Cercospora janseana*; kernel smut, caused by *Tilletia barclayana*; false smut, caused by *Ustilaginoidea virens*; stem rot, caused by *Sclerotium oryzae*; and bacterial panicle blight, caused by *Burkholderia glumae* and *B. gladioli*. Seed rot and seedling diseases continue to cause major stand establishment problems in both water- and dry-seeded systems and in organic production systems, especially with the trend towards earlier planting dates. In water-seeded systems, *Achlya* and *Pythium* spp. are important while *Pythium*, *Rhizoctonia, Fusarium,* and possibly *Bipolaris*, and additional fungi have been considered important in dry-seeded rice in the southern U.S. Straighthead, a physiological disease, remains a major problem in certain geographic areas.

Rice diseases that are more locally important or may occur more infrequently include aggregate sheath spot, caused by *Rhizoctonia oryzae-sativae*; brown spot, caused by *Bipolaris oryzae*; crown sheath rot, caused by *Gaeumannomyces graminis*; and bakanae, caused by *Gibberella fujikuroi*. White tip, a nematode disease of rice caused by *Aphelenchoides besseyi*, remains an economic constraint to rice exports in the southern U.S. although direct yield and quality losses in the field remain minor. Peck of rice, caused by a poorly defined complex of fungi and possibly additional microbes in concert with rice stinkbug feeding, remains a problem in certain areas and years.

Currently, the minor diseases of rice include leaf scald, caused by *Microdochium oryzae*; sheath rot caused by *Sarocladium oryzae*; stackburn, caused by *Alternaria padwickii*; sheath spot caused by *Rhizoctonia oryzae*; and leaf smut, caused by *Entyloma oryzae*. In addition, limited information exists on some of the "newer" observations of specific organisms including: *Agroathelia rolfsii,* and *Marasmius graminum* (sterile white basidiomycetes fungus) which to date has only been observed in a limited geography. In the 1990s, a minor and confusing strain of *Xanthomonas* was observed causing symptoms on rice in parts of Louisiana and Texas. Originally identified as a weakly virulent strain of *Xanthomonas oryzae* Ishiyama pv. *oryzae* Swings (*Xoo*), the cause of bacterial leaf blight in other parts of the world, recent information suggests this strain differs from *Xoo*. In 2021 and 2022, rice bacterial blight disease, caused by *Pantoea ananatis*, was identified in research plots in Arkansas. The disease was characterized by spreading and coalescing lesions on leaves, panicle sterility and reduced yield in highly susceptible, mature rice germplasm. No spread of the disease to nearby plants was observed. *P. ananatis* was also recovered from several similarly diseased rice breeding lines. In 2023, *P. ananatis* causing blight-like symptoms on leaves and panicles was also identified in research plots in Louisiana.

Three recently identified foliar diseases, brown leaf spot caused by *Curvularia hawaiiensis*, leaf spot caused by *Epicoccum sorghum*, and Fusarium sheath rot caused by *Fusarium incarnatum-equiseti*, have been identified to be present in Texas. However, their distribution and economic importance need to be investigated throughout the rice growing region.

Priority areas in which research should be continued or initiated are:

1) Cooperation with breeding programs should be continued for improved disease resistance

within rice varieties and hybrids to be released. Screening programs should use coordinated efforts to include evaluations in the field and greenhouse and integrate the current molecular techniques in the laboratory as well as considering the use of genetic markers to identify and incorporate resistance genes. Diseases to be given significant priorities include rice blast, sheath blight, bacterial panicle blight, Cercospora, kernel smut, stem rot, aggregate sheath spot, and false smut. Novel sources of resistance should be identified and developed for incorporation into rice germplasm and hybrids/varieties.

2) Research must be initiated and continued to develop biological strategies to manage rice diseases and continue efforts at reducing the dependency on chemical control options.

Other specific priority areas should include:

1) Systematic and coordinated field monitoring and diagnostics should be established and continued on a long-term basis within rice-producing states to detect new pathogens or potential changes within the existing pathogen complex. Yearly surveys on the genetic makeup of blast, including the composition of blast avirulence genes in blast nurseries and commercial fields in each state, should be conducted to support existing and future research and Extension programs, including breeding for improved resistance using the identified major resistance genes.

2) A comprehensive testing program focused on new and existing chemical management options should be continued with regional coordination where available. A better understanding of chemical efficacy and economic return under realistic field conditions should be emphasized, in addition to inoculated efficacy trials where possible. The discovery and development of improved scouting and detection methods and decision thresholds should be continued. Measurement of crop losses associated with the current diseases identified under different conditions should be encouraged.

3) Genetic and chemical control options should be researched for early-planted rice to improve the reliability of stand establishment and survival annually.

4) Chemical, cultural and biological management options for bacterial panicle blight need more research. Intensive screening for greater levels of resistance is required. More research is needed to better understand host range, inoculum source and other aspects of the biology of bacterial panicle blight that contribute to the epidemic potential of the disease.

5) Research on the molecular genetics of host/parasite interactions, including molecular characterization of the pathogen isolates, and their interaction mechanisms with U.S. rice and the use of molecular genetics and biotechnology, including genetic engineering, molecular-assisted breeding, genomic prediction, and biotechnology-based tools including CRISPR-CAS9 and deep machine learning to improve disease control should be a high priority. Research using simple sequence repeat (SSR) markers for *M. oryzae* and PCR based on rDNA for other pathogens, and pathogen critical pathogenicity factors and their interacting genes should be explored.

6) Research on the effects of cultural practices on disease incidence and severity and the interaction of rice soil fertility (mineral nutrition) and other soil factors in disease severity should be continued and increased.

7) Molecular characterization of virulent blast races IE1k and IC1 in commercial fields and on the weakly virulent bacterial strains, originally reported as Xoo in Louisiana and Texas, should be conducted to characterize and identify them. An international rice blast differential system or monogenic lines or near isogenic lines with major blast resistance genes and user- friendly high throughput scoring system should be established to provide effective screening for useful blast resistance genes.

8) Additional disease research should be conducted on hybrid rice, niche varieties, and

organic systems to provide workable management suggestions for current and future producers. Research should be initiated on the understanding of the diseases and their biology and epidemiology in organic rice production systems. Research efforts should be made to develop profitable management options, including, but not limited to, varietal resistance, fertility, seed treatment, seeding rate, cover crops, and biological control.

9) Encourage and assist in monitoring the potential development of fungicide resistance in the pathogen populations of sheath blight, Cercospora, blast, and kernel smut across the rice-producing region.

10) More research is needed to improve the efficacy of genetic, chemical and cultural options for management of Cercospora in the ratoon crop in Texas and Louisiana.

11) Continue studies on using genetic, chemical and cultural management options for improved management of kernel and false smut.

12) Cooperative research on the interaction of disease with water stress (limited irrigation water), salt, and other environmental stresses should be encouraged as these problems increase in certain areas.

13) Research on alternate irrigation (alternate wetting and drying, mid-summer drainage, furrow irrigation, and overhead (pivot) irrigation) and its effect on rice disease incidence and severity should be encouraged since these cultural strategies continue to increase as methods to conserve natural resources.

14) Research should continue to investigate the microbiome to explore novel strategies to manage diseases in rice.

15) Research is encouraged on the development and application of UAV (drone)-based technologies, artificial intelligence for the detection and management of rice diseases.

Insects and Other Animal Pests

The major insect pests that damage the seed or rice plants between planting and harvesting are the rice water weevil, *Lissorhoptrus oryzophilus* Kuschel; rice stink bug, *Oebalus pugnax* (Fabricius); grape colaspis, *Colaspis brunnea* (Fabricius), and *Colaspis louisianae*; stem borers, *Diatraea saccharalis* (Fabricius), *Eoreuma loftini* (Dyar), and *Chilo plejadellus* Zincken; rice leaf miner, *Hydrellia griseola* (Fallen); South American rice miner, *Hydrellia wirthi* Korytkowski; true armyworm, *Mythimna unipuncta* (Haworth); fall armyworm, *Spodoptera frugiperda* (JE Smith); chinch bug, *Blissus leucopterus* (Say); various species of leaf and plant hoppers; numerous grasshopper species (Locustidae and Tettigoniidae); midge larvae (Chironomidae); greenbug, *Schizaphis graminum* (Rondani); bird cherry-oat aphid, *Rhopalosiphum padi* (Linnaeus.); rice root aphid, *Rhopalosiphum rufiabdominalis* Sasaki; yellow sugarcane aphid, *Sipha flava* (Forbes); sugarcane beetles, *Eutheola rugiceps* (LeConte); billbugs, *Sphenopherous* spp.; and thrips (various species). In 2015, the rice delphacid, *Tagosodes orizicolus* (Muir), was found attacking ratoon rice in Texas. After several years of no detections, the delphacid is now causing damage in some fields in Texas. Infestations now occur yearly in late-planted main crop and ratoon crops in Texas. Two additional species of stink bugs, *Oebalus insularis* and *O. ypsilongriseus*, are know to attack rice in Florida, but not in other rice growing regions.

Pests other than insects can damage rice directly or indirectly. These include the panicle rice mite, *Steneotarsonemus spinki* Smiley; the tadpole shrimp, *Triops longicaudatus* (LeConte); crayfish, *Procambarus clarkii* (Girard); and the apple snail, *Pomacea maculata* (Lamark). Birds trample and feed on seeds and sprouting and ripening rice. Rodents, through their burrowing activity, damage levees and can directly feed on rice plants. Feral hogs root and wallow in rice paddies, destroying large sections of fields.

Priority areas in which research should be continued or initiated are:

1) Refine chemical control strategies for rice

water weevil, stem borers, and rice stink bug. Recent decreases in the efficacy of widely used insecticidal seed treatments have created need for additional chemical controls. Foliar insecticide strategies are needed for stem borers. Alternative insecticides are needed for management of pyrethroid-resistant populations of rice stink bug.

2) Conduct research and outreach that leads to the development and adoption of integrated pest management (IPM). Research on IPM includes studies on the biology and ecology of rice pests; the effects of agronomic practices on rice pests and their natural enemies; identification of pest resistant cultivars; assessing the role of natural enemies and pathogens, individually and collectively, in reducing rice pest populations; research to improve sampling and monitoring of rice pests; develop economic injury levels and damage thresholds; research on biological and chemical control compounds; and pesticide resistance management.

3) Monitor rice for possible introduction of exotic pests. In addition, continue to monitor for Hoja blanca virus as it relates to the rice delphacid.

4) Study the environmental impacts of current and novel rice pest management tools.

5) Understanding how water conservation practices, such as row rice and alternate wetting and drying, may influence the biology, ecology, and management of arthropod pests of rice in the U.S.

As a combined group of scientists, the group would like to make an overarching statement regarding the continued efforts to train graduate students in the disciplines of entomology and plant pathology. As a group of scientists working for the rice industry, we feel that students should be encouraged to enroll in the plant protection disciplines and embrace the field-level aspects of these two important disciplines. Moreover, students should be encouraged to learn how to properly conduct field-level research trials in rice systems to address the continued management concerns we face within our respective disciplines as rice researchers.

POSTHARVEST QUALITY, UTILIZATION, AND NUTRITION

Panel Chair: Griffiths Atungulu

Recommended Research Priorities:

1) Develop technologies, sensors, electronic systems and database for improving production efficiency, food safety, product quality and processing quality of rice, such as real-time monitoring and detection devices/systems for rice grain quality during harvest, insect occurrence during storage and grain quality during milling.

2) Study the rice quality (such as chalkiness) and safety (such as arsenic) from genetic, physiological, environmental and production management aspects to improve the rice quality.

3) Develop technologies for producing value added products, and reducing losses and increasing values in harvest, storage and processing.

Specific Recommendations:

Website: Varietal Database

- Breeding stations in the mid-south and gulf coast (CA has already completed this effort) would post data for released varieties, including parentage, amylose content, milling yield, grain weight, alkali number, sensory, and functional data, etc.

- Identify available personnel to compile all data of released varieties and create a web-based database to store these data so that it is accessible to the public.

- Awareness of Postharvest Quality, Utilization and Nutrition.

- Increase the awareness of work related to postharvest quality, utilization and nutrition through cosponsoring meeting and marketing.

Rice Harvesting, Drying, Storage, and Handling

- Correlate environmental factors (temperature, humidity) at harvest to physical, chemical, and functional properties of the rice kernel.

- Develop new and/or improved rice drying, storage, and handling systems to impart desirable functional properties, improve efficiency, and reduce energy use.

- Incorporate economic factors into post-harvest models and guidelines for harvesting, drying, storage, and insect management recommendations.

- Develop sensors to rapidly and objectively monitor rice properties.

- Evaluate alternatives to chemical fumigants for grain and facility treatment.

- Develop resistance management program for phosphine gas, a fumigant.

- Determine mechanisms for head rice loss when rice is transferred.

- Study the effects of post-harvest storage on grain quality and nutritional value.

Milling Characteristics

- Compare the accuracies of milling results from standard laboratory milling and commercial milling.

- Determine the physicochemical properties of rice varieties and milling conditions that contribute to optimizing milling performance based on degree of milling.

- Determine the nature of defective or fissured grains that survive processing and their effect on the end use processing.

- Develop sensors to rapidly determine and objectively predict milling quality (constrained by degree of milling) for U.S. and international varieties.

- Incorporate laboratory research into industry practice. Validate methods and identify performance levels.

Processing, Quality, & Cooking Characteristics

- Develop instrumental methods for screening lots and evaluations of prospective new varieties for processing quality.

- Study the correlations of 'functional amylose' and resistant starch to processing and cooking properties.

- Determine the basic relationship between composition, molecular structure, physical state, and end-use performance (flavor, texture, processing properties, storage stability, etc.).

- Determine impact of genetic, environmental, and processing factors on sensory properties, functionality, kernel size and property uniformity, and storage stability.

- Improve inspection methods for measuring chemical constituents and quality factors.

Utilization of Rice Components

- Characterize the 1800 lines of USDA rice core collection for grain quality, disease resistance, and biotic and abiotic stresses.

- Develop effective, cost-efficient methods for fractionating rice components (e.g., starch, protein, oil, and fiber).
- Develop methods for modification of rice starch, bran, and protein to enhance functionality.

- Identify applications for rice components (i.e. starch, protein, bran) in native and modified forms.

- Study the genetic mechanisms controlling amounts and compositions of components that might have significant economical and nutritional value (e.g., oil, brain, phytochemicals, etc.).

- Characterize bioactive components in varieties in regards to physicochemical and functional properties.

- Measure the amount of these bioactive components in various varieties.

- Develop non-food uses for rice, rice hulls and ash, straw, bran, and protein.

Nutrition and Food Safety

- Promote the health benefits of rice and develop rice products and constituents that promote human and animal health.

- Evaluate the bioavailability of rice components of nutritional importance, and investigate the levels required to generate responses in humans and animals.

- Investigate the effects of processing, and storage conditions on microbial loads in rice for improved food safety.

- Evaluate genetic, growth environment and grain processes on the nutritional value of rice grain and on the exclusion of toxic compounds.

AGRONOMY AND RICE CULTURE

Panel Chair: Manoch Kongchum

Participants: Dustin Harrell, Bruce Linquist, Jarod Hardke, Fugen Dou, Michele Reba, Benjamin Runkle, Nathan Slaton, Justin Chlapecka, Angelia Seyfferth, Chris Henry, Jim Wang, Matt Limmer, Kris Keller, Cherryl Quinones, Geoffery Payne, Kharla Mendee, Beatriz Moreno-Garcia, Krizzia Guardado, Dorsa Darikendeh, Marc Gomez, Will Richardson, Reti Ranniku, Huihui Sun, and Yoshida Shinoto

The panel on rice culture reaffirms the value of the meeting in (1) reviewing the research already completed, (2) facilitating the exchange of information, (3) developing cooperative research on problems of mutual interest, and (4) in directing the attention of proper authorities to further work that should be undertaken. Under various research categories represented by this panel, the following continuing research needs are specified:

In order to secure a safe and abundant food supply, we must intensify the production on the existing agricultural land base while exercising responsible environmental stewardship. Broad categories of recommended research are: (1) Develop management practices to achieve the genetic yield and grain quality potentials of our existing and future rice cultivars; (2) Increase production efficiencies to ensure on-farm economic viability while minimizing the adverse impacts on our air, water, and soil qualities; and (3) Modernize current best management practices by upscaling and integrating emerging technologies into on-farm and post-harvest production practices.

Cultural Practices

- Evaluate rotation systems that involve rice.

- Determine the effects of water management, fertilization, and water-use efficiency on grain yield and grain milling yield and other quality parameters.

- Determine the influence of irrigation management strategy (i.e. furrow irrigated, Alternate Wetting and Drying, and Traditional) on biotic stresses to the delayed-flood rice production system.

- Identify factors that cause poor stand establishment and develop practices that will ameliorate these conditions.

- Develop conservation tillage practices for efficient production of rice under water-seeded and dry-seeded systems, including "stale" seedbed management.

- Expand research on crop residue management, including soil incorporation, collection, and economic uses. Study management systems that enhance ratoon production.

- Evaluate aquaculture rotation systems that involve rice, such as co-culture with fish and crawfish/rice rotations.

- Explore crop establishment, including planting methods and geometry, plant density, seeding date, and other factors necessary to characterize BMPs for various cultivars of interest.

- Evaluate the use of harvest aid chemicals in rice production.

- Develop cultural practices to minimize potential detrimental environmental impacts on rice quality and nutritional value.

- Develop tools and apps that allow growers to remotely access field conditions such as soil moisture and nitrogen status of crop.

- Evaluate the adoption of cover crops and the cultural practices used for cover crops in rice production systems.

- Organic farming practices.

Fertilizers and Soils

- Develop a greater understanding of the chemical, physical, and physicochemical changes of metals/metalloids that occur in flooded soils and their influence on the growth of rice, nutrient transformations, and continued productivity of the soil.

- Study nutrient transformations, biological nitrogen fixation, and fertilizer management systems in wetland soils, especially as related to soil pH and redox potential.

- Develop soil and plant analysis techniques for evaluation of the nutrient supply capacity of soils and the nutritional status of rice to enhance the formulation of fertilizer recommendations.

- Cooperate with plant breeders, physiologists, and soil researchers to develop techniques for efficient utilization of nutrients.

- In cooperation with other disciplines, study the interactions among cultivars, soil fertility, uptake and translocation of plant essential and non-essential nutrients, diseases, weeds, insects, climate, and water management.

- Develop integrated systems to more efficiently utilize fertilizer while reducing pesticide use.

- Gain a better understanding of silicon deficient soils, silicon sources, and their effect on rice yield.

- Determine the potential use of non-traditional fertilizer sources and additives in rice production.

Physiology

- Determine the effects of varying environments on growth, development, and yield of both main and ratoon crops of rice and identify potential mitigation strategies.

- Determine the physiological factors related to grain yield and quality and plant growth and development of the main and ratoon crops of rice.

- Determine the physiological processes, including root functions, involved in nutrient uptake and utilization in an anoxic environment.

- Develop a better understanding of the micro- and macroenvironment of the rice canopy and its influence on growth of the rice crop.

Water

- Accurately determine the complete water balance on rice as a function of soil textural groups, regions, time within the irrigation season, rice growth stage, and meteorological parameters.

- Determine the impact of sub-optimal water availability at various physiological stages on dry matter accumulation, maturation, grain yield, nutritional value and grain quality.

Determine optimum water management guidelines for flush-flood, pin-point flood, continuous-flood, alternate wetting and drying, and furrow irrigated rice.

- Evaluate the effect of water conservation practices, such as underground pipe and/or flexible polyethylene pipe, land forming, multiple inlets, reduced levee intervals, and lateral maintenance on water use.

- Continue to evaluate water quality in terms of salinity and alkalinity and its effect on rice productivity. Evaluate water use as related to water loss and evapotranspiration.

Quality

- Determine the effect of various management systems on changes in the quality of water used in rice production. Monitoring should include all water quality parameters, such as nutrient inputs, suspended and/or dissolved solids, organic matter, etc.

- Assess the relationships between trace gases, environment, and rice production. Quantify the potential to mitigate field-to-atmosphere gaseous losses from rice fields.

Engineering Systems

- Study energy inputs in rice production and harvesting.

- Expand investigations to improve technology and equipment for effective rice management.

- Analyze and improve harvesting practices to assure maximum recovery of top quality grain through timeliness of harvest and harvester adjustments by cultivar and climatic zone.

- Determine ways to use the Geospatial systems and related sensor technologies to aid rice research and reduce rice production cost.

Rice System Modeling

- Encourage development of rice models and expert systems that enhance our knowledge of rice development, aid in diagnosing problem situations, and provide decision support for growers.

- Determine the effects of cultural and chemical practices used in rice-based cropping systems on species demography and dynamics.

- Determine the fate of agricultural inputs in the soil, water, and plant continuum as related to varying rice cropping systems. This information should be applied to minimize losses from the field and reduce any attendant environmental degradation associated with such losses and in the development of Nutrient Management Plans.

- Assess the relationships of environment and rice production.

RICE WEED CONTROL AND GROWTH REGULATION

Panel Chair: Connor Webster

The overall objective of the Rice Weed Control and Growth Regulation Panel's recommendations is to develop integrated nonchemical and chemical methods with basic biological processes to improve weed control and growth regulation in rice. The categories listed below are separated for the purpose of describing the research areas more specifically.

It was mentioned that very little if any "Growth Regulation" topics or research existed and discussion to remove "Growth Regulation" form the panel name was proposed. However, due to low attendance, no vote was officially taken

Chemical Weed Control

- Evaluate weed control systems for prevention and management of herbicide-resistant weeds.
- Investigate mechanisms of resistance.

- Evaluate new chemicals for the control of weeds in rice.

- Facilitate label clearance and continued registration for rice herbicides.

- Evaluate varietal tolerance to herbicides in cooperation with plant breeders.

- Study new and existing herbicides for their fit in conservation tillage in rice-based cropping systems.

- Cooperate with environmental toxicologists and others to study the fate of herbicides in the rice environment and their potential to affect non-target organisms.

- Cooperate with agricultural engineers and others to study improved application systems.

- Study basic processes on the effect of herbicides on growth and physiology of rice and weeds.

- Cooperate in the development of herbicide-resistant rice weed control systems.

- Establish rotational methods with new chemistries for red rice control to prevent possible outcrossing.

Weed Biology and Ecology

- Determine and verify competitive indices for rice weeds to predict yield and quality losses and cost/benefit ratios for weed control practices. Verify yield and quality loss models.

- Intensify studies on weed biology and physiology, gene flow, molecular biology, and population genetics.

- Survey rice-producing areas to estimate weed infestations and losses due to weeds.
- Determine the effects of cultural and chemical practices used in rice-based cropping systems on species demography and dynamics.

Non-Chemical Weed Control

- Evaluate the influence of cultural practices, including crop density, fertility and irrigation management, tillage practices, and others, on weed control and production efficiency.
- Evaluate the influence of cultural practices on red rice control.
- Study methods for the biological control of important rice weeds.
- Evaluate rice cultivars for weed suppressive traits.

Research Priorities

- Weed management under new water management strategies.

- Chemical and non-chemical management of herbicide resistant weeds.

- Weed biology and competition studies.

- Work with NIFA to create funding opportunities for weed biology and management support in rice.

Extension Priorities

- Online training for Extension and interactive tools

ABSTRACT OF PAPERS FROM STUDENT PANEL ORAL CONTEST: BREEDING, GENTETICS, AND CYTOGENETICS
Moderator: Karina Borges

Yield Linkage Drag Associated with the Introgression of the sd1 Semi-Dwarf Allele in US Long Grain Germplasm

Furlan, F.J.F., Famoso, A.N., Angira, B., Cerioli, T., and Montiel, M.

The sd1 semi-dwarf allele revolutionized rice cultivation during the Green Revolution by enhancing lodging resistance and enabling the development of high-yielding varieties. This allele was introduced into the U.S. from indica varieties such as TN1 and IR8. However, associated genetic variation and recombination events may have influenced yield performance following its introgression into modern germplasm. This study investigates yield variation linked to the sd1 region, focusing on the unique Presidio haplotype and its introgression into U.S. rice germplasm.

A multi-parent population (MP6-8) comprising 316 lines, developed from elite U.S. long-grain lines (CL111, RoyJ, CL153, Lakast, Cypress, CL172, Catahoula, and Presidio), was evaluated for yield and plant height across Louisiana and Arkansas in 2021 and 2022. Genotypic data were derived from DArTseq markers. A genome-wide association study (GWAS) identified a yield-associated SNP at 36.69 Mb on chromosome 1 (PVE: 44.66), located in a region where the Presidio consistently carries a unique allele in all significant trials. For plant height, a SNP near the sd1 locus at 38.33 Mb (PVE: 73.58%) showed a significant association. The allele near the sd1 locus (38.38–38.39 Mb) consistently differentiated wild-type parents (RoyJ and LaKast) from those with the semi-dwarf allele. Haplotype analyses were performed to investigate the GWAS findings and examine the effect of the Presidio haplotype on yield variation. The region spanning 32.7–40.7 Mb on chromosome 1, encompassing the most significant yield-associated SNP at 36.7 Mb and extending 4 Mb on either side was analyzed. This approach divided the sd1 region into six sub-regions, identifying two significant sub-regions (33.32–35.33 Mb and 35.35–38.18 Mb) linked to Presidio's unique haplotype and yield reductions. To validate the findings in the MP6-8 population, a Presidio/Catahoula biparental population of 100 lines was analyzed, identifying a critical sub-region (34.27–37.69 Mb) where the Presidio haplotype was linked to lower yields. Single-marker analysis within the biparental revealed a peak at 36.7 Mb, aligning with the GWAS results. Historical analysis traced the Presidio haplotype's origin to TN1. This study identifies a large-effect locus associated with reduced yield, emphasizing the negative impact of the Presidio haplotype and the need for targeted breeding strategies to mitigate its effects and improve U.S. rice germplasm.

Genomic Selection of Seed Dormancy Loci to Improve Germinability of Hybrid Seeds in Rice

Bhattarai, K., Guo, M., Batth, B.S., Bibi, M., Xu, H., Guzman, C.D., and Gu, X.Y.

"Inadequate germination" has negatively impacted the profitability of hybrid rice. When parents lack seed dormancy (SD), the gibberellin (GA) application to promote the panicle emergence also triggers germination and nutrient hydrolysis during maturation, transportation and storage and lowers the germination level at sowing. This project aimed to integrate SD genes into male sterility (MS) and fertility restoration (RF) lines to improve the germinability of hybrid F_1 seeds. *qSD12* is a major quantitative trait locus (QTL) associated with embryo dormancy and the isogenic line for the wild-type allele *SD12* (IL_{SD12})

is GA-insensitive for germination. The present research was to identify QTLs for SD and agronomic traits in an F_2 population from a cross of IL_{SD12} with the RF line ZY1, and to evaluate effects of *SD12* on the dormancy duration and resistance to pre-harvest sprouting (PHS) in the F_2 or advanced generations. A total of 12 QTLs for flowering time (3), plant height (5) and SD (4) were identified using a high-resolution genetic map. Of the 4 SD loci, *qSD12* accounted for most (34%) of the total variance, and 2 (*qSD3* & *qSD6*) of a small effect have the SD alleles from ZY1. The major effect of *qSD12* on SD was broken by a 7-week storage at 24°C or a 3-week heating at 45°C, and the effect on germination/PHS was confirmed with the F_3 to F_5 lines developed by genomic selection for all the QTLs. Recurrent backcrossing and genomic selection to introduce *SD12* into MS and MS maintainer lines is on-going.

Transcriptomic Analysis of Genes Regulated by Gibberellin Signaling in Embryos of Germinating Seeds in Rice

Xu, H., Chakraborty, R., Bhattarai, K., Bibi, M., and Gu, X.Y.

Germination is a physiological process of ecological and agricultural significance. Gibberellins (GA) promote germination through GA signaling, which is mediated by the DELLA, GID1, and GID2 elements encoded by *SLENDER RICE 1* (*SLR1*), *GID1* and *GID2*, respectively, in rice. Preliminary research revealed that a loss-of-function mutation of the genes promotes (*slr1-1*) or delays (*gid1* & *gid2*) germination. This research aimed to identify genes regulated by *SLR1* for the germination promotion or delay. Seeds developed on the *SLR1slr1-1* (*Ss*) plant were imbibed for 20 h to isolate the S^fS^m, S^fs^m, s^fS^m and s^fs^m embryos, based on the endospermic genotypes for alleles from the female (f) or male (m) gametes. Twelve cDNA libraries for the genotypes were sequenced, and sequence analyses identified an average of 20,246 genes transcribed in the embryos. The number of differentially expressed genes (DEGs) varied with the pairs of genotypes from 18 (S^fS^m-S^fs^m) to 2565 (S^fS^m-s^fs^m), and the variations among all 6 pairs suggested the involvement of genome imprinting in regulating gene expressions by *SLR1*. Of the 2565 DEGs, 58.4% and 41.6% were down- and up-regulated, respectively, by *SLR1*. The down-regulated genes include those functioning to promote germination, such as *OsABA1* for ABA biosynthesis and *OsEXPB6* for cell wall expansion, while the up-regulated genes include *SD12A* for seed dormancy, whose transcripts were linearly correlated with the copy number of *SLR1* in the endosperms. This research provided evidence that GA signaling is involved in the regulation of seed dormancy and germination and candidate genes to manipulate the germination process.

Genome-Wide Association Study for Early Morning Flowering Trait in the AUS Rice Diversity Panel

Rana, P., Kondi, R.K.R., Chaudhary, C., Rohila, J.S., and Subudhi, P.K.

Early morning flowering in rice is a crucial trait for mitigating the adverse effects of heat stress on grain yield, particularly under changing climatic conditions. A genome-wide association study (GWAS) was conducted in a panel of 197 AUS rice lines to investigate the genetic basis of this trait under controlled conditions. The early morning flowering trait was divided into three distinct time points: early, mid, and late. The phenotypic variation across these categories provided valuable insights into the diversity within the panel.

The GWAS identified significant marker-trait associations linked to early morning flowering, revealing genetic loci that could serve as targets for improving this trait. These markers were further analyzed for their potential role in heat stress tolerance and yield enhancement. Candidate genes within significant loci were functionally annotated to explore their involvement in flowering time regulation.

The findings from this study highlight the heritable nature of early morning flowering and its genetic determinants. These results provide valuable tools for marker-assisted selection in breeding programs aimed at developing heat-tolerant rice lines with improved grain yield potential, enhancing their adaptability to future climate challenges.

Candidate Gene Analysis for Alkalinity Tolerance Using QTL-Seq Approach in Rice

Kondi, R.K.R., Chaudhury, C., Rana, P., Pruthi, R., and Subudhi, P.K.

Rice (*Oryza sativa* L.) is sensitive to saline and alkaline conditions, which can severely impact its growth, development, and yield. Since the mechanisms for salt tolerance and alkali tolerance in rice are different, it is essential to study and identify alkali-tolerant genes to enhance the ability of rice varieties to thrive in saline-alkali environments. This study aimed to investigate the genetic basis of alkalinity tolerance in rice using QTL-seq approach.

A panel of 20 rice introgression lines were selected from previously screened IL population, developed from the cross involving N22 and Cocodrie. Both resistant and susceptible bulks consisting of ten ILs each were evaluated for alkalinity tolerance at the seedling stage. The experiment was conducted in a controlled environment using a randomized complete block design (RCBD). Seedlings at the two-leaf stage were exposed to 0.20% sodium carbonate for two weeks, followed by 0.40% sodium carbonate for one week. Physiological and morphological data were collected to assess the impact of alkaline stress.

Analysis of variance (ANOVA) revealed significant treatment effects for several physiological parameters, including stomatal conductance (SC), transpiration rate, quantum yield of Photosystem II (PhiPS2), and electron transport rate (ETR). Genotypic differences were observed for SC and ETR, indicating variability in alkalinity tolerance among the rice genotypes. The interaction between treatment and genotype was significant for SC and ETR, suggesting that the response to alkaline stress varies among genotypes. Under stress conditions, tolerant ILs outperform the susceptible ILs by maintaining higher electron transport rates, photosystem II efficiency (PhiPS2), stomatal conductance, and transpiration rates, while also regulating leaf temperature more effectively. The observed statistically significant differences highlight the superior physiological mechanisms of tolerant ILs in adapting to alkaline stress. Despite a decline in all measured traits under stress, the ability of tolerant genotypes to sustain better photosynthetic and gas exchange efficiency, along with improved thermal regulation, underscores their enhanced resilience to adverse conditions. QTL-Seq analysis will be conducted to identify candidate genes for alkalinity tolerance.

Our findings will not only provide valuable insights into the physiological and morphological mechanisms underlying alkalinity tolerance but also will guide future efforts to breed rice varieties with improved tolerance to alkaline conditions

Genetic Characterization of the Quantitative Inheritance of Sheath Blight (*Rhizoctonia solani* Kühn) Resistance in Rice (*Oryza sative* L.) Under Field Conditions

Manangkil, J.M., Cerioli, T., Montiel, M., Punzalan, J., Angira, B., Richards, J.K., Fritsche-Neto, R., and Famoso, A.N.

Sheath blight, caused by *Rhizoctonia solani* Kühn, is a significant disease in rice (*Oryza sativa* L.), with US cultivars generally exhibiting susceptibility. The absence of complete resistance, coupled with the quantitative inheritance of sheath blight resistance, has hindered progress in genetic studies and breeding efforts. This research aimed to understand the genetic architecture of sheath blight resistance in US elite germplasm and identify the most effective breeding strategies for applied breeding programs.

A total of 841 elite breeding lines, derived from a cross between six to eight founder lines, representing the elite diversity of US rice varieties, were evaluated under field conditions for three years with three replications. The lines were genotyped using 13,179 SNPs and inoculated at the green ring stage with a rice hull and paddy substrate. Sheath blight resistance was assessed by measuring the percentage horizontal disease progression at the top (SBTOP) and base (SBBASE) of the plants. Field evaluations demonstrated high heritability and a wide range of variation in resistance, indicating significant opportunities for selection and genetic improvement in sheath blight resistance within the breeding population. Additionally, sheath blight was found to be correlated with days to heading and plant height.

A Genome Wide Association study (GWAS) identified 23 significant SNPs associated with sheath blight resistance; however, the variance explained by each of these loci was relatively small. The small effect of the identified SNPs suggests that marker-assisted selection may not be an effective breeding approach for improving sheath blight resistance. Given the quantitative nature of the trait, genomic selection was explored through cross-validation, resulting in prediction accuracies of 0.43 for SBTOP and 0.42 for SBBASE. Although phenotypic heritabilities were strong each year, there were significant differences in the degree of infection based on the year, highlighting the complexity in breeding for this trait. These findings highlight that population improvement through genomic selection is the most effective molecular breeding strategy for enhancing the sheath blight resistance and that establishing a multi-year and environment training set is critical.

ABSTRACT OF PAPERS FROM THE STUDENT ORAL CONTEST PANEL: AGRONOMY AND RICE CULTURE
Moderators: Jacob Fluitt and Fugen Dou

Yield and Nutrient Uptake Response to Cover Cropping in Zero-Grade, Flood-Irrigated Rice

Vickmark, H.E., Roberts, T.L., Drescher, G.L., Weisflog, D.A., French, K.S., Bessa de Lima, G.H., and McLain, T.D.

As the global human population is projected to reach 9.8 billion by 2050, the demand for crops such as rice (*Oryza sativa* L.) is expected to proportionally increase by 44 MMT. Regenerative agricultural management practices, such as no tillage (NT), cover crops (CC), and the addition of organic manures, have grown in popularity to preserve soil health, sequester soil carbon (C), and mitigate global climate change, which is a dynamic driver of potential yield losses. While the effects of these regenerative agricultural management practices are being researched globally, these effects on soil health and yield of many production systems have yet to be defined.

The objective of this study is to investigate the long-term effects of regenerative management practices on soil health and rough rice yield in a zero-grade, flood-irrigated rice production system in eastern Arkansas. A randomized complete block design was established with three replications of seven treatments, consisting of various combinations of tillage regimes, cover crops, and biochar incorporation. Biomass samples were collected from CC prior to rice planting, as well as from rice at 50% heading and maturity, and analyzed for nutrient concentrations. One-way ANOVAs and planned comparisons were then performed on rice yield and nutrient uptake with P-values less than 0.05 considered significant. After year one (2023), a one-way ANOVA and multiple planned comparisons revealed no significant differences in rice nutrient uptake or yield amongst treatments. A second year (2024) of treatment implementation revealed a significantly greater yield in the conventionally managed treatment when compared to the NT, legume/grass CC mixture treatment, averaging 6,700 and 4,960 kg ha^{-1}, respectively.

While these results suggest an initial yield drag by implementing CC and NT, the results of previous studies follow a similar trend in an initial yield decrease, and a subsequent increase in rice yield can be expected amongst CC and NT treatments in the next two to four years.

Understanding Nutrient Uptake Timing and Demand from Recently Released Rice Cultivars Planted in the Arkansas Delta

Bessa de Lima, G.H., Roberts, T.L., Drescher, G.L., Hardke, J.T., Weisflog, D.A., McClain, T. D., and Vickmark, H.E.

Nutrient uptake is crucial information for determining fertilizer rate recommendations for rice (*Oryza sativa L.*). However, investigations in this regard have not been extensively done for the most recent rice cultivars in the Arkansas Delta. The objective of this study was to investigate nutrient uptake timing and demand from four modern rice cultivars widely planted in Arkansas under two fertilization regimes. It was hypothesized that total nutrient uptake will not exist amongst four widely planted rice cultivars and fertilization rates in the Arkansas Delta due to the similar nutrient timing and demand. The experiments were established in 2022 and 2023 on silt loam soils with optimum soil tests for essential macro and

micronutrients at the Rohwer Research Station (RRS) and Pine Tree Research Station (PTRS). Cultivars planted were CLL 16, Diamond, RT 7521 FP, and Titan, under two fertilizer management regimes (100 and 125% of soil-test based rate recommendations). Samples were taken at V3, V5/6, 2 weeks post flood, 4 weeks post flood, 50% heading, and maturity, dried in the oven for 72°C, ground, and submitted for nutrient concentration analysis by ICP. Despite different fertilization rates, our data shows that most macro and micronutrients had similar nutrient uptake timing and demand, showing mostly numerical differences, with few nutrients showing statistical differences due to the effect of cultivar ($P < 0.05$). We believe these differences were driven by variations in biomass and yield potential from each rice cultivar. This work provides a broad understanding of all essential nutrient timing and demand for the newest rice cultivars, allowing the development of new tools for in-season management to fine-tune fertilizer recommendations for rice growers in the Arkansas Delta.

Nitrogen Rate and Split Application Timings in Mississippi Furrow-Irrigated Rice

IV Eubank, T.W, Bond, J.A, Mangialardi, G.A, Whitt, D.R, Dodd, J.B, and King, T.A.

Furrow-irrigated rice has gained popularity in Mississippi due to ease of production in this system. Nitrogen fertilizer management can be difficult in furrow-irrigated rice due to the cycling between wet and dry soil conditions, which promote nitrous oxide losses. A 'spoon-fed' approach is recommended for furrow-irrigated rice to minimize nitrogen fertilizer losses. Rice producers in Mississippi have repeatedly requested refined nitrogen fertilizer management strategies for furrow-irrigated rice. Therefore, research was conducted in Stoneville, MS, from 2022 to 2024 to evaluate nitrogen fertilizer rates and split applications in furrow-irrigated rice.

Two concurrent studies were conducted on inbred and hybrid rice cultivars to evaluate nitrogen fertilizer rates and split applications. The experimental design for both studies was a randomized complete block design with a 2 x 4 factorial arrangement of treatments. Nitrogen fertilizer as urea was applied at 168 and 246 kg N ha^{-1} across four different timing intervals of five-leaf, panicle differentiation (PD), PD + 14 d, and 5% heading. The nitrogen split applications were arranged as follows; 100% single, 2:1, 1:1:1, 2:1:1, 1:1:1:1, and 2:1:1:1. The inbred cultivar utilized was 'CLL16' and the hybrid cultivar was 'RT 7321 FP'. Rice plant height was recorded by measuring from the base of the plant to the uppermost leaf of five randomly selected plants. Rice maturity was estimated as the number of days to 50% heading and recorded as days after emergence. At maturity, whole aboveground portion of rice plants were collected from 1 m^2 to obtain rice dry weight and calculate yield components. Rough, total, and whole milled yields were also obtained. Data was subjected to ANOVA using the PROC GLIMMIX procedure in SAS 9.4 with site year and replication (nested within site year) as random effect parameters. Estimates of the Least Square Means at 5% significance level were used for mean separation.

In the Inbred Nitrogen Fertilizer Study, rice plant height was maximized following the 100% single and the 2:1 split applications. When 246 kg N ha^{-1} was applied, maturity was delayed 1.74 d compared with rice following nitrogen fertilizer at 168 kg N ha^{-1}. The 2:1 split application increased panicle density 28, 20, 36, and 15% compared with the 1:1:1, 2:1:1, 1:1:1:1, and 2:1:1:1 applications, respectively. Rough rice yield was increased following a 2:1, 1:1:1, and 2:1:1 split applications compared with the 100% single application and nontreated check. In the Hybrid Nitrogen Fertilizer Study, maturity was delayed 0.70 d following nitrogen fertilizer at 246 compared with 168 kg N ha^{-1}. Rough rice yield was 7,092 kg ha^{-1} following the 246 kg N ha^{-1} fertilizer rate, which was 11.6% greater than that following 168 kg N ha^{-1}. The 1:1:1:1 split application improved yield 28, 18, 16, and 22% compared with the 100%, 2:1, 1:1:1, and 2:1:1 applications, respectively.

These results indicate that, while split applications of nitrogen fertilizer can improve nitrogen use efficiency over a single application, improved yield was not always observed. Increasing the number of treatments in a nitrogen fertilizer split application can also increase input and labor costs that are associated with the additional splits. Due to the potential of increased nitrogen loss from a single application of nitrogen fertilizer in a furrow-irrigated rice system, split applications would be most efficient in this system.

Rice Yield Response to Phosphorus and Potassium Fertilizer Application Timing

Mengez, G.A.L., Drescher, G.L., Roberts, T.L., Hardke, J.T., Smartt, A.D., Weisflog, D.A., Prado, M.P.R., French, K.S., and Bessa de Lima, G.H.

Phosphorus (P) and potassium (K) are macronutrients essential for plant growth and optimizing fertilization strategies in rice is critical for maximizing grain yield. Field studies were established in 2023 and 2024 at the Pine Tree Research Station, in Colt, Arkansas, to determine flood-irrigated rice yield response to fertilizer-P and -K application rates and timings. Fertilizer-P (0, 39, and 78 kg P_2O_5 ha^{-1} as triple superphosphate) and -K rates (0, 67, and 135 kg K_2O ha^{-1} as muriate of potash) were applied at preplant (PP), pre-flood (PF), 3 weeks after flood (3WAF), and booting (R2). The cultivars planted were Diamond and Ozark in 2023 and 2024, respectively. At maturity, rice grain yield was determined using a small plot combine. Preplant soil samples categorized soil-test P and K in both years as Low, indicating that the trials were likely to respond to fertilization.

In 2023, the yield in the P trial was maximized with PP application, resulting in a 9% and 12% significant ($P \leq 0.10$) yield increase over the control when 39 and 78 kg P_2O_5 ha^{-1} were applied, respectively. In 2024, there was no statistical difference between the timings and rates. For K, yield was maximized with K application of 67 kg K_2O ha^{-1} at 3WAF in both years, increasing yield 10-12% over the control. However, no significant difference was observed when this rate was applied at PF and PP in 2023 and 2024, respectively. When 135 kg K_2O ha^{-1} was applied, no significant difference was observed between the timings. The no-fertilizer-K control, however, resulted in a significantly lower yield than all fertilized treatments.

These results emphasize the importance of applying P early in the season, due to its dynamic nature in soil and high plant demand at the beginning of crop development and highlight the potential of in-season K application to correct K-deficient rice and maintain rice grain yield potential under flood-irrigated conditions.

Effects of Different Nitrogen Rates on Yield, Nitrogen Use Efficiency, and Greenhouse Gas Emissions Under Alternate Wetting and Drying Management

Petrowicz, H.L., Dou, F., Lloyd, A.W., Lasar, H.G.W., Ranasinghe Hetti Arachchige, N.H., Gentry, T., Wilson, L.T., Yang, Y., and Tarpley, L.

Alternate wetting and drying (AWD) management remains a promising method for reducing greenhouse gas (GHG) emissions in rice production. However, AWD may also result in additional losses of nitrogen (N) that may not otherwise occur under continuous flooding (CF). To balance profitable yield, N use, and GHG emissions, effective N management is essential for producers and climate smart practices. A field study was conducted to determine the optimum N application rates for rice under AWD management in Southeast Texas, along with the resulting effects on yield, nitrogen use efficiency (NUE), and GHG emissions. A high-yielding long-grain rice variety, DG263L (*Oryza sativa* L.), was planted following a randomized complete block design for the 2024 season. The AWD management treatment was applied at a 15-cm level during the tillering stage to the panicle differentiation stage. Urea fertilizer was applied to each field using a tractor-mounted fertilizer spreader, with five different N rates: 0 kg N ha^{-1}, 135 kg N ha^{-1}, 168 kg N ha^{-1}, 202 kg N ha^{-1}, and 235 kg N ha^{-1}. Static chambers were placed in three of the N treatments (0 kg N ha^{-1}, 168 kg N ha^{-1}, and 235 kg N ha^{-1}) with 4 replications each. Results indicate that N application rate and yield (kg ha^{-1}) share a quadratic relationship in both the AWD and CF models, each with a strong fit (R^2 >0.8). Yield reaches its maximum at ~234 kg N ha^{-1} for AWD and ~188 kg N ha^{-1} for CF. Applying N past these maximum points resulted in a reduction of yield. Overall, yield was not statistically different between AWD and CF. N application rate and NUE were found to share a cubic relationship with a strong fit to the model (R^2>0.9). Water management significantly influenced the effect of N rate on NUE. NUE reaches its local maximum at ~94 kg N ha^{-1} for CF and ~163 kg N ha^{-1} for AWD after which, NUE begins to decrease as more N is applied. In CF management, NUE begins to rebound after ~231 kg N ha^{-1}. Implementing AWD resulted in a 53% decrease in cumulative CH_4 emissions. Neither water management, nor N rate significantly impacted cumulative N_2O emissions. Cumulative CO_2 emissions were significantly influenced by the interaction between water management and N treatment. Water management alone also had a significant effect on cumulative CO_2 emissions independent of N treatment. However, the fitness of the model is weak for both water management treatments (R^2<0.3). Considering the weakness of fit to the model, it is likely that other factors such as organic matter or microbial activities played a larger part in cumulative CO_2 emissions. It is recommended that, under these conditions, a N rate of 163 kg N ha^{-1} be applied to fields undergoing AWD to maximize NUE without risking luxury consumption or environmental impacts of excess N application. However, further research across multiple years is necessary to confirm these results.

Evaluating the Impact of Zinc Based Nanoparticles on Rice Production: Insights into Growth, Soil Health, and Microbial Dynamics

Hettiarachchi, R.H.A.N., Dou, F., Gentry, T., Ma, S., Lasar, H.G.W., and Petrowicz, H.L.

Metal based Engineered nanoparticles (ENPs) have gained significant attention in nanotechnological research for their potential applications as soil amendments. These nanomaterials possess the capacity to enhance soil structure by interacting with soil particles and improving aggregate stability, thereby increasing nutrient availability to plants. This is facilitated by their ability to enhance water retention and regulate soil porosity, which collectively expands the soil's surface area. These materials not only increase these nutrients into the plants but also improve soil plant microbe interactions. This study investigates the effects of various Zinc based nanoparticles, including ZnO NPs as well as their transformed products ZnS NPs, $Zn_3(PO_4)_2$ NPs) and ionic form $ZnSO_4$ on rice production, soil health and microbial dynamics.

The experiment utilized soil collected from rice paddy fields in Agrilife research, Beaumont, Texas and variety XP753, grown in a greenhouse. A randomized complete block design (RCBD) with three replications was employed to evaluate different treatments in pot trials. The study examined the impact of Zn based nanoparticles and transformed products synthesized via a chemical precipitation method at a concentration of 50 $mgkg^{-1}$, along with their transformed products on growth parameters, soil health and microbiological properties within the rhizosphere and rice grain yield. Microbial community structure and their functional dynamics in the rhizosphere were assessed across the treatments using advanced techniques, including DNA extraction, 454 high throughput sequencing and quantitative polymerase chain reaction (qPCR).

Descriptive statistical analysis and analysis of variance (ANOVA) were performed on all soil health indicator and rice production data. The findings revealed that the application of Zn based nanoparticles and their transformed products had varying effects on rice production soil health and microbial community.

Notable observations included significant improvement in growth and yield parameters such as plant height, dry biomass, number of panicles, panicle weight, and grain weight. Additionally, the study identified a microbial community conductive to plant growth across the different treatments.

Validation of Rice Tissue Sampling for In-Season Nutrient Management of Nitrogen, Phosphorus, and Potassium

Smith, T.M., Hardke, J.T., and Roberts, T.L.

Arkansas has led the U.S. in rice (*Oryza sativa* (L.) production since 1973, growing nearly half of all rice produced. Fertilizer and nutrient expenses are the greatest annual expense in rice production in Arkansas. Nutrient management can be impacted by different management practices, soil types, cultivar selection, etc. The nutrients researched in this project are nitrogen (N), phosphorus (P), and potassium (K) because they are the three most important macronutrients involved in rice growth and development and often the most limiting. Tissue sampling serves as a potential tool to provide information about plant nutrient concentrations at given timings and growth stages. With increased interest in tissue sampling and improving nutrient management effectiveness, more information is needed to validate critical plant tissue concentrations at which additional fertilizer inputs may be warranted to maximize rice production and profitability. Additionally, the window of opportunity for nutrient application to make meaningful impacts on rice yield needs to be defined for each of these nutrients. Trials were conducted at the Rice Research and Extension Center near Stuttgart, the Pine Tree Research Station near Colt, and the Northeast Research and Extension Center near Keiser. Trials for N, P, and K were conducted separately. A randomized complete block design with a split block approach was utilized. Trials consisted of seven treatments with four replications. Treatments included an nonfertilized control, a soil test recommended rate, and five timings ranging from panicle initiation (PI) to PI plus 28 days. Plots were split to allow for one fertilized plot and one non-fertilized plot at each tissue sample timing. Fertilizer sources utilized urea (46-0-0), triple super phosphate (TSP; 0-46-0) for P, and muriate of potash (0-0-60) for K. Rates utilized for treatments were equivalent to 122 kg of product per hectare (100lbs/acre). Tissue samples were collected before fertilizer applications for all treatment timings. Final tissue samples were collected from all plots at approximately 50% heading. The objective of this research is to validate rice plant responses during reproductive growth to additional N, P, and K and relate these responses to plant tissue concentrations; and to evaluate and compare the yield difference associated with different fertilizer application timings. The sample process is still being completed, and available data will be presented on nutrient concentration, grain yield, and milling yield.

Critical Thresholds of Alternate Wetting and Drying on Greenhouse Gas Emissions and Rice Yield

Lasar, H.G.W., Petrowicz, H.L., Dou, F., Gentry, T., and Bronson, K.

Water table level is among the key factors affecting greenhouse gas (GHG) emissions in rice paddies. Among water management practices, alternate wetting and drying (AWD) irrigations has shown promise; however, its effectiveness in mitigating GHG emissions while maintaining maximum rice yield remains inconclusive. This study aims to identify a critical AWD threshold that effectively reduces GHG emissions while maintaining comparable yields to continuous flooding systems. Here, we investigated the effect of varying AWD intensities – 100%, 75%, and 50% field water holding capacity (FWHC) – as well as the continues flooding across different soil types on GHG emissions and rice yield. Our findings revealed that AWD at 100% and 75% FWHC did not result in substantial yield reduction. Conversely, AWD at 50%

FWHC led to a significant decrease in yield, particularly in clay soil. We anticipate that the varying AWD intensities will have notable effects on CO_2, CH_4, and N_2O emissions.

Evaluating Agronomic Characteristics and Water Usage of Four Irrigation Regimes in Furrow-Irrigated Rice

Smyly, A.C., Gholson, D.M., Bond, J.A., Bowman, H.D., Bryant, C.J., and Golden, B.R.

The traditional irrigation method for rice *(Oryza sativa L.)* in Mississippi requires large inputs of water throughout the growing season. Irrigation water for rice production in the Mississippi Delta is extensively drawn from the Mississippi River Valley alluvial aquifer (MRVAA) and the aquifer is beginning to deplete. In order for the aquifer to remain sustainable and viable for agriculture, irrigation approaches using less water should be determined. Research has shown furrow-irrigated rice (FIR) to produce rice with less water. However, water distribution and yield are not uniform across the entire field and yield tends to lack in the upper zone of a FIR field. This study was conducted to evaluate rice response, agronomic characteristics, and water usage of four different irrigation regimes.

Research was conducted at the Delta Research and Extension Center in Stoneville, MS in 2021, 2022, and 2023. Four different irrigation regimes (irrigating every day, every 3, 5, and 7 days), each replicated 3 times, were the assigned treatments for this study. Soil moisture, water level depths, and water usage were recorded using WaterMark® Soil Moisture Sensors, Pani-Pipes, Precision King AgSense Sensors, and flowmeters. Rice grain yield and milling yield were determined for each treatment plot and each zone within treatment plots. Plots irrigated every day used 0.39 (2022) and 0.34 (2023) hectare-meters of water compared to 0.12 (2022) and 0.11 (2023) hectare-meters when irrigating every 7 days. On average, across all 3 years, plots irrigated every day produced numerically greater yields (10,222 kg ha^{-1}, 10,625 kg ha^{-1}, and 12,105 kg ha^{-1}) compared to all other irrigation regimes. Across all irrigation treatments, the bottom zone out yielded the middle and top zones where water levels tended to drop quicker. FIR is another irrigation method, but research still needs to be done to determine if FIR is a sustainable method for growing rice and using less water.

Effect of High Night Temperature on Metabolite Accumulation in Rice Pollen Development

Munkaila, M., Lamichhane, S., and Tarpley L.

Night temperatures will rise over the next few decades in the Southern U.S. rice growing region. High night temperatures in this region are often detrimental to seed set in the tropical japonica rice typically grown here. Seed set largely depends on pollen viability and function. Although the impact of high night temperature on pollen is known, the physiological and biochemical components of the impact are still unclear. The study investigated the impact of high night temperatures on metabolite accumulation in pollen development in two rice varieties, Colorado' and 'Antonio' contrasting in response to high night temperature. Two temperature conditions, ambient night temperatures (24/25 ^{O}C) and high night temperatures (30 ^{O}C) were imposed on the two varieties at early rice booting stage. Rice pollen was collected at anthesis and analyzed for viability, germination and metabolite accumulation. Spikelet fertility, grain yield and quality were also determined.

Fish Cultivation in Fallow Season Rice Fields: Effects on CH_4 Emissions

Carroll, S.R., Moreno-Garcia, B., Mahbub, R.B., Reba, M.L., and Runkle, B.R.K.

Rice cultivation is important for the global food supply, but the flooded production conditions mean that it is a large contributor of the greenhouse gas (GHG) methane (CH_4) to the atmosphere, generating about 8% of global anthropogenic CH_4 emissions. This impact is important since CH_4 has 28-34 times more global warming potential than carbon dioxide (CO_2). While most of these emissions take place during the growing season when fields are flooded and temperatures are higher, less is known about the contribution of fallow season emissions. As a result, CH_4 emissions reduction strategies tend to focus on the growing season. However, around 27.5% of Arkansas rice fields are flooded in the winter as well, which can increase CH_4 emissions in the fallow season by 45% compared to non-flooded fields.

One possible strategy to decrease fallow season CH_4 emissions is co-cultivation, a process whereby rice and aquatic animals are cultivated in the same field. Co-cultivation techniques can reduce CH_4 emissions through trophic cascading and provide a second revenue stream to farmers along with the rice crop. The objective of this research was to analyze the effects of golden shiners, a native fish species, on fallow season GHG emissions in an Arkansas rice field using the eddy covariance (EC) method.

This study uses a pair of adjacent fields in Lonoke County, Arkansas to quantify the effects of fish on fallow season CH_4 emissions with fish added to the North Field (NF) and the South Field (SF) left flooded with no fish. Gas flux measurements were taken using the EC method. Water samples were taken weekly to be analyzed for zooplankton abundance, phytoplankton abundance, algal biomass, total nutrients, and dissolved nutrients. Gaps in the CH_4 flux data were filled using a random forest model using an 80/20 train/test split.

Initial results on CH_4 emissions reductions are mixed, with lower emissions in the NF (fish added) in the 2022-2023 season and lower emissions in the SF (no fish) in the 2023-2024 season. Cumulative seasonal emissions, measured from initial flooding to fish harvest, were 1.63 CH_4-C ha^{-1} and 6.06 CH_4-C ha^{-1} for the NF and SF, respectively for the 2022-2023 season and 3.11 kg CH_4-C ha^{-1} and -0.62 CH_4-C ha^{-1} for the NF and SF, respectively in the 2023-2024 season. Both fields, however, were found to have much lower emissions than those found during the growing season in other studies, lending confidence to recommending winter flooding practices for waterfowl or other biodiversity initiatives without generating substantial GHG impacts. Certain difficulties such as gaps in the data, lack of field replicates, and inconsistencies between the fields make it challenging to relate impacts on CH_4 emissions to presence of the fish. Incorporation of the water sample results, as well as more years of data, could provide more insight into the ecological mechanisms at work in this system.

ABSTRACT OF PAPERS FROM THE STUDENT ORAL CONTEST PANEL: PLANT PROTECTION

Moderators: Sanuel de Paula, Dulakshi Mohottige, and Bruno Borges

Yeast as a Biological Control for Rice Kernel Smut

Goetze, P.K., Zhou, X.G., and Jo, Y.K.

Rice kernel smut (RKS, *Tilletia horrida*) is a recurring fungal disease in the United States' Rice Belt region. With limited fungicide options and growing concerns about fungicide resistance development for the disease, there is an increasing need for alternative solutions. Biological control methods represent this new alternative possibility for disease suppression in an environmentally friendly way. In this study, yeast biocontrol candidates were isolated from rice flowers and pollens originating from the Texas Gulf Coast. All candidates were screened in the laboratory for RKS control efficacy. This lab screening was accomplished by a two-step process using a well-plate broth assay and a petri-dish inhibition assay. High-efficacy candidates (>50% inhibition of RKS) were further determined for their additional phenotypes such as drought tolerance, heat tolerance, yeast-to-yeast inhibition, and fungicide tolerance. The top candidates – especially isolates of *Dirkmeia churashimaensis*, *Moesziomyces antarticus*, and *Sporidiobolus pararoseus* - will be evaluated for RKS control in field trials during 2025.

Sheath Blight Management in Mississippi Furrow Irrigated Rice

Mangialardi, G.A., Eubank, T.W., Bond, J.A., Allen, T.W., Whitt, D.R., King, T.A., and Dodd, J.B.

Most rice produced in the United States is either dry- or wet-seeded, with dry-seeding most common in Arkansas, Mississippi, and Texas. After germination, moisture is maintained until plants are mature enough to survive in flooded conditions. Furrow-irrigated rice has gained popularity in the interest of water conservation and reduced labor needs. Removing flood water can potentially induce more disease incidence, especially sheath blight that can cause up to 45% yield reduction. Little research has been conducted on how to best manage disease issues such as sheath blight in a furrow-irrigated system.

A field study was established at the Mississippi State University Delta Research and Extension Center in Stoneville, MS, from 2022 to 2024 to evaluate nitrogen (N) fertilizer rate and fungicide treatment effect on sheath blight incidence and severity in a furrow-irrigated rice system. Experimental design was a randomized complete block with a 2 (N fertilizer rate) x 6 (fungicide treatment) factorial arrangement of treatments and four replications. The N fertilizer rates were 201 and 403 kg N ha^{-1} applied at the one-tiller growth stage. Fungicide treatments included no fungicide, azoxystrobin, propiconazole, azoxystrobin plus difenoconazole, flutolanil, and azoxystrobin plus propiconazole at labeled rates applied at mid-boot growth stage. Sheath blight inoculum was applied at panicle initiation growth stage of rice to ensure consistent disease infestation. Data were subjected to ANOVA and estimates of least squared means were utilized for mean separation ($p \leq 0.05$). Additionally, a survey was conducted to evaluate incidence and severity of sheath blight in furrow-irrigated rice across the Mississippi Delta region. Sheath blight incidence and severity ratings were collected from 54 commercial rice fields from 2022 to 2024. Fields were concentrated in counties where rice is commonly grown in the Mississippi Delta. Fields surveyed were at 50% heading to maturity and observations were collected from a single visit to each field during July or August. For sampling purposes, the fields were separated into three separate zones (top, middle, and bottom) to determine any zonal differences related to sheath blight incidence and severity.

In the replicated field study, incidence and severity of sheath blight increased with nitrogen rate. In plots treated with 403 kg N ha^{-1}, sheath blight incidence was $\geq$ 2% higher than in plots treated with 201 kg N ha^{-1}. Sheath blight severity ratings were also greater in plots treated with the higher rate of N. Despite greater disease incidence and severity, plots treated with the higher N rate produced yield $\geq$ 1,000 kg ha^{-1} greater than plots treated receiving the lower N rate. Fungicide application had no effect on incidence, severity, or rice yield. Results from the survey indicated greater sheath blight incidence in the top and middle zones of commercial furrow-irrigated rice fields compared with the bottom zone. Sheath blight severity, however, was greatest in the middle zone. Nitrogen fertilizer rate can severely affect sheath blight incidence and severity but may not necessarily lead to rice yield reductions. Fungicides may aid in extremely severe cases but proved to be unimportant to incidence, severity, or rice yield in this study. Though more sheath blight was present in the top zone of surveyed fields, severity seemed to be influenced more by changing water levels in the middle zone.

Compatibility of Insecticidal Seed Treatment and Host Plant Resistance in Management of Stem Borers in Rice

Khan, M.D., Stout, M.J., and Wilson, B.E.

The rice water weevil, *Lissorhoptrus oryzophilus*, is the most important insect pest of rice in the United States. Additionally, lepidopteran pests, particularly stem borers, also threaten the U.S. rice crop. The Mexican rice borer, *Eoreuma loftini* (Lepidoptera: Crambidae), is an invasive pest that affects sugarcane (*Saccharum spp.*), rice (*Oryza sativa L.*), and other graminaceous crops. Insecticidal seed treatments like chlorantraniliprole are used to control both the rice water weevil and the Mexican rice borer. However, reliance on a single insecticide increases the risk of resistance, urging the development of alternative management strategies. A field study was conducted in Crowley, Louisiana, evaluated the impact of plant resistance and the compatibility of chemical control for managing the Mexican rice borer. Four commonly grown rice varieties (Cheniere, Mermentau, Jazzman, and PVL03) were treated with four insecticides: Dermacor (chlorantraniliprole) for controlling borer and weevils, Fortenza (cyantraniliprole) and Cruiser (thiamethoxam) for controlling weevils only and untreated control. A two-factor factorial design with a randomized complete block design was used with four replications. Results showed moderate resistance among cultivars against the rice water weevil, with Mermentau and PVL03 having the fewest weevils. Fortenza-treated plots exhibited the lowest weevil numbers. Variety had a highly significant effect on stem borers, with Mermentau showing the fewest whiteheads and PVL03 being the most susceptible. Dermacor failed to control borers, however, Cruiser-treated plots unexpectedly had high whitehead counts. The interaction between varieties and insecticides was significant for stem borers but there was no compatibility found between varietal resistance and insecticidal seed treatment for stem borers.

Determining the Impact of Resistant Cultivars Against the Rice Billbug (*Sphenophorus Pertinax* Olivier) in Furrow-Irrigated Rice (*Oryza sativa* L.)

Musgrove, T., Landry, K., Villegas, J.A., Stout, M.J., Bateman, N.R., Floyd, C.A., Cook, D.R., and Wilson, B.E.

The rice billbug (*Sphenophorus pertinax* Olivier) is an important pest of furrow-irrigated rice (FIR) across the Midsouth. Female *S. pertinax* deposit eggs into feeding holes near the base of the plant where larvae emerge and feed. Larval injury leads to blank panicles, aka whiteheads. Experiments were conducted to determine the impact of resistant cultivars on *S. pertinax* injury and to define the yield loss relationship associated with *S. pertinax*. Rice was planted at two locations in Louisiana and three additional locations in Arkansas, Missouri, and Mississippi in 2024 using cultivars ‘Addi Jo’ (tolerant) and ‘CLL17’ (susceptible) compared to ‘PVL03’ (RT7401 in Arkansas) and ‘RT7521FP’ under protected vs unprotected conditions. Adult feeding injury (dead tillers) and whiteheads were quantified per m^2 and rice was harvested at grain maturity with a whole-plot harvester. Data was subjected to GLMM in SAS using PROC GLIMMIX and means were separated using Tukey’s HSD (α=0.05). The effect of variety and insecticides on whiteheads/m^2 and/or rough rice yields were detected in Louisiana, Missouri, and Arkansas. At each site in Louisiana, both Addi Jo and PVL03 significantly reduced whiteheads/m^2 compared to CLL17 and RT7521FP. An interaction was detected between insecticides and cultivar on rough rice yields, suggesting that CLL17 and RT7521FP were tolerant of *S. pertinax* injury despite heavy insect pressure. Regression analysis revealed that whiteheads/m^2 was found to be a significant linear predictor of percentage yield loss in Louisiana and Arkansas. Results indicate that varieties common to FIR may be tolerant of *S. pertinax* larval feeding injury.

Rice Growth Stage Influences the Vulnerability of Rice Plants to Infestation by Mexican Rice Borer Larvae

Osako, M.L.M. and Bernaola L.

Among the key insect pests impacting U.S. rice (*Oryza sativa*) crops are the invasive stemborer complex, which includes the Mexican rice borer (*Eoreuma loftini* Dyar), the sugarcane borer (*Diatraea saccharalis* Fabricius), and the rice stalk borer (*Chilo plejadellus* Zincken), all members of the Lepidoptera: Crambidae family. Of these, the Mexican rice borer (MRB) poses the most significant threat to Texas rice production, with reports indicating potential yield losses of up to 50% due to its damage. A primary symptom of MRB infestation is the formation of whiteheads, characterized by whitish, dry panicles that lead to reduced yields. Currently, the main control method for MRB relies on a single insecticide seed treatment, Dermacor X-100 (Chlorantraniliprole), an anthranilic diamide. However, the dependence on this sole chemical raises concerns about the development of resistance. This highlights the urgent need for new Integrated Pest Management (IPM) strategies.

A no-choice experiment in the greenhouse evaluated the susceptibility of three rice varieties and four growth stages to MRB damage. The study aimed to assess whether whiteheads formed and if the larvae could complete their life cycle, including the timing of these events. Identifying resistant rice genotypes is crucial for the development of sustainable IPM strategies. Variety resistance offers an economical, durable, and environmentally responsive method of pest control.

The experiment was conducted in a greenhouse at the TAMU AgriLife Research Center, Beaumont, TX, using three rice varieties (PVL03, Jupiter, CL111) at different growth stages: mid-tillering, panicle differentiation, booting, and heading. Plants were grown individually, one per pot. MRB infestations were affected by placing one second instar larva to primary tillers. Growth stages were confirmed by dissecting non-infested plants. Whitehead formation and MRB life cycle completion were monitored weekly and analyzed by growth stages. ANOVA analysis revealed no significant differences in MRB emergence, whitehead formation, or the number of whiteheads across the three rice varieties and four growth stages with p-value > 0.05. This one-year study could suggest that the varieties had similar levels of susceptibility to MRB damage, regardless of the growth stage at which they were infested. These findings emphasize the need for continuous exploration of these rice varieties for a better understanding of the relationship between MRB development and rice plants vulnerability. This strategic approach would support the adoption of more holistic IPM practices and promoting long-term sustainability in Texas rice production.

Field Varietal Performance Against the Rice Stink Bug (*Oebalus pugnax)* in Texas Rice

Agpawa, E. and Bernaola, L.

An issue present with Texas rice production is the insect pest, *Oebalus pugnax* F. (Hemiptera: Pentatomidae), commonly known as the rice stink bug (RSB). This is a late season pest that feeds on rice panicles which can lead to economic losses but can be controlled through insecticidal treatment, which is the primary method of control. Over reliance on insecticides over time can lead to the formation of RSB populations resistant to these chemicals. Additionally, some of these chemicals are non-specific on what they target, leading to a higher risk of affecting non-target organisms and causing further harm to the environment. One promising alternative is to utilize host-plant resistance. In this study, the resistance of commercial rice varieties grown in the Texas Rice Belt was assessed towards the RSB. The objective of this study was to determine how rice yield is impacted by the presence of RSB and habitational and ovipositional preference of the RSB towards those same varieties.

A randomized block design field experiment was conducted in 2024 at the Texas A&M AgriLife Research Center, Beaumont, TX. This study included conventional inbred (Cheniere, Presidio, Jupiter) and herbicide-tolerant varieties (PVL03, and CL111). Resistance was evaluated by comparing densities of individual RSBs (adults and nymphs), ovipositional preference, and yield performance of each variety taken on a weekly basis (during four consecutive weeks) once rice had reached the flowering stage. Rice was then harvested after maturity to obtain yield performance. ANOVA and Kruskal-Wallis tests were then conducted to determine differences for yield, RSB adults, and ovipositional preference. Analysis of data showed that Jupiter and Presidio were observed to have the highest yields; differences were significant between the means of all varieties. For RSB adult preference, a significant difference was observed during the first week, but the following weeks had non-significant results. This may suggest potential preference for the varieties Jupiter and PVL-03. For ovipositional preference, results were not significant. Overall, results suggest that PVL-03 is susceptible to RSB. As for Jupiter, results may indicate some tolerance to RSB. Additional experiments would be required to better understand and corroborate these results. The information obtained from this study would help contribute different control strategies against the RSB that are not reliant on insecticides. This would also assist in reducing both direct and indirect costs for controlling the RSB and help guide future breeding programs to create varieties that respond well towards RSB pressure.

Evaluating Defoliation Thresholds and the Efficacy of Foliar Insecticide Applications for Control of Armyworms in Rice

Fletcher, W.A., Bateman, N.R., Thrash, B.C., Plummer, W.A., Felts, S.G., Harris, T., Maris, P.G., and Linn, J.B.

Armyworms are commonly found in rice fields across Arkansas and have the capability to cause severe defoliation of rice plants leading to significant yield losses. Recent studies have established a damage threshold in pure-line rice cultivars for armyworms, however, hybrid cultivars have yet to be evaluated. Studies were conducted in 2022, 2023, and 2024 on pure-line and hybrid cultivars in order to establish a damage threshold for hybrid cultivars. Plots of each cultivar were mechanically defoliated to 100% using a weed eater at the two- three leaf, early tiller, late tiller, and green ring growth stages across an April, May, and June planting. Similar yield loss trends were observed at the two- three leaf and early tiller growth stages between pure-line and hybrid cultivars at all planting dates. Hybrid cultivars suffered less yield loss at the late tiller and green ring growth stages for the second and third planting dates. These data suggest that thresholds could potentially be increased in hybrid cultivars compared to pure- line cultivars. In another study in 2024, the efficacy of several insecticides was tested for control of fall army worms (Spodoptera frugiperda). Insecticides tested include lambda cyhalothrin 3.65 and 5.0 oz per acre, Intrepid, Intrepid Edge, Denim, Beseige, Plemax, Diamond, and SpearLep +Leprotec. The results of this study suggest that Intrepid, Intrepid Edge, Denim, Beseige, Plemax, and Diamond provided control of fall army worms at all sampling dates.

Rice Water Weevil Scouting Methods and the Efficacy of Foliar Insecticide Applications Applied Pre and Post Flood for Control of Rice Water Weevils

Maris, P.G., Bateman, N.R., Thrash, B.C., Hardke, J.T., Kariyat, R., Plummer, W.A., and Felts, S.G.,

Rice water weevil (*Lissorhoptrus oryzophilus*) is the most economically important insect pest for flooded rice production in the southern US. Current scouting methods for rice water weevils (RWW) are based on feeding by adult RWW on plant foliage or the population of RWW larvae in the root zone. Traditionally, foliar insecticide applications are recommended when 50-60% of new leaves have feeding scars or when five or more larvae are present in a four cubic inch soil core. These sampling methods are cumbersome and inefficient, which can lead to growers making applications too late to effectively control RWW. Sweep nets are used to scout for insect pests in many row crops, therefore utilizing them to scout for RWW would streamline the process and make scouting more similar to the techniques that producers and consultants are already accustomed to. A study was conducted in 2023 and 2024 at two locations in Arkansas to determine the relationship of adult RWW caught in a sweep net to plant tissue scarring, larval populations, and yield. Preliminary results suggest that there is a relationship between adult populations, larval numbers, and yield, however continued research is required to establish a sweep net threshold for RWW adults. Another study was conducted in 2023 and 2024, evaluating the efficacy of foliar insecticides applied pre and post flood for control of RWW. Overall, Endigo ZCX applied post flood and Vantacor applied pre-flood showed the greatest percent control of RWW larvae. Vantacor pre-flood and Endigo ZCX pre-flood increased yield when compared to the untreated check.

Evaluating the Effect of Insecticide Treated Seed for Managing Rice Water Weevil (Coleoptera: Curculionidae) in Alternate Wetting and Drying Rice Systems

Linn, J.B., Maris, P.G., Fletcher, W.A., Nicolli, C., Kariyat, R., and Bateman, N.R.

Alternate wetting and drying (AWD) is a novel rice water management system designed to reduce water-related costs. However, limited research has investigated the effects of AWD systems on management rice water weevil, *Lissorhoptrus oryzophilus* Kushel (Coleoptera: Curculionidae), and the efficacy of insecticide-treated seeds. To investigate the efficacy of insecticide seed treatments a split-split plot design was initiated at the Pine Tree Research Station near Colt, AR in 2024. The main plot treatment consisted of two water management systems: a conventionally flooded system and AWD system. Subplots were arranged in randomized complete blocks with four replications. The treatments included five cultivars (CLL16, DG263L, Ozark, RT7421FP, and Taurus) and three seed treatments: an untreated control, thiamethoxam (TMX), and thiamethoxam + cyantraniliprole (TMX+Cy).

Water management had no effect on larval densities, however an interaction with seed treatment was observed. The TMX+Cy seed treatment had the highest efficacy with 4.9 and 6.1 larvae/820 cm^3 in the conventional flooded and AWD systems. TMX treated seed performed similarly between both systems with densities of 12.0 and 16.4 larvae/820 cm^3 for conventional and AWD systems, respectively. However, the TMX treatment in AWD performed similarly to the untreated control in both water management systems which averaged around 24 larvae/820 cm^3. No interaction between water management systems and seed treatment was observed in terms of yield production. TMX+Cy treated seed averaged 9,049.8 kg/ha, TMX performed similarly with 9,014.5 kg/ha but did not differ from the untreated control which averaged of 8,767.5 kg/ha. Additionally, the AWD system averaged 8,762.3 kg/ha which was a 4% yield reduction from the conventional system. Overall, the AWD system had no effect on rice water weevil control and resulted in reduced overall yield. Additionally, TMX-treated seed lost its effectiveness under AWD conditions, highlighting its limited application for managing rice water weevil in this system.

Best Management Practices for Pyrethroid Resistant Rice Stink Bugs in the Mid-South

Lytle, M.J., Cook, D.R., Crow, W.D., Towles, T.B., Bond, J.A., Gore, J., Catchot, A.L., Bateman, N.R., and Lipsey, H.L.

The rice stink bug, *Oebalus pugnax* (F.), is a key late season insect pest in Mississippi and Mid-South rice (*Oryza sativa* L.) production. Historically, Mississippi rice producers have been dependent on pyrethroids to effectively control rice stink bugs because they are more cost effective than other insecticide classes. The damage associated with rice stink bug feeding has the potential to result in yield loss, which can be attributed to rice grain development being restricted and profit loss due to decreased grain quality (e.g., peck) and subsequent milling damage. Currently labeled insecticides for use in Mississippi rice production include dinotefuran (Tenchu), gamma-cyhalothrin (Declare), lambda-cyhalothrin (Warrior II), malathion (Malathion 57 EC, Malathion 5EC), and zeta-cypermethrin (Mustang Maxx), but failed pyrethroid applications have been reported across the rice producing region of Mississippi. Reductions in efficacy potentially indicate an increased tolerance and ultimately, resistance to the pyrethroid class. These control issues may be the result of overreliance on pyrethroids, due to the cost effectiveness of the insecticides. Current input prices surrounding rice production may impact insect pest management decisions. With an already limited number of chemical options for rice stink bug control, the loss of an economical insecticide may be challenging for Mississippi rice producers to protect yields.

ABSRTACT OF PAPERS FROM THE STUDENT ORAL CONTEST PANEL: WEED CONTROAL AND GROWTH REGULATION
Moderators: Sam Rustom and Lawson Priess

ACCase Resistance Progression in Weedy Rice and Barnyardgrass Since 2022

Avent, T.H., Norsworthy, J.K., Botelho, R., Arnold, C.T., and Scott, R.C.

The University of Arkansas System Division of Agriculture offers herbicide resistance screening services to help producers in the state understand what resistance is present in fields and what herbicide options would be effective in the subsequent year. Postemergence-applied acetyl-coenzyme-A-carboxylase-inhibiting herbicides are among the least occurring resistance cases in barnyardgrass [*Echinochloa crus-galli* (L.) P. Beauv.] and weedy rice (*Oryza sativa* L.), but producers need more insight into the spread and distribution of resistance. Results reported here include screenings of samples submitted from the 2022, 2023, and 2024 growing seasons. Barnyardgrass samples were screened with 1x rates of cyhalofop (2022) or fenoxaprop (2023 and 2024) and quizalofop (all years), while weedy rice samples were screened with 1x rates of quizalofop. All samples were reported as susceptible or resistant. Data included field history and county, if provided with samples. Field history was consolidated to "no history," "crop rotation," or "continuous rice" if the field had been in rice production for three or more consecutive years. The first quizalofop-resistant weedy rice sample was reported in 2022 from a field in Jefferson County that had been in continuous rice production for 5+ years. From 2024, 10 of 74 (14%) submitted weedy rice samples tested positive for resistance to quizalofop from six fields in Jefferson, Faulkner, Lonoke, or Monroe counties. Four of the fields were in continuous rice for at least 4 years, and field history did not accompany samples from the other two fields. The 2024 barnyardgrass screening is still ongoing, but as of December 12, 2024, only one sample has resistance from 2022 to quizalofop (<1% of all samples), and 26% of the 192 samples screened have resistance to fenoxaprop or cyhalofop.

Addressing Suspected Resistance of White Margin Sedge to ALS-Inhibiting Herbicides

Ross, A.D., Norsworthy, J.K., Sudhakar, S., and Avent, T.H.

White margin sedge (*Cyperus macrostachyos* Lam.) is a relatively new problem weed of rice (*Oryza sativa* L.) in Arkansas and Missouri. Growers in the Mississippi Delta region have reported this weed surviving applications of various herbicides typically used to control other sedge weeds, including products like Ricebeaux™ (propanil + thiobencarb), Sharpen™ (saflufenacil), and Gambit™ (halosulfuron + prosulfuron). The failure of the acetolactate synthase (ALS)-inhibiting herbicides Gambit™ and Regiment™ (bispyribac-sodium) to control an accession of white margin sedge was observed in preliminary research trials. This validated the reports of growers and spurred an investigation into the cause of resistance. Given the abundance of resistance-conferring mutations in other ALS-inhibitor-resistant weed species, the full transcriptome of white margin sedge was sequenced to locate the ALS-encoding region. After location, the presence or absence of the eight single-nucleotide polymorphisms (SNPs) known to confer resistance was determined. A substitution of glutamate at aspartate-376 (standardized to *Arabidopsis thaliana* (L.) Heynh.) was confirmed in each accession. Once identified, a pair of primers were designed to amplify the transcriptome region only immediately surrounding the Asp-376-Glu mutation, and additional accessions were sequenced. The Asp-376-Glu mutation was present in every accession analyzed, only being absent in a single plant from accession WMS-23-43.

In ongoing research, the resistance of mutant white margin sedge accessions will be characterized in response to ALS-inhibiting herbicides in a greenhouse study. Each of the five chemical families that comprise the ALS inhibitors will be examined: the sulfonylureas (SU), imidazolinones (IMI), pyrimidinyl thiobenzoates (PTB), triazolopyrimidines (TP), and triazolinones (TN). The following treatments will be sprayed, as well as a nontreated control, when white margin sedge plants are 5 to 15 cm tall: the SU halosulfuron-methyl at 66 g ai/ha; the IMIs imazethapyr at 105 g ai/ha, imazamox at 52.5 g ai/ha, and imazaquin at 137 g ai/ha; the PTB bispyribac-sodium at 32 g ai/ha; the TP penoxsulam at 49 g ai/ha; and the TN thiencarbazone-methyl at 15 g ai/ha. Visual ratings and heights will be taken 2, 3, and 4 weeks after treatment (WAT); and biomass will be collected and weighed at 4 WAT. Results will be presented to better understand the activity of these herbicides on white margin sedge along with sequencing of the mutation site within ALS for this specific population.

Influence of Bleacher Herbicides on Rice with and without Seed Treatment Safeners

Baxley, R.C., Norsworthy, J.K., Avent, T.H., Pierce, L.D., Carvalho-Moore, P., Smith, J.T., Barber, L.T., and Scott, R.C.

The sustainability of profitable rice production in the mid-southern U.S. is threatened by the ongoing occurrence of herbicide resistance. Populations of key rice weed species, such as barnyardgrass [*Echinochloa crus-galli* (L.) P. Beauv.] and weedy rice (*Oryza sativa* L.), have evolved resistance to many of the herbicides that are commercially available. Therefore, it is undoubtedly necessary to incorporate alternative, effective herbicide chemistries into rice weed control programs. In the summer of 2023, a randomized complete block design study was initiated at the Pine Tree Research Station near Colt, AR, to evaluate the effectiveness of eight potential safeners for rice protection against herbicides that cause bleaching symptoms. Seed of the rice cultivar Ozark was treated with one of the eight safeners and was compared to treatments without a safener. Using a Hege drill, plots were planted nine rows wide at 59 seeds/m at a depth of 1.5 to 2 cm and each three rows represented a microplot for each seed treatment. The safeners evaluated included fluxofenim, fenclorim, benoxacor, cloquintocet, dichlormid, mefenpyr, isoxadifen, and cyprosulfamide. The rates that seed treatments were applied will remain undisclosed at this time. The seven herbicides evaluated included topramezone, tembotrione, mesotrione, tolpyralate, diflufenican (DFF), fluridone, and clomazone at a preemergence (PRE) application timing. All herbicides were applied at rates labeled in other crops, except clomazone, which was applied at 674 g ai/ha, a 2X rate for a silt loam soil. Although clomazone was the only herbicide evaluated that is labeled for rice, cosmetic injury in the form of bleaching on early-season rice can occur following its use. Crop injury was assessed at 14, 21, and 28 days after rice emergence (DAE). Crop densities were recorded 14 DAE, from two one-meter sections of row per plot. At 14 DAE, each of the safeners differed in ability to reduce phytotoxicity relative to herbicides applied without a seed treatment. Fluxofenim and fenclorim provided significant reduction in injury following applications of clomazone and mesotrione, However, when mesotrione was applied, cyprosulfamide appeared to induce higher bleaching and injury than that of the non-treated seed. The increase in injury from mesotrione exhibited by cyprosulfamide could be attributed to enhancing uptake of the herbicide or prevention of metabolism. The extent of observable phytotoxicity to rice differed among herbicides, with tembotrione and DFF causing the least amount of crop injury (≤ 5%). These results indicate that there may be potential for some of the evaluated seed treatments to safen rice to PRE-applied bleaching herbicides, and that DFF and tembotrione should be further evaluated for use in rice.

Evaluation of Safeners for Group 15 Herbicides Applied as a Seed Treatment in Rice

Malone J.C., Norsworthy J.K., Baxley R.C., and Barber L.T.

The occurrence of herbicide resistance and the limitation of effective herbicides to control problematic weeds has caused Arkansas rice (*Oryza sativa* L.) producers to search for alternate control measures. In the United States, very long-chain fatty acid elongase inhibitors (Group 15) are not labeled in rice. However, research has shown the effectiveness of microencapsulated acetochlor, a Group 15 herbicide, in rice. The objective of this experiment was to evaluate the effectiveness of several potential herbicide safeners applied as seed treatments in rice, followed by the application of Group 15 herbicides. Research was conducted in 2024 at the Pine Tree Research Station near Colt, AR. The experiment was designed as a factorial arrangement of treatments, consisting of herbicide and seed treatments. Herbicide treatments included: dimethenamid-P (Outlook) at 740g ai/ha, acetochlor (Warrant) at 1260 g ai/ha, *S*-metolachlor (Dual Magnum) at 800 g ai/ha, pyrozasulfone (Zidua) at 73 g ai/ha, and no herbicide. The seed treatments included: fluxofenim, fenclorim, benoxacor, mefenpyr, isoxadifen, cyprosulfamide, cloquintocet, dichlormid, and no safener. Rates of seed treatments cannot be disclosed at this time. All herbicides were applied on the day of planting. Rice injury ratings, shoot counts, and biomass data were collected. At 14 days after rice emergence, some safening of rice to *S*-metolachlor occurred for benoxacor and fenclorim; however, at the *S*-metolachlor rate tested, injury exceeded 60% for all potential safeners. Fenclorim was the only seed treatment to provide significant safening of rice to dimethenamid-P, but even then, injury exceeded 90%. Similarly, fenclorim was the only seed treatment to safen pyroxasulfone, although injury exceeded 75% for all seed treatments. Conversely, commercial rice tolerance to the microencapsulated acetochlor resulted when the seed was treated with fluxofenim, benoxacor, or fenclorim, with the herbicide causing only 16%, 5%, and 4% injury to the crop, respectively, at 14 days after emergence. Shoot and biomass data were more variable, but generally closely matched the injury ratings.

A New Cyperaceae Genus Infesting Louisiana Rice (*Oryza Sativa* L.)

Sparks, G.R., Webster, L.C., Hains, M.P., Stoker, S.B., Carr, W.B., and Williams, E.M.

Over the past several years (*Fimbristylis littoralis* G.) has become a prevalent issue throughout southwestern Louisiana rice production. Although Fimbristylis belongs to the sedge family, control options differ compared to the typical sedge species that infest rice fields in Louisiana. Fimbristylis is commonly misidentified as rice flatsedge (*Cyperus iria* L.), which can be problematic due to differing control options. Due to the recent introduction to rice production in the U.S., there is little evidence of effective control options for Fimbristylis. Therefore, in 2022 an on-farm trial was conducted near Abbeville, Louisiana on a Crowley silt loam soil to determine post emergence control options for Fimbristylis.

The experiment was organized as a randomized complete block comparing common systemic and contact herbicides used in Louisiana rice production. The study consisted of four replications including 15 herbicide treatments and a nontreated added for comparison. The plots were 1.5 by 5m in size. Treatments were applied postflood using a CO_2-pressurized backpack sprayer calibrated to deliver 140 L ha^{-1}. The application was made at 4.8 kmh when the Fimbristylis was 15 to 20 cm in height with a population ranging from 15 to 20 per m^{-2}. Visual ratings for Fimbristylis control were observed at 7, 14, and 28 DAT. Applications of 2,4-D at 798 g ai ha^{-1} and 1065 g ai ha^{-1} controlled Fimbristylis 90 and 99% at 14 DAT, and 91 and 98% at 28 DAT, respectively. Triclopyr applied at 315 g ai ha^{-1} controlled Fimbristylis 98% at 14 DAT and 93% at 28 DAT. When byspiribac was applied at 33.6 g ai ha^{-1} 19, 79, and 83% control of Fimbristylis was observed at 7, 14, and 28 DAT, respectively. The results of this experiment indicate that applications of 2,4-D and triclopyr are effective options for Fimbristylis control. Additionally, byspiribac is an effective control option although control is achieved at a slower rate than 2,4-D and triclopyr. Supplemental research is needed to determine additional control options due to 2,4-D restrictions.

Does Application Timing Effect Rice Tolerance to Brake in a Flooded Rice System?

Dodde M.R., Norsworthy J.K., Souza M.C.C.R., Carvalho-Moore P., and Barber L.T.

Rice tolerance to herbicides can vary depending on the growth stage at which the application is made. Fluridone, under the trade name Brake®, recently became labeled for use in rice to add a new site of action for producers to help combat Palmer amaranth [*Amaranthus palmeri* (S.) Wats]. Field experiments were conducted in 2022 and 2023 at the Rice Research and Extension Center in Stuttgart, AR, to determine the effect of application timing on rice tolerance to fluridone. The experiment was conducted as a randomized complete block design with four replications. Treatments included fluridone applied at 168 g ai hectare^{-1} at ten timings: 20 and 10 days preplant, preemergence (PRE), delayed-preemergence (DPRE), 1-leaf, 2-leaf, 3-leaf, 4-leaf, tillering (preflood) and immediately after flooding (postflood). A weed-free control for comparison was also included. Visual injury was assessed weekly, and rice canopy coverage was estimated 10 weeks after emergence (WAE). Rough rice grain yield was determined at harvest. The highest injury observed at the 3 WAE evaluation time in 2022 was 5%. However, injury in 2023 reached 24% at this time caused by the PRE treatment. A large increase in injury in 2022 was observed at 10 WAE, with the PRE and DPRE treatments causing 36% and 32% injury, respectively. In 2023, injury levels dropped for all treatments by 10 WAE except for the PRE treatment, which resulted in 39% injury. The PRE treatment caused the greatest reduction in canopy closure in both years, with a decrease of 4% in 2022 and 21% in 2023. In 2022, the PRE and DPRE treatments caused a yield reduction compared to the weed-free control, while only the PRE treatment led to a yield reduction in 2023. Based on these findings, application timing of fluridone influences rice tolerance, and early applications, such as PRE and DPRE, should be avoided.

Crop Response of Provisia Rice Systems in Overcast Weather

Carr, W.B., Webster, L.C., Arcement, M.P., Stoker, S.B., Sparks, G.B., and Williams, E.M.

Crop injury in herbicide-resistant rice (*Oryza Sativa* L.) can be induced by decreased herbicide metabolism as a result of adverse growing conditions. In 2023 and previous growing seasons, crop injury has been observed when quizalofop was applied at the labeled rate in Provisia® rice during periods of low solar radiation and low temperatures.

In 2023 and 2024, at the H. Rouse Caffey Rice Research Station near Crowley, Louisiana, three studies were conducted to evaluate overcast weather conditions before and after quizalofop applications in Provisia® rice. Shade cloths (The Shade Cloth Store, Mundelein, Illinois 60060) were used in these studies to simulate overcast growing conditions. Each study was set up as a three-factor factorial arrangement of treatments with three replications. Factor A consisted of overcast conditions simulated for a period of 7 days prior to quizalofop applications or overcast conditions simulated for a period of 7 days after quizalofop applications. Factor B consisted of either no shade cloths or shade cloths at 30, 60, or 90 percent shade. Factor C consisted of quizalofop applied at 0, 120, or 240 g ai ha^{-1} at the three- to four-leaf rice growth stage. Herbicide applications were made with a CO_2-pressurized backpack sprayer calibrated to deliver 140 L ha^{-1}. Visual evaluations for crop injury were recorded 14 days after treatment (DAT). In addition to crop injury, rice plant heights and stand counts were recorded at 14 DAT. Yield was obtained and adjusted to 12% moisture.

At 14 DAT, crop injury was 1% following quizalofop applications when no overcast weather was simulated across both rates. Crop injury was observed at 5, 10, and 15% when quizalofop was applied at 120 g ha^{-1} following a period of 7 days of 30, 60, and 90% shade, respectively. Crop injury was observed at 5, 18, and 30% when quizalofop was applied at 120 g ha^{-1} followed by shade at 30, 60, and 90% for a period of 7 days. This research indicates that overcast growing conditions are playing a role in crop injury in the Provisia® rice production system.

Evaluating the Impact of Weedy Rice on Rice Yields

Herrman, W., Norsworthy, J.K., Barber, L.T., Scott, B., Carvalho-Moore, P., and Avent, T.H.

The first herbicide-resistant (HR) rice (*Oryza sativa* L.), Clearfield rice, was commercially launched in 2002. This technology conferred resistance to imidazolinone herbicides, but HR volunteer rice, or weedy rice (*Oryza sativa* L.), soon became a major issue in rice fields. Provisia rice, with resistance to aryloxyphenoxy propionic acids, was commercially launched in 2018 to help alleviate this problem. Unfortunately, HR rice continues to pose a threat to rice yields. In the summer of 2024, a field trial was conducted in Stuttgart, AR, to evaluate the impact of weedy rice on the yields of cultivated rice. A ten-treatment randomized complete block design test was conducted in 1.8 x 5.2 m plots with four replications. PVL04 rice, a Provisia variety, was drill seeded in a field with a natural infestation of, on average, five weedy rice plants per m^2. Quizalofop was applied at 120 g ai/ha at a range of timings using single and sequential applications to result in a range of weedy rice densities or control levels at crop harvest. Weedy rice control was rated before harvest, and the percentage of total grain, whole grain, and broken grain was determined from samples collected at harvest. Rough rice grain yield was also determined. At the final evaluation, a single application of quizalofop, regardless of application timing, provided no more than 45% weedy rice control. Treatments comprising sequential applications of quizalofop provided 66 to 95% control. As late-season weedy rice control improved, there was a decrease in the percent broken grains, an increase in the percent total grain, an increase in the percent whole grain, and an increase in rough rice grain yield. The results clearly show that the severity of weedy rice present in cultivated rice will not only negatively affect rough rice yields but likewise cause a decrease in milling quality, magnifying the monetary impact of this weed on the crop.

Weed Control in Furrow-Irrigated Rice with Oxyfluorfen-Based Herbicide Programs

King, T.A., Eubank, T.W., Bond, J.A., Mangialardi, G.A., Whitt, D.R., Dodd, J.B., and Bell, L.T.

When choosing to adopt a furrow-irrigated rice (FIR) production system, rice producers in the midsouthern U.S. are faced with new weed control challenges due to prolonged moist soil conditions prolonging weed emergence throughout the growing season. Oxyfluorfen, a Herbicide Resistance Action Committee(HRAC)/Weed Science Society of America(WSSA) Group 14 herbicide, inhibits protoporphyrinogen IX oxidase and has been demonstrated to control a variety of grass and broadleaf weeds. With the potential commercialization of the ROXY® Rice Production System, which permits in-season use of oxyfluorfen through the introduction of a non-GMO resistant rice trait, growers will have an effective alternative site of action for controlling problematic weed species such as Palmer amaranth and barnyardgrass. The lack of research evaluating oxyfluorfen and enhanced weed pressure in FIR prompts the need to study the herbicide in a production system that is gaining popularity.

From 2022 to 2024, two separate experiments were conducted at the Delta Research and Extension Center in Stoneville, MS, to evaluate barnyardgrass and Palmer amaranth control with oxyfluorfen in a FIR ROXY rice production system. The Early-season study evaluated weed control with oxyfluorfen applied delayed-preemergence (DPRE) and was arranged as a two-factor factorial within a randomized complete block design with four replications. Factor A was oxyfluorfen rates of 0, 700, and 981 g ai ha^{-1}. Factor B was herbicide mixture with oxyfluorfen and included no mixture, clomazone at 560 g ai ha^{-1}, saflufenacil at 50 g ai ha^{-1}, and halosulfuron plus prosulfuron at 83 g ai ha^{-1}. The Herbicide Program Study assessed weed control with oxyfluorfen in a full-season herbicide program and was organized as a three-factor factorial in a randomized complete block design with four replications. Factor A was DPRE treatment, which included no DPRE, oxyfluorfen at 1,121 g ha^{-1}, oxyfluorfen at 1,121 g ha^{-1} plus clomazone at 560 g ha^{-1}, and clomazone at 560 g ha^{-1} plus saflufenacil at 50 g ha^{-1}. Factor B was early-postemergence (EPOST) treatment at the two- to three-leaf rice stage and included no EPOST and propanil plus thiobencarb at 6,728 g ai ha^{-1}. Factor C was late-postemergence (LPOST) treatment at the four-leaf to one-tiller rice stage and included no LPOST and quinclorac at 421 g ai ha^{-1} plus halosulfuron and prosulfuron at 83 g ha^{-1}. For both experiments, barnyardgrass and Palmer amaranth control were evaluated 14, 21, 28, 35, and 42 d after DPRE. Additionally, weed densities were recorded at 42 and 56 d after DPRE for the Early-season Study and Herbicide Program Study, respectively. All data were subjected to ANOVA and estimates of least squared means were utilized for mean separation ($p \leq 0.05$).

In the Early-season study, barnyardgrass control was reduced by 22, 40, and 34% with clomazone, saflufenacil, and halosulfuron plus prosulfuron, respectively, when oxyfluorfen was excluded as a DPRE treatment. Palmer amaranth control was 68 and 80% when oxyfluorfen was applied alone at 700 and 981 g ha^{-1}, respectively. In the Herbicide Program Study, treatments containing oxyfluorfen plus clomazone DPRE provided comparable weed control regardless of EPOST or LPOST treatments compared to the traditional weed control program including clomazone plus saflufenacil. Based on these results, oxyfluorfen, applied alone or in combination with commercial standard herbicide products, enhances barnyardgrass and Palmer amaranth control with minimal injury to rice.

Including Tetflupyroliment in Herbicide Programs in Flooded Mississippi Rice

Dodd, J.B., Whitt, D.R., Edwards, H.M., Bell, L.T., Eubank, T.W., Mangialardi, G.A., and Bond, J.A.

Barnyardgrass (*Echinochloa crus-galli*) is the most troublesome weeds of rice in Mississippi. From 1990 to 2013, populations of barnyardgrass in the midsouthern U.S. were identified as resistant to six different herbicide modes of action common in rice production. The lack of new herbicide modes of action and the repeated use of the same herbicide modes of action have contributed to herbicide resistance in barnyardgrass. Tetflupyrolimet, which was developed by FMC Corporation, is the first herbicide with a new mode of action in nearly 30 years. Tetflupyrolimet is used to target barnyardgrass and other annual grass species in rice. Research was conducted to evaluate barnyardgrass control using herbicide mixtures with and without tetflupyrolimet in a flooded rice production system.

The study was conducted from 2022 to 2024 at the Delta Research and Extension Center in Stoneville, Mississippi. The experimental design was a randomized complete block with four replications and included thirteen unique herbicide treatments. Herbicide treatments were applied preemergence (PRE) and postemergence (POST) to simulate a traditional full-season rice weed control program. Barnyardgrass control was evaluated 14 and 21 days after application PRE (DA-PRE) and 14 and 28 days after POST (DA-POST). Rice yield was collected at crop maturity. Data were subjected to ANOVA and estimates of least squared means were utilized for mean separation ($p \leq 0.05$).

Treatments including tetflupyrolimet controlled more barnyardgrass than treatments with no tetflupyrolimet applied PRE and POST. Treatments including clomazone mixed with the low rate of tetflupyrolimet PRE controlled barnyardgrass 95% 28 DA-POST. A PRE treatment of clomazone mixed with the low rate of tetflupyrolimet offered improved barnyardgrass control compared to a split application and the low rate of tetflupyrolimet POST. Yields ranged from 6,609 to 10,026 kg ha^{-1}. Treatments containing tetflupyrolimet PRE performed better than those with no tetflupyrolimet except clomazone (571 g ai ha^{-1}) and quinclorac (560 g ai ha^{-1}) followed by pendimethalin plus clomazone (1121 g ai ha^{-1}) plus propanil (4488 g ai ha-1). Greater yield following treatments containing tetflupyrolimet PRE resulted from greater weed control compared with other treatments. Tetflupyrolimet can serve as an alternative residual herbicide for rice when barnyardgrass is the primary target.

Alternative Application Methods of Tetflupyrolimet in Louisiana Rice

Stoker, S.B., Webster, L.C., Hains, M.P., Sparks, G.R., Carr, W.B., and Williams, E.M.

Tetflupyrolimet is a novel herbicide undergoing development by FMC® and is classified as group 28 by The Herbicide Resistance Action Committee. Tetflupyrolimet inhibits pyrimidine biosynthesis via inhibition of dihydroorotate dehydrogenase synthesis and has been observed to express selective herbicidal action on various grass species found in Louisiana.

Studies were conducted in 2023 and 2024 at the H. Rouse Caffey Rice Research Station near Crowley, Louisiana to evaluate tetflupyrolimet applied as a spray and impregnated on fertilizer. Plot size was 1.5 by 5.2m^{-2} and all plots were seeded with 'PVL03' at 78.4 kg ha^{-1}. Experimental design of these studies was a two-factor factorial arrangement of treatments with a randomized complete block design with four replications. Factor A consisted of herbicides PRE either impregnated on fertilizer or sprayed. Factor B consisted of tetflupyrolimet at 90 or 125 g ai ha^{-1}, clomazone at 225 or 313 g ha^{-1}, tetflupyrolimet at 90 g ha^{-1} plus clomazone at 225 g ha^{-1}, or tetflupyrolimet at 125 g ha^{-1} plus clomazone at 313 g ha^{-1}. All sprayed treatments were applied using a CO_2-pressurized backpack sprayer calibrated to deliver 93.5 L ha^{-1}. Fertilizer impregnation treatments were applied using a starter fertilizer 0-23-30 (N-P_2O_5-K_2O) at 280 kg ha^{-1}. Visual evaluations of percent control for barnyardgrass [*Echinochloa crus-galli* (L.) P. Beauv.] and broadleaf signalgrass [*Urochloa platyphylla* (Munro ex C. Wright) R.D. Webster] were observed at 14, 21, and 35 days after treatment (DAT). Rough rice yields were obtained and adjusted to 12% moisture content.

At 35 DAT, barnyardgrass was controlled 63 to 85% and broadleaf signalgrass was controlled 76 to 89% with tetflupyrolimet impregnated on fertilizer. Spayed treatments provided 65 to 83% barnyardgrass control and 78 to 92% broadleaf signalgrass control at 35 DAT. Similar control of barnyardgrass and broadleaf signalgrass was observed regardless of application method. These results justify the application of tetflupyrolimet and clomazone using fertilizer impregnation for control of annual grass species in Louisiana.

Influence of Tetflupyrolimet on Agronomic Performance of Southern Crops

Whitt, D.R., Edwards, H.M., Bell, L.T. Mangialardi, G.A. Eubank, T.W. Dodd, J.B., and Bond, J.A.

The utility of synthetic herbicides is threatened by the widespread evolution of resistance to most herbicide modes of actions (MOA). Currently, effective chemical control options for barnyardgrass in rice are scarce due to selection for resistance to many commonly applied herbicides. Additionally, a novel herbicide MOA has not been introduced for nearly 30 years. Considering this, agricultural companies have revamped their herbicide discovery efforts. FMC Corporation recently discovered tetflupyrolimet, also known as Dodhylex™ active, a new MOA classified as a Weed Science Society of America Group 28 herbicide inhibiting dihydroorotate dehydrogenase (DHODH). Understanding crop response to a new herbicide is critical for making proactive management decisions and minimizing injury potential. Research was conducted to evaluate tetflupyrolimet for midsouthern U.S. rice production.

Multiple studies were conducted in 2023 and 2024 at the Delta Research and Extension Center in Stoneville, MS, to assess different aspects of tetflupyrolimet use in rice. Studies were designed as randomized complete blocks with four replications. Data were analyzed with ANOVA and estimates of Least Square Means at 5% significance level was utilized for mean separation. The first study evaluated crop safety to tetflupyrolimet among eight rice cultivars. Factor A was cultivar, and included: Ozark', 'Taurus', 'CLL19' (Clearfield®), 'PVLO3' (Provisia®), 'RT XP 753', 'RT 7331 MA' (MaxAce®), 'RT 7521 FP' (FullPage®), and 'DG 263L'. Hybrid and conventional cultivars were planted at 28 and 73 kg ha^{-1}, respectively, with DG 263L planted at 50 kg ha^{-1}. Factor B was tetflupyrolimet rates representing 1X and 2X rates applied preemergence (PRE) and a 1/2X rate applied PRE followed by (fb) postemergence (POST). The second study evaluated tolerance of four midsouthern U.S. row crops to sub-lethal concentrations of tetflupyrolimet and clomazone. Factor A was crop and included cotton, soybean, grain sorghum, and corn. Factor B was tetflupyrolimet plus clomazone application timings at PRE and POST targeting V3 crop stages.

None of the crops exhibited injury consistent with tetflupyrolimet symptomology. Yields were not reduced in either study except for DG 263L and Ozark cultivars treated with the split application of tetflupyrolimet. The integration of tetflupyrolimet as a residual herbicide appears to offer a safe option for application to rice with no effect on common crops that might be planted in proximity to rice in the midsouthern U.S.

Residual Grass Control with Tetflupyrolimet versus Clomazone and Quinclorac in Midsouth Rice

Ketchum, C.C, Norsworthy, J.K., Castner, M.C., Carvalho-Moore, P., and Dodde, M.R.

Clomazone has historically been a residual barnyardgrass control option since its commercialization in the early 2000s. However, with the discovery of clomazone-resistant barnyardgrass populations in Arkansas, new herbicide options are needed to provide additional control options. Tetflupyrolimet is a novel site of action (SOA) that provides control of barnyardgrass and other select grass weeds while exhibiting a high level of crop safety in paddy rice systems. To understand the efficacy and versatility of tetflupyrolimet as a residual control option for barnyardgrass, field experiments were conducted in Arkansas from 2021 to 2023 on silt loam and clay soils common in midsouthern U.S. rice production. Each field experiment was arranged as a single-factor randomized complete block design with four replications. Clomazone, tetflupyrolimet, and quinclorac were applied individually preemergence at 336 (560), 134 (224), and 336 (560) g ai ha^{-1}, respectively (clay rate in parenthesis). Also tested were treatments of clomazone mixed with tetflupyrolimet and clomazone mixed with quinclorac at the same rates. Visible rice injury ratings, grass control ratings, and weed densities were taken at 21, 28, 35, and 42 days after treatment in the silt loam sites. The same assessments were taken 14, 28, and 42 days after treatment in the clay soil sites. Barnyardgrass and broadleaf signalgrass control ratings were collected in the silt loam experiments; however, barnyardgrass was the only weed evaluated in the clay soil site. Overall, rice injury was comparable for each herbicide treatment, except tetflupyrolimet alone, which exhibited the lowest visible injury (3%), and clomazone plus quinclorac, which generated the highest injury (9%) in the silt loam site. The clay site had tetflupyrolimet and quinclorac, providing the lowest injury (4%) and the clomazone plus Tetflupyrolimet, producing the highest rice injury (9%). Weed control ratings indicated that combining SOAs provided the highest control of both broadleaf signalgrass and barnyardgrass. Applications of clomazone plus tetflupyrolimet and clomazone plus quinclorac in the silt loam experiments provided the best control at 97% of both weeds. Among single applications, tetflupyrolimet exhibited the highest level of barnyardgrass control in the silt loam (93%), while also being comparable to other single SOA applications in clay soils (87%), with clomazone (91%) performing the best in clay soils. Weed counts supported tetflupyrolimet efficacy for control of barnyardgrass, having the lowest number of escapes of all single SOA applications in the silt loam site, and the second least number of escapes at the clay site. Grain yield was highest in treatments with multiple SOAs; however, single tetflupyrolimet applications led to better rough rice grain yields in clay soils among single SOA applications and identical yield to rice in clomazone plots in silt loam soils among single SOA applications.

Does Rogue Bring Value to Quizalofop-Resistant Rice Programs?

Carvalho-Moore, P., Norsworthy, J.K., Schmidt, L., Scott, R., Barber, L.T., Botelho, R., and Pierce, L.D.

With the introduction of technologies enabling the application of the acetyl-CoA carboxylase inhibitor quizalofop-P in rice, implementing a strong stewardship strategy is crucial to avoid resistance evolution. The herbicide Rogue® (benzobicyclon) has the potential to improve post-flood control of weedy rice (*Oryza* spp.) and other aquatic and semi-aquatic weeds. Therefore, an experiment was conducted to evaluate if the addition of Rogue is beneficial to Max-Ace® or Provisia® rice programs under different flooding initiation dates. The experiment was organized in a three-factor randomized complete block design, and it was conducted at the Pine Tree Research Center near Colt, AR. The first factor was herbicide treatments consisting of two applications of Provisia or Highcard™ at early postemergence (EPOST) and late postemergence (preflood), or three applications of Provisia at EPOST, preflood, and post-flood (POSTF). The second factor was flooding at 3-5 (early) or 10-12 (late) days after preflood application, and the third factor was the presence or absence of Rogue application at 4-7 days after flooding. Weedy rice and barnyardgrass [*Echinochloa crus-galli* (L.) P. Beauv.] control was rated at 1 and 4 weeks after POSTF treatments. For barnyardgrass, there was no significant effect, and control averaged across treatments was 99 and 100% at 1 and 4 weeks after POSTF, respectively. Two weeks after POSTF, weedy rice control was higher (98%) with early flooding in comparison to late flooding (95%). No differences were observed at 4 weeks after POSTF though. Overall, all treatments containing quizalofop-P were highly effective in controlling the weeds evaluated in this experiment, with an average control of above 96% across treatments. Therefore, it was not possible to statistically observe a difference with the addition of Rogue. However, a propensity for weedy rice survivors was observed when no Rogue was added in POSTF applications following only two applications of quizalofop-P, regardless of flooding dates, and there was less variability in weedy rice control in Rogue treated plots. Including a robust weedy rice control ally such as Rogue in rice programs relying on a single postemergence technology is recommended to delay herbicide resistance evolution.

Evaluation of Preemergence-Applied HPPD Inhibitors and Diflufenican in Rice with and without Fenclorim

Pierce, L.D., Norsworthy, J.K., Avent, T.H., Smith, J.T., Souza, M.C.C.R., and Carvalho-Moore, P.

Fenclorim applied as a seed treatment is a novel herbicide safener in rice shown to safen the crop to a delayed preemergence application of microencapsulated acetochlor. This research aimed to build on earlier findings by determining the effect of 4-hydroxyphenylpyruvate dioxygenase (HPPD)-inhibiting herbicides and diflufenican on weed control and rice injury when applied preemergence (PRE) with and without a fenclorim seed treatment. In 2024, a randomized complete block design experiment with seven treatments and four replications was conducted near Colt, AR. Each treatment was sprayed PRE with topramezone (Armezon), tembotrione (Laudis), tolpyralate (Shieldex), and diflufenican. A 2x and 4x rate was applied for Armezon, Laudis, and Shieldex, while only a 2x rate was used for diflufenican. Rates were based off use of these herbicides in other crops since none are currently labeled for use in rice. The 1X rate of topramezone, tembotrione, tolpyralate, and diflufenican was assumed to be 24.5, 98, 29.2, and 120 g/ha, respectively. Overall injury was evaluated 2, 4, 5, and 6 weeks after PRE (WAPRE). Weed control ratings were collected for hemp sesbania [*herbacea* (R.) McVaugh], barnyardgrass [*Echinochloa crus-galli* (L.) P. Beauv], weedy rice (*Oryza sativa* L.), and Palmer amaranth [*Amaranthus palmeri* (S.) Wats.]. During the 6 WAPRE evaluation, all 4x rates and Shieldex at a 2x caused unacceptable injury levels (≥ 33%), and fenclorim reduced injury on average by 9 percentage points. Diflufenican was ineffective on most of the weeds evaluated but did provide 96% Palmer amaranth control with no injury to rice, regardless of fenclorim use, at 4 WAPRE. Overall, Laudis at a 2x rate appears to provide the best weed control and tolerance, providing hemp sesbania control of 83%, weedy rice control of 20%, barnyardgrass control of 92%, and 11% rice injury with a fenclorim seed treatment.

ABSTRACT OF PAPERS FROM THE STUDENT ORAL CONTEST PANEL: ECONOMICS AND MARKETING/POSTHARVEST QUALITY, UTILIZATION, & NUTRITION

Moderator: Brian Hilburn

Examining the Differences in USDA Cost of Production for Rice

Klawinsky, K.M., Outlaw, J., and Fischer, B.

Rice cost of production varies significantly across the rice belt, according to USDA ERS Commodity Costs and Returns. There are some major differences in the cost of production across four regions, Mississippi River Delta, Gulf Coast, California, and Arkansas Non-Delta. This study examines the components of production costs, including fertilizer, labor, purchased irrigation water, drying, chemicals, and seed. Also, we will evaluate the impact of regional yields on the relative costs of production.

Due to the wide range of climates including rainfall amounts in these regions, purchased irrigation water is the most significant factor. The Mississippi River Delta Region and the Arkansas Non-Delta do not have to purchase irrigation water. The Gulf Coast paid approximately $14.61 per acre for irrigation water in 2023. The region with the highest cost for purchased irrigation water is California, estimated to be $91.39 per acre in 2023. A few other important factors include fertilizer, commercial drying, chemicals, and seed. Fertilizer costs were highest in California of the four regions. These producers paid $226.29 per acre in 2023, when the national average was $196.41 per acre. Commercial drying costs are cheapest in the Mississippi River Delta, averaging $12.44 per acre in 2023. The region that faces the highest commercial drying cost is California. The estimated expense per acre is $141.12. Seed is most expensive in the Arkansas Non-Delta region and cheapest in California. Chemical costs are most expensive in California and cheapest in the Arkansas Non-Delta Region. California's total operating costs were $1,177.84 in 2023, while the U.S. average was $837.19.

Across the rice belt, the rice yields per hundredweight are quite similar. The United States total for yield was 83 hundredweight per planted acre. The price per hundredweight at harvest showed fluctuations across regions. California prices were much higher than the prices observed in other regions due to being primarily higher valued japonica rice. California's rice price was $33.35 per hundredweight at harvest in 2023, but the national average was $19.39. These results provide valuable insights into identifying some of the key differences in cost of production across the rice belt. By examining these differences, we are able to gain a clearer understanding of these regions' farm economies that shape their production costs.

Identifying the Factors that Separate the Profitable from Unprofitable Rice Farms

Castillo, C., Outlaw, J., Fischer, B., Knapek, G., and Raulston, J.M.

Depressed market prices and high production costs continue to contribute to the cost-price squeeze faced by rice farmers in the United States. With the potential for production costs to remain elevated, coupled with uncertainty regarding Title I assistance for rice growers in the next farm bill, rice farmers will continue to face uncertainty regarding their hopes of achieving a profit. This research utilizes financial projections from the Texas A&M Agricultural and Food Policy Center's representative rice farms to identify some of the major factors that are different among farms that are projected to make a profit versus those that are projected to be unprofitable.

AFPC maintains representative rice farms in California, Missouri, Louisiana, Arkansas, Mississippi and Texas. In general, California and Texas are the only farms where rice makes up almost all of crop receipts. The other rice states tend to produce a larger variety of crops along with rice including cotton, soybeans and corn. Very few of the representative farms have ratoon crops outside of Texas which means all else equal, the higher production costs experienced in Texas are divided by relatively larger yields which enables them to remain cost competitive. Most of the representative farms rent a significant percentage of the land in their operation. Cash rents are reflective of the availability of other cropping alternatives across the rice belt.

The most recent baseline analysis of the representative farms indicates significant financial problems over the next few years. Farms with cost or production advantages appear to be able to weather the downturn better than those with fewer alternatives.

Dehydration of Rice Bran Protein Concentrate Using Novel Vacuum-Assisted Microwave Drying Techniques

Ameyaw, E.O., Tachie, C.Y.E, and Atungulu, G.

Efficient dehydration methods are critical for processing high-quality protein isolates and concentrates. This study investigated the application of a novel vacuum-assisted microwave drying technique for dehydrating rice bran protein concentrate, aiming to enhance efficiency and quality compared to conventional freeze-drying methods.

Rice bran protein concentrate was prepared from the defatted bran of cultivar RT 3202, which was pre-dried to a moisture content of 12.5%. In each experimental run, 50 g of concentrate was hydrated in a 1:1 solid-to-water ratio and dried using two methods: conventional freeze drying, and microwave (2450 MHz) vacuum-assisted drying (power levels of 10, 8, and 5 W for 8, 12, and 20 minutes, respectively) followed with a vacuum-assisted water bath drying (60°C for 2 hours). Drying processes were optimized to achieve target water activity levels between 0.1 – 0.3 aw.

The resulting protein concentrates were evaluated for quality and functional properties, including protein content, solubility, water and oil holding capacities, color parameters, foaming capacity and stability, emulsifying activity and stability, and emulsion stability. The vacuum-assisted microwave drying (10 W for 8 minutes) and vacuum-assisted water bath drying (60°C for 2 hours) method effectively reduced water activity to 0.2 aw, demonstrating superior efficiency and comparable protein quality to freeze drying.

This study provides valuable insights into optimizing drying parameters for rice bran protein concentrates, offering an efficient alternative that preserves functional and nutritional quality.

Engineering Functional High-Value Food Ingredients from Rice Milling Byproducts in Insect Diets

Tachie, C.Y.E., Chukkapalli, D., Vasquez, A., Nodupalli, N., Luthra, K., Kariyat, R., Rahman, M., and Atungulu, G.

Conventional protein production from farm animals causes about 18% of greenhouse gas (methane) emissions, contributing to climate change. Alternative sources such as insects, legumes, and pseudo-cereals are being investigated to meet vegan needs and world protein demand and minimize environmental footprints. By-products obtained from rice processing, such as bran, husk, second heads, broken, brewers, and dust, are discarded as waste or used as feed for pets. Insects are efficient feed converters and can easily convert by-products into beneficial products with minimal dependence on water and space for survival. Manduca sexta, an agricultural pest, was used in this study. Insect diets were substituted with 10 or 20% of each by-product and fed for three weeks. Harvesting was done at the larva and pupa stages. Preliminary results indicated a statistically significant difference ($p < 0.05$) between larvae and pupa protein content, with higher values in the latter. Proximate analysis, in vitro protein digestibility, and amino acid profiling of the two insect groups will be presented. Techniques such as SDS-page electrophoresis, Fourier-transform infrared spectroscopy (FTIR), and differential scanning calorimetry (DSC) are employed to understand the protein profile, behaviour, structure, and thermal stability. The results will give comprehensive details about the properties of the isolated insect flour, proteins, fiber, and oils, providing information about how they may be used as functional components in pharmaceuticals or animal feed. The study intends to valorize rice by-products, some of which are discarded as waste or milled into flour for low-value pet food, by promoting them as an affordable and environmentally friendly feed source for raising insects.

Exploring GABA Enrichment of Instantized Brown Rice through Germination Treatments

Ouma, F.A, Luthra, K and Atungulu, G.

Germinated brown rice (GBR), recognized for its high content of dietary fiber, essential nutrients, and bioactive compounds such as gamma-aminobutyric acid (GABA), has gained significant popularity in the health food market. This study aimed to investigate the impact of different germination methods on the functional properties of GBR and evaluate its potential for instantization to produce instant germinated brown rice (IGBR). Instant brown rice produced from 25 rice cultivars was screened to identify cultivars with optimal rehydration ratio, bulk density, volume increase ratio, and textural attributes for GABA enrichment through germination. Selected cultivars (50 g each) were soaked in plasma-activated water (PAW) generated from different gases (atmospheric air, argon, nitrogen, and carbon dioxide) at 30°C for 24 hours. Control samples were soaked in distilled water under the same conditions. The soaked samples were then rinsed and germinated in darkness at 35°C for 24, 48, 72 and 96 hours. Significant differences in physicochemical and textural properties were observed among the instant brown rice samples ($p < 0.05$). Out of the 25 rice cultivars, nine were identified as top performers for further GABA enrichment based on their optimal physicochemical properties. Notably, the germination rate of brown rice soaked in PAW (85%) was higher compared to that soaked in distilled water (80%). This study highlights the potential of PAW as an effective germination treatment to enhance beneficial compounds, such as GABA, in GBR, thereby improving its nutritional value and suitability as a functional food.

Exploring Malted Rice as a Novel Brewing Ingredient

Guimaraes, B.P. and Lafontaine, S.R.

Historically, barley is the malted grain used for beer brewing, with rice being used as an adjunct in brewing, mostly due to its neutral flavor. Barley is a crop with low tolerance to changes in climate and may see its yield reduced in the forthcoming years, whereas rice presents itself as a more tolerant crop to climate change, in addition to being a gluten-free cereal. The ten best candidates (one hybrid, three with purple bran, aromatic and non-aromatic varieties) from a previous screening of 20 rice varieties for malting and brewing qualities were used to brew non-alcoholic (NAB) and low-alcohol beer (LAB) using a maltose-negative yeast strain (*Saccharomycodes ludwigii*), along with a barley malt as a control for current industry practices. Volatiles from rice beer were analyzed in qualitative mode using gas chromatography-mass

spectrometry (Shimadzu GC-2030) coupled with an autosampler (AOC 6000 Plus). Non-volatiles (sugars and anthocyanins) were measured using high pressure liquid chromatography (HPLC, Waters) coupled with PDA and QDA detectors. The beer was analyzed for various physicochemical parameters (i.e. alcohol by volume (ABV), density, attenuation, real degree of fermentation, etc.) using an Anton Paar DMA 4501 coupled with Alcolyzer 3001 and color by EBC (Shimadzu UV-Vis) and Hunter's L*a*b*. Sensory attributes were described using descriptive analysis by a group of trained panelists. Most rice worts self-saccharified (i.e. were able to breakdown starch into simple sugars without using exogenous enzymes) and their forced fermentation using ale yeast (*Saccharomyces cerevisiae*) had apparent fermentability ranging from 46% to 75%, reaching values close to the control barley wort, 78.5%. Some rice LABs had higher alcohol production (0.55% to 0.96% ABV) compared to barley LAB (0.80%) due to the activity of amyloglucosidase and alpha-glucosidase as both enzymes yield glucose (2x-8x compared to barley wort) which is metabolized by the maltose-negative yeast. Purple rice beer had a reddish color confirmed by the positive values of a*, whereas others were generally paler than barley malt. Aromatic rice malts retained most of their aromas throughout the fermentation, displaying vanilla aroma and purple-bran varieties had a fruity/berry aroma associated with them. These results highlight the possibility of using rice malt as a novel brewing ingredient to obtain both new and traditional colors, aromas, and characteristics compared to pale barley malt for full strength, low-alcohol, and non-alcoholic beers.

Case Studies of Rapid Milling Yield Assessment Using New AI-Based Tools

Olaoni, S. and Atungulu, G.

Milling is a critical postharvest process in rice production that significantly influences the head rice yield. This study aims to introduce and evaluate a new tool for easy quantification of rice milling assessments. The MachVision rice analyzer is an innovative artificial vision software developed to optimize and standardize the physical purity quality control of rice. The system can provide shape characteristics of rice, detect certain kernel defects and foreign materials, and classify samples into paddy, whole, and broken kernels, while also generating reports that include data and images. Rough rice samples, including long-grain conventional (PVL 03), long-grain hybrid (XP 760), and medium-grain hybrid (RT 3202) cultivars, were milled at 12.5% moisture content using the McGill #2 mill for varying durations (10, 15, 20, 30, and 40 seconds). The milled rice samples analyzed were categorized into whole and broken kernels according to the classification column to determine the head rice yield (HRY) using the MachVision analyzer. HRY was also determined by conventional methods using the gravity shaker table. The results from the rice analyzer were compared and correlated with conventional methods to validate its efficiency and accuracy regarding milling yield assessments. RT 3202 exhibited the highest HRY for both conventional and MachVision analyzer. The conventional method estimated higher HRY compared to the MachVision analyzer. On average, the HRY difference for long grain cultivar between the conventional and MachVision is ≈ 3%, while for medium grain, the HRY remains nearly the same with little to no variation. The MachVision analyzer explained more variability in HRY for RT 3202 (97%) & PVL 03 (93%) than in XP 760 (52%) when correlated with the conventional method. The tool looked promising, but there is a need to incorporate more cultivars to further improve the estimation, predictability, and accuracy of head rice yield assessments. This experiment will provide artificial vision solutions for easy rice milling and quality assessment processes in the industry.

ABSTRACT OF PAPERS FROM PANEL ORAL PRESENTATIONS: BREEDING, GENETICS, AND CYTOGENETICS

Panel Chair: Brijesh Angira

Moderators: Christian Torres De Guzman, Teresa De Leon, Shyamal Talukder, Adam Famoso, and Xueyan Sha

Breeding Better Rice for High Temperature and Other Abiotic Stresses Tolerance in the Philippines and Current Issues on Variety Performance as Affected by Climate Change

Manigbas, N.L. and Manangkil, O.E.

Rice is one of the most important staple crops, consumed daily by 60–70% of the world's population. Global rice production is approximately 530 million tons per year, with 90–92% produced and consumed in Asia. In the Philippines, yield growth over the past decade has averaged only 1.8% per annum, and the challenge of increasing productivity remains significant. The irrigated lowland ecosystem, which accounts for 71% of the total harvested area, is the most reliable environment for intensive rice cultivation, while the remaining 29% consists of rainfed areas that are highly vulnerable to abiotic stresses. Variety development for these rainfed and stress-prone environments focuses on creating adaptable, high-yielding varieties that are resistant to major pests and diseases and possess desirable grain quality traits.

Global climate change is expected to bring extreme and unpredictable weather conditions that will further impact rice production. The rainfed ecosystem in the Philippines, covering about 1.5 million hectares, is particularly prone to high temperatures, drought, submergence, salinity, and biotic stresses—all of which will intensify with climate change. Rice thrives at temperatures between 20–35°C, but becomes highly sensitive above 35°C, especially during the reproductive stage. Studies have shown that many rice varieties currently grown in farmers' fields exhibit spikelet sterility rates of up to 80% under heat stress, and very few varieties can tolerate such conditions. Historical data from PhilRice (1998–2019) and DOST-PAGASA (1971–2000) indicate that field temperatures have already reached critical levels of 35°C or higher. Projections suggest that by 2065, temperatures could rise by 2.5–3.0°C, posing a severe constraint on rice production. Heat stress alone can cause yield declines of 14–20% in susceptible varieties.

One of the most effective strategies to mitigate these impacts is the adoption of high-temperature-tolerant cultivars. Without genetic improvement, current varieties lacking heat tolerance will suffer significant yield losses. High temperatures during the reproductive stage induce spikelet sterility, resulting in unfilled grains and lower yields. They also cause chalky grains, which break easily during milling, reducing recovery rates, grain quality, and market value. To address these challenges, plant breeders must have a deep understanding of genetic resources and employ innovative technologies to develop improved varieties. The objectives of breeding programs for high-temperature and abiotic stress tolerance include: (1) developing multi-trait tolerant rice varieties and breeding lines adapted to rainfed areas affected by high temperature, drought, submergence, and salinity; (2) evaluating high-yielding released varieties and breeding lines with combined stress tolerance and good grain quality; and (3) increasing yields of promising lines to 4–5 t/ha in stress-prone areas.

Although many rainfed rice varieties have been released, most possess only single-trait tolerance. Future breeding efforts aim to develop varieties with two or three combined traits. Current pipelines include elite lines with combinations such as submergence + salinity, drought + high temperature, and salinity + drought + high temperature. Pre-breeding efforts continue to explore new germplasm and create novel genetic materials. Climate change imposes increasing pressure on farmers, making it essential that varieties possess traits to withstand these stresses. Severe and unpredictable weather events frequently affect the Philippines, and many existing varieties exhibit high sterility under heat stress. While some varieties escape stress through early flowering, this is not a sustainable solution. Drought can occur at any growth stage, with varying impacts depending on timing. Submergence, often caused by flash floods, can last 14–20 days, while salinity tolerance fluctuates across growth stages—rice is tolerant during germination, sensitive during early seedling and reproductive stages, and more tolerant at maturity. Addressing these complex challenges requires collaborative efforts among breeders, researchers from diverse disciplines within PhilRice, and international partners employing advanced technologies.

Genomic Selection for Sustainable Quantitative Resistance to Narrow Brown Leaf Spot in U.S.

Borges, K.L.R., Richards, J.K., Punzalan, J., Montiel, M., Cerioli, T., Angira, B., Famoso, A.N.

Narrow brown leaf spot (NBLS) is a significant disease affecting rice in the southern United States, with notable variation in resistance among varieties. A recent study identified a major resistance locus, *CRSP2.1*, which explains 81.4% of the phenotypic variation. While the discovery of *CRSP2.1* marks a significant breakthrough, reliance on a single, large-effect locus poses risks due to potential pathogen adaptation. To achieve long-term resistance, breeding strategies should include efforts to increase quantitative resistance. In the presence of a qualitative resistance gene, traditional selection methods to increase quantitative resistance are difficult as the observed phenotypic inheritance is driven by the resistance gene. Genomic selection (GS) offers a unique strategy to improve the quantitative resistance while simultaneously breeding with the qualitative resistance gene. This approach offers a sustainable pathway to enhance resistance durability and mitigate the risk of resistance breakdown by the pathogen. In this approach, we have explored the potential of using training sets comprised of lines lacking *CRSP2.1* resistance allele to predict the quantitative resistance of the lines in the prediction set. These predictions will be based on the quantitative resistance of the lines, regardless of the allelic state at *CRSP2.1* in the predicted line.

Exploring Morpho-Genetic Variability of Seedling Cold Tolerance Traits in Rice (*Oryza Sativa* L.) for Ratoon Enhancement

Singh, G. Das, S.J., Harper, C.L., Samonte, S.O.P.B., and Talukder, S.K.

Seedling cold tolerance (SCT) is important for early planted rice to harvest a second crop as ratoon. Root architecture, rate of emergence and seedling vigor can be affected by cold stress when farmers plant early to allow for ratoon crop production. Seedling cold tolerance (SCT) is important for planting rice in colder temperatures that occur during early planting and ratooning in some rice-growing regions in the world. The present study aims to screen a diverse rice germplasm pool at seedling stage to identify cold tolerant breeding materials for Texas rice growers. The experiment was conducted in 2023 using 204 rice lines/accessions screened for SCT under three environmental conditions (E1; natural cold low temperature 6.3ºC-23.3ºC, E2; growth chamber cold condition 10ºC-17ºC, and E3; controlled in greenhouse 28-30ºC). Seedling emergence (counted at 6, 8, and 12 days after planting) and seedling length (measured at 2 and 4 weeks after planting) were recorded, along with root harvest after 4 weeks of planting in all three experiments. The root analysis was performed with a WinRhizo scanner, and the data were collected on nine different root architecture traits. Both seedling and root traits showed a wide range of phenotypic variability in all three experiments. GWAS (genome-wide association study) was performed using mrMLM six multi-locus models, and 107 significant QTLs (quantitative trait loci) were identified for seedling emergence and seedling length related trait. Among them nine QTLs with phenotypic variation ranging

from 10.98-20.72% and three (S06_22947376, S07_27594541, and S07_3833577) genetic loci showed pleiotropic responses for multiple traits in different experiments. Six multi-trait QTLs were selected for candidate gene analysis, and 146 putative candidate genes were identified. For root traits, GWAS analysis is underway and further candidate gene analysis will be performed to identify the putative gene under SCT. At the end of this study, potential markers associated with seedling and root-related traits will be identified for SCT, which will help develop early-planting, cold-tolerant cultivars and ultimately enhance ratoon production in the region.

Whole-Genome Sequencing of the LSU380 Panel Sheds Light onto Rice Breeding Germplasm Diversity

Richards, J.K., Angira, B., McCouch, S., and Famoso, A.N.

Beneficial traits are often mined from exotic germplasm, however, there is frequently untapped potential in elite gene pools that is more readily available to most breeding programs. This diversity could potentially be used to further improve rice varieties, but it remains largely uncharacterized. To address this knowledge gap and leverage existing genetic diversity for variety improvement, we conducted whole-genome sequencing of 380 lines extensively used in the LSU rice breeding program (hereafter the LSU380 panel). The panel comprises 293 advanced breeding lines and varieties from U.S. breeding programs and 87 diverse lines from other sources. Classification by grain-size identified 21 long grain aromatic varieties, 298 long grain, 43 medium grain, and 18 short grain varieties. Using the genome-wide variant data derived from sequencing, we first characterized population structure in the LSU380 using a validated global core panel which includes a balanced set of *tropical japonica*, *temperate japonica*, *indica*, *aromatic*, and *aus* varieties. As expected, the majority of LSU380 lines clustered with the core *tropical japonica* lines based on principal components analysis (PCA). A set of primarily short and medium grain lines clustered more closely with *temperate japonica* core lines. Genome-wide estimates of LD decay (average pairwise r^2 values) in the LSU380 panel ($r^2 < 0.2$ at ~4 Mb) were slower than in the core panel; the most rapid LD decay was observed in the *indica* subpopulation ($r^2 < 0.2$ at 455 kb). Second, to complement the PCA analysis, a maximum likelihood approach implemented in ADMIXTURE was used to estimate subpopulation ancestries in individual lines. Using a threshold of 80% ancestry from a single subpopulation, 272 LSU380 lines were designated as *tropical japonica,* 21 as *temperate japonica*, 21 as *indica*, and 66 as admixed. To further characterize the extent and composition of admixture in individual lines, we used local ancestry inference to identify genomic regions introgressed from other rice subpopulations. Among the 272 LSU380 rice varieties classified as *tropical japonica*, we identified between 0-30 *indica* introgressions per line, cumulatively accounting for up to 81.96 Mb per line. When lines carrying introgressed regions known to harbor important traits, like the *Pita* blast resistance gene on chromosome 12, were compared, notable variation in the size of introgressed *indica* regions was observed. Differences in the introgression profiles of individual lines are the result of recombination and selection that occurred throughout the breeding process and are of interest for both breeding and genetic research. Third, we performed a genome-wide association study (GWAS) to identify narrow brown leaf spot (NBLS) resistance loci. Using historical phenotype data in combination with genome-wide variant data for the LSU380, we detected three significant loci, including the previously mapped major-effect NBLS resistance locus *CRSP2.1,* along with two previously unknown loci with smaller effect sizes. Taken together, these results show how whole-genome sequencing can be leveraged for detailed genomic inspection of historical varieties and rice breeding lines to clarify population structure and LD decay, identify ancestry components of individual lines, analyze historical introgression profiles, and undertake marker/trait discovery.

Development of Elite US Rice Breeding Lines with Three New Broad Spectrum Blast Resistance Genes

Angira, B. and Famoso, A. N.

Blast disease, caused by the fungus *Magnaporthe oryzae*, remains a persistent challenge for rice production in the southern United States. While the resistant Pita allele is common within long-grain US rice germplasm and confers resistance to the prevalent blast races, medium-grain rice cultivars lack major resistance genes effective against the common blast races.

To address this gap, the LSU rice breeding program initiated a backcross breeding project in 2016–2017 to incorporate major blast resistance genes (Pi9, Pi42, and Pib) from exotic indica germplasm. Crosses were made between elite U.S. long- and medium-grain lines and exotic donor lines, ZHE733 and IR96660, advancing to the BC_3F_1 generation using marker-assisted selection (MAS) for the target genes at each generation. The BC_3F_1 plants were selfed to produce BC_3F_2 populations, which underwent selection for the blast resistance genes using markers and agronomic traits through visual observation.

By 2021, 40 advanced lines were developed, each carrying one or more of the exotic blast resistance genes and exhibiting adaptation to the southern U.S. rice-growing environment. These lines have been characterized for yield, agronomic, and grain quality attributes to identify the suitable lines to use as parental sources for elite breeding crosses. In 2025, we tested 44 breeding lines in preliminary yield trials, each containing one or more exotic blast-resistant genes. This work lays the foundation for the development of medium- and long-grain rice varieties with robust blast resistance and superior performance.

Implementation of Genomic Selection in the LSU Rice Breeding Program

Famoso, A.N., Angira, B., Fritsche-Neto, R., Hernandez, C., Robbins, K., McCouch S.,
Cerioli, T., Montiel, M., Manangkil, J., and Borges, K.L.R.

Molecular markers are a valuable tool to increase the productivity of applied breeding programs. Marker assisted selection is a useful approach for when there is a single major gene controlling the trait of interest. However, it requires significant research and investment to discover and validate the gene/marker and the number of traits that can effectively be selected during breeding is limited. For quantitative traits controlled by many genes, genomic selection has been demonstrated to be a much more efficient approach. Genomic selection can utilize the data routinely generated in an applied breeding program and does not require special populations or discovery activities. However, for genomic selection to be a routine component of the breeding program, some key infrastructure must be established and optimized within the breeding program. This includes a structured database to store and retrieve data, an optimized marker set, leaf and DNA sampling and tracking protocols, robust training sets that represent the target germplasm and environments, and efficient statistical models and selection strategies.

The LSU AgCenter rice breeding program has been working to explore, optimize, and deploy genomic selection since 2019 and has recently fully deployed it as a routine component of the applied breeding program. This talk will highlight some of the key activities that have been conducted to enable the routine implementation and will highlight some of the opportunities and challenges of deploying genomic selection. Specific topics will include the development of the marker panel and genotyping service, establishment of the Breedbase breeding management software, training set development and prediction accuracies, tissue sampling and tracking, and the breeding stages of deployment, and the impact on the applied breeding program.

Leveraging Seven Years of Data to Enhance Genomic Selection Accuracy in LSU's Rice Breeding Program

Punzalan, J., Angira, B., and Famoso, A.N.

Training set construction is crucial for achieving consistent accuracy in genomic selection (GS). This study evaluated the impact of adding successive years of data to the training set on GS accuracy using seven years (2018–2024) of genotypic and phenotypic data from preliminary yield trials (PYT) across two conventional breeding pipelines. Training sets were incrementally constructed by combining data from two to six successive years, with adjustments for year effects. Results revealed a general trend of improved mean accuracy and reliability with additional years, though the magnitude of improvement varied between pipelines. Conventional Medium (CNM) achieved a higher accuracy rate of 0.06 yr^{-1}, reaching the highest mean accuracy of 0.36 but with a higher mean prediction variability of 0.16. Conventional Long (CNL) recorded lower genetic gain rate of 0.03 yr^{-1} due to its high initial mean prediction accuracy using single year, achieving the highest accuracy of 0.35 with a more stable mean prediction variability of 0.06. Both pipelines achieved at least 0.30 accuracy and improved prediction stability with four or more years of training data, underscoring the importance of multi-year datasets for consistent GS performance.

Cross-validation (CV) was conducted to assess the individual effects of the number of years, training set size, and their interaction on improving mean prediction accuracy. The analysis revealed that the number of years had a stronger influence, driven by broader environmental sampling and the accumulation of genetic changes over time, which improved marker effect estimates. The findings highlight the importance of continuously updating training sets with data from recent trials. This approach allows for capturing key elements such as environmental variation, breeding progress, and shifts in allele frequencies—factors that are challenging, if not impossible, to capture in single-year multi-location trials, even if a large number of entries are included.

Incorporating additional years is strongly recommended to achieve consistent and reliable accuracy, facilitating the effective implementation of genomic selection. Regularly integrating historical and current trial data ensures the training set remains robust and reflective of dynamic breeding conditions. This work also demonstrates that simply utilizing the standard Preliminary Yield trials of the program as a training set is very effective and it is not necessary to create

Genomic Analysis of a Salt-Tolerant Introgression Line of Rice Reveals Genetic Mechanisms for Adaptation to Saline Environments

Chaudhary, C., Pruthi, R., and Subudhi, P.K.

Salinity is a major abiotic constraint to rice farming. High salinity causes osmotic and ionic stresses, nutritional imbalances, and compromised soil physical properties, reducing rice yield by reducing germination, crop growth, and seed set. This study aims to enhance our understanding of the molecular mechanisms underlying salt tolerance in a salt-tolerant rice introgression line, derived from the cross involving a Louisiana-adapted rice variety and a well-known salt-tolerant landrace. Genomic composition and the differentially expressed genes (DEGs) in the introgression line were determined using both whole genome sequencing and RNA sequencing. Four major introgression regions, mapped onto the chromosomes 1, 2, and 9, constituted 4.3% of the total rice genome. There were 175 DEGs between the IL and the recurrent parent under non-stress conditions whereas the corresponding number under salt stress was 300. Introgressed regions harbored only 14 and 25 DEGs under control and salt stress conditions with 6 overlapping DEGs. DEGs associated with introgression regions included transporters and transcription factors involved in abscisic acid (ABA) and calcium-mediated signaling pathways. A few key genes and proteins such as *OsDREPP, OsbZIP71, OsCCA1, OsNCED3,* and *OsSDIR1* could be potential contributors to salt tolerance in the IL. Our study highlights the potential of integrating whole genome sequencing and RNA sequencing to uncover molecular mechanisms by identifying candidate genes that could be targeted to improve resilience to salinity stress in rice.

Identification of Blast QTL in a Presidio/*Oryza rufipogon* Rice Advanced Backcross Population

Eizenga, G.C., Jia, M.H., Tran, N.T., Jia, Y., and Jackson, A.K.

The wild ancestral species of cultivated rice, *Oryza sativa* are *O. rufipogon* and *O. nivara*, collectively referred to as the *Oryza rufipogon* Species Complex (*ORSC*) which includes *Oryza* spp. accessions. These accessions are a potential source of novel alleles for rice improvement. Blast disease caused by the fungal pathogen *Magnaporthe oryzae*, is a major threat to global rice production with more than 25 blast resistance genes molecularly characterized. The objectives of this study were to a) genotype a collection of 94 *ORSC* accessions with DNA markers targeting blast resistance genes, *Pib*, *Piz*, *Pik* and *Pita*, b) screen the *ORSC* collection for reaction to three virulent US blast races, and c) develop an advanced backcross (ABC) mapping population using one of the most resistant accessions as the donor parent and an adapted *O. sativa* cultivar as the recurrent parent to map the potential novel allele/gene for blast resistance.

Based on DNA markers, the *Pib* resistance allele was in two of the 94 *ORSC* accessions, *Piz* in one accession, *Pita* was homozygous in 13 accessions and segregated in three accessions, and twelve accessions had a variate of one of the three *Pik* resistance genes (Pik^{Leah}, Pik^{m}, Pik^{s}). Screening these accessions for reaction to leaf blast using the three of the most virulent US blast races, IA1, IB49 and IB33 using a 0 (resistant) to 9 (susceptible) rating scale where ratings < 2.0 were considered resistant, revealed 22 accessions were resistant to IB49, seven accessions resistant to IA1 and four accessions resistant to IB33.

Considering *Pi*-gene presence and the blast ratings, five accessions were selected to cross with two US Midsouth long grain cultivars, Presidio and LaGrue. Based on the F_1 seed produced from these crosses, the blast ratings and *Pi*-genes present, the Presidio/*O. rufipogon* (IRGC103404) cross was selected for developing an ABC mapping population. This *O. rufipogon* accession originated in Bangladesh, exhibited resistance to the three races, and segregated for *Pi-ta*. Presidio is a Texas semidwarf, long grain possessing *Piz*. The final population was comprised of 244 BC_2F_2 backcross inbred lines (BILs) which were genotyped with the 1K-Rice Custom Amplicon and 229 of the 1,000 SNP markers on the amplicon were polymorphic and well-distributed across the genome. An additional 20 polymorphic SSR markers were included to improve mapping in the regions with low SNP marker coverage.

The population was screened for the same three races used to screen the *ORSC* accessions at the seedling stage and IB54 using the spot inoculation method. Screening with IB45 and IB54 at the seedling stage and IE1K using the spot inoculation is in progress. The frequency distribution of IB33, IA1 and IB49 ratings were negatively skewed, thus the results from QTL mapping were inconclusive. Surveying the ratings of the BILs for these three races revealed three BILs which rated as resistant to all three races. Examining the genotypes of these BILs identified the chromosome (chr.) 6 region (28.10 - 30.81 Mb) had overlapping *O. rufipogon* introgressions across the resistant BILs. The candidate gene, *Pitq1* (29.02 Mb) was reported in this chr. 6 region. Compiling the results of screening with all six races should better define the source of the blast resistance discovered in this wild *O. rufipogon* accession.

Development of High-Amylose Rice at Texas A&M AgriLife Research

Samonte, S.O.P.B., Sanchez, D.L., Perdiguera, K.N.C., Prodhan, Z.H., Bocco, R., Talukder, S.K., and Wilson, L.T.

High-amylose rice, which is associated with a glycemic index, is a healthy alternative to intermediate and low-amylose rice for people with diabetes. The Specialty Rice Breeding Program at Texas A&M AgriLife Research is developing high-amylose, high-quality rice lines and has evaluated them genetically and phenotypically across multi-environment yield trials. Top-yielding elite long-grain rice lines that have been genetically classified as high-amylose based on the *waxy* gene were identified as TIL22043, TIL23025, and TIL23021. In 2024, their mean chalky grain percentages were 3.28, 7.35, and 2.11%, respectively. Their while milled grain lengths (L) were 5.91, 6.11, and 6.12 mm, respectively, widths (W) were 1.85, 1.90, and 1.97 mm, respectively, and LW ratios were 3.20, 3.21, and 3.11, respectively. Apparent amylose concentrations of TIL22043, estimated using the iodine colorimetric method, were 34.0 in 2023 and 36.1% in 2024. These selections will be evaluated in the Uniform Rice Regional Nursery starting in 2025. Further updates on the stability of their grain yield and quality will be presented during the Rice Technical Working Group Conference in 2025.

Development of New and Potential Long Grain and Aromatic Rice Varieties in Arkansas

De Guzman, C.T., McCarty, D. L., Hemphill, C., Sha, X., Hardke, J., Nicolli, C., and Counce, P.

Arkansas is the biggest rice producer with about 1.4 million acres in 2023 and about 25% of rice acreage were planted with the University of Arkansas rice varieties. Arkansas released more than forty varieties since the 1980's with an average of release of one variety per year. Conventional and herbicide tolerant rice lines are continuously being bred and incorporated into the rice breeding pipeline. Releases of these new varieties gives more farmers options to manage and control weeds in their production systems.

Continuous breeding in the University of Arkansas long grain rice breeding has shown yield gains of advanced lines in the pipeline over the years with increases up to 10% more than varieties in the past 6 years. We increased our testcrosses and expanded our aromatic rice populations to have a higher probability of selecting for high yielding lines while maintaining excellent grain qualities. Extreme environmental factors and changes in production during the growing period can negatively impact yield and grain quality thus a need to focus on breeding for stress tolerance. Understanding the genetic mechanism of high night-time temperatures (HNT) is being investigated and tolerance traits are being introduced to elite cultivars. This presentation will show potential lines in the pipeline and the progress in varietal development evidenced by high yielding varieties released over the years as well as adaptation to newer traits and technologies to further advance the rice breeding and variety development in Arkansas and the U.S. mid-south.

Fast-Track Breeding of the Provisia Long Grain Variety PVL04

Sha, X., Beaty, B.A., Bulloch, J.A., Hale, K.F., Bounds, W.K., and Fortune, S.

To provide Arkansas rice industry new and improved Provisia rice varieties, a Provisia breeding project was carefully designed in spring 2019 and rapidly executed ever since, which culminates to the release of the first University of Arkansas (UofA) developed Provisia variety PVL04 in 2023 and its successful commercial production in 2024.

PVL04 (*Oryza sativa* L.) is a high yielding, early maturing, and short stature Provisia® (PV) long-grain rice variety developed at the UofA Rice Research and Extension Center (RREC) near Stuttgart, Arkansas, and approved for release in spring 2023. It was fast-track developed from the backcross BC2F1 of 18SIT0557*3/HPHI2 made in spring 2020. 18SIT0557 is an unreleased conventional long-grain rice line developed by the RREC, while HPHI2 is a BASF (Ludwigshafen, Germany) proprietary mutant line with resistance to group 1 herbicide quizalofop-p-ethyl. PVL04 initiated as a bulk of a single BC2F3 progeny row 20B3796 at the winter nursery near Lajas, Puerto Rico in spring 2021. It was evaluated in 2021 Provisia® Advanced Elite Line Yield Trial (PAYT) as entry 21PSIT2035 at RREC and UofA Pine Tree Research Station near Colt, AR, and ranked the 2nd among 50 experimental PV lines and checks. In 2022, it was advanced to the Arkansas Rice Variety Advancement Trials (ARVAT), Pre-commercial Trials (PC), and the Cooperative Uniform Regional Rice Nurseries (URRN) with the experimental designation RU2201021.

PVL04 has an improved yield potential, good milling and grain quality, and good lodging tolerance compared with the current commercial variety PVL03. In 44 statewide and regional trials during 2021-2022, PVL04 yielded an average 9.45 t ha^{-1} as compared with 9.37 of PVL03. Average milling yields (g kg^{-1} whole milled kernels: g kg^{-1} total milled rice) were 605:690 for PVL04, compared with 598:700 for PVL03. PVL04 has a similar semi-dwarf plant type as PVL03 and appears moderately susceptible to lodging. On average, PVL04 took 88 days to reach 50% heading, which is 2 days later than PVL03.

Similar to Cheniere, PVL04 is a southern long-grain with a L-202 type cooking quality, which is characterized by a high amylose content, intermediate gelatinization temperature, but a weak RVA profile. PVL04 has a slender long grain and longer than all predominant pureline varieties on the market, which include Diamond, DG263L, Cheniere, Presidio, PVL03, CLL16, CLL18, and CLL19. PVL04 has an average apparent amylose content of 24.5 g kg^{-1} and gelatinization temperature of 70.5°C. PVL04 possesses resistance genes *Pi-kh* and *Pi-ta*, therefore, is resistant to blast (caused by *Pyricularia grisea* (Cooke) Sacc.). Successful development of PVL04 variety demonstrated that effective incorporation of the new herbicide resistance trait into the elite breeding line through limited backcrossing (BC2) and rapid generation advancement, selection, and purification in both greenhouse and winter nursery can be achieved in as short as 4 years, from initial cross to the commercial production.

Rice Grain Quality Evaluations in RES Breeding Program

De Leon, T.B., McKenzie, K., Sharma, N., Maulana, F., Zaunbrecher, G.M., and Harrell, D.L.

The California Rice Experiment Station has developed and released 57 rice varieties to date. Calrose, in particular, has become synonymous with high-quality medium-grain rice. In 2015, California's Calrose rice was awarded "World's Best Rice" at the 7th World Rice Conference, surpassing 25 competitors including the Thai Jasmine. The station continues to breed rice across all market classes—long, medium, and short grain—as well as conventional, premium, and specialty types. The program employs traditional breeding techniques such as pedigree method, mutation breeding, mass selection, rapid generation advance, and the use of DNA markers for trait selection, fingerprinting, and purity testing.

To ensure high grain quality, cooking and eating qualities of promising lines in the pipeline, rigorous evaluations of breeding lines were conducted. A key aspect of variety development process before a line is propose for release involves external feedback from rice growers, mills, and marketing companies, who participate in grain quality and sensory evaluations to assess market acceptability. Advanced promising lines in the pipeline undergo multiple years of statewide yield testing and grain quality characterization before being subjected to blind tests. Rice samples are number-coded for impartial evaluation, and participants assess them for grain quality, cooking, and eating qualities.

Multivariate analysis shows that Calrose's taste is positively correlated with mouthfeel, aroma, softness, cohesiveness, and whiteness of cooked rice. These sensory attributes are also linked to grain uniformity, translucency, low chalkiness, and overall grain appearance of milled rice. Consequently, the overall grower and market acceptability of California's Calrose and specialty rice varieties hinges on their superior grain quality and exceptional eating qualities.

Genomic Regions Associated with Rice Grain Shape-Related Traits

Sanchez, D.L. and Samonte, S.O.P.B.

Rice grain quality and consumer demand are influenced by grain size and shape. Understanding the genetic basis for grain shape can lead to the development of functional DNA markers to implement effective marker-assisted selection for specific grain shape types. The objective of this study was to identify marker-trait associations (MTAs) for grain shape, i.e., grain length (GL), grain width (GW), and length-to-width ratio (LWR), through genome-wide association studies (GWAS).

Rice samples from at least 200 diverse rice accessions were harvested from field plots at Texas A&M AgriLife Research Center at Beaumont in 2018 and 2019. Their whole-milled rice was evaluated for GL, GW, and LWR using an S21 Rice Statistical Analyzer. Association analyses for these traits were conducted along with 854,832 single nucleotide polymorphism (SNP) markers using three statistical models: mixed linear model (MLM), multi-locus mixed model (MLMM), and fixed and random model circulating probability unification (FarmCPU).

Significant variations in GL, GW, and LWR were observed among rice accessions. In 2018, GL ranged from 4.01 mm (Haginomae Mochi) to 7.10 mm (171R), GW ranged from 1.76 mm (Katy) to 3.04 mm (Ardito), and LWR ranged from 1.53 (Haginomae Mochi) to 3.67 (Camponi SML). In 2019, GL ranged from 3.92 mm (Kaukkyi Ani) to 7.02 mm (L-201 and L-202), GW ranged from 1.79 mm (Katy) to 2.93 mm (89-Y-235), and LWR ranged from 1.49 (Kaukkyi Ani) to 3.72 (Katy).

GWAS results detected 6, 25, and 26 significant MTAs for GL, GW, and LWR, respectively. Three significant MTAs for GL, seven MTAs for GW, and nine MTAs for LWR were detected by at least two statistical models. Three MTAs for GW (S04_6627061, S04_19428146, S09_7387691) and six MTAs for LWR (S04_6627061, S04_6647610, S07_29551767, S07_29551770, S07_29551784, S11_1022851) were observed in both 2018 and 2019. Candidate genes linked to these MTAs will be identified and validated, and this information will be used to efficiently breed rice cultivars with the desired grain size dimensions and shape.

Genetic Markers and Transcriptome Studies During Grain-Filling of Caryopsis Tissue Reveal that Rice Chalky Grain Growth is Controlled by Numerous Regulatory Pathways at High Night Temperature

Julie, T., Riaz, A., Kumar, A., Dwiningsih, Y., Shi, A., and Pereira, A.

The rice yield and quality have been reduced due to the rise in temperature resulting from substantial climate change. High temperatures during flowering limit spikelet fertility, impeding sugar energy transport from the flag leaf to the developing caryopsis tissue, causing chalky grains, which affect grain quality. Enhancing the quality and appearance of rice is crucial for achieving approval from the marketplace. The development of efficient methods in rice breeding has been the primary focus of mining potential grain quality-related genes. Although grain chalkiness is a complex, quantitative genetic trait, the molecular mechanisms underlying its formation are poorly understood. In this study, genome-wide association (GWAS) and linkage studies were conducted in a diverse and mapping population to identify loci associated with grain quality-related traits in control and high night temperatures. An in-depth analysis of the transcriptome and post-transcriptional regulation revealed differential gene expression patterns between chalk and non-chalk genotypes under both conditions, particularly genes related to sucrose and starch metabolism. Overexpression of the HYR gene led to increased expression levels of genes involved in oxidoreductive homeostasis in growing caryopsis tissue. This indicates that ROS and water deficits in starch granules may play in grain chalkiness. The knockout of SCl26, a negative splicing regulator, resulted in a reduction in chalk formation and drought and heat tolerance. This integrated approach provides novel insight to mitigate the high-night temperature effect on starch metabolism for grain quality improvement.

Marker-Trait Associations for Cold Tolerance Trais in U.S. Rice

Shahi, D., Baisakh, N., Wongsa, T., Pradhan, A.K., Sichai, K., Omolekan, T., and Gawande, G.

In comparison with other cereal crops, rice is more sensitive to cold temperatures (<17 °C). Cold stress threatens rice cultivation at the germination, seedling, and reproductive stages, causing significant yield loss. Tolerance of rice to cold temperature at seed germination is very important in the U.S. where early spring freezes are becoming more frequent under the changing climate. Therefore, incorporating cold tolerance in rice is one of the important objectives in relevant rice breeding programs. Rice germplasms exhibit a wide range of variations for tolerance to cold stress. Breeding for cold tolerance, like any other abiotic stress, has not been very effective mostly due to low correlation of cold tolerance between developmental stages, multigenic inheritance of the tolerance traits, and low reliability of phenotypic screening results.

To understand the genetics of cold tolerance, we evaluated 288 rice cultivars that included 145 cultivars within the US breeding programs and 143 exotic cultivars selected from the rice diversity panel 1 for their response to cold at different growth stages. Cultivars Zenith, Palmyra, and Lacrosse had the highest germination and better root and shoot growth under cold. Under reproductive stage cold, only three temperate rice genotypes were able to successfully set seeds. Genome-wide association mapping identified 15 unique, including two novel, significant, quantitative trait nucleotides that explained up to 47.3% of total variance for germination and growth under cold conditions. Cultivars such as Palmyra, Orion Early Wataribune, Koshhikari, Lacrosse, and Nato with high number of favorable alleles were identified as prospective donors for introgression of their superior alleles. Five QTN-SNPs that caused moderate to high effect mutations in genes encoding mitochondrial glycoprotein, SWI/SNF-related matrix-associated actin-dependent regulator of chromatin C, no apical meristem, and NBS-LRR proteins were considered as candidates for validation and development of haplotype-specific markers for their potential use in marker-assisted improvement of cold tolerance in high yielding US rice cultivars.

CRISPR-Based Genome Editing for Flowering Time in Rice

Thomson, M.J., Herndon, L.E., Trisnaputri, A., Morales, K.Y., Tsakirpaloglou, N., Biswas, S., and Septiningsih, E.M.

Genome editing using CRISPR/Cas9 has the potential to accelerate a wide range of plant breeding applications. We are exploring strategies to optimize and deploy genome editing to rapidly validate genes underlying important QTLs and modify critical traits for rice improvement. The rice community is well positioned to take advantage of the power of CRISPR/Cas9 gene editing, as the wealth of cloned genes, diverse genetic donors, and sequence data present numerous opportunities for testing and modification of candidate genes for rice improvement. Texas A&M AgriLife Research has supported the development of the Crop Genome Editing Lab on the College Station campus to support research activities for CRISPR-based genome editing in crop plants. Recent efforts have focused on using multiplexed editing to simultaneously modify multiple gene targets for trait improvement. *Agrobacterium*-mediated transformation of the southern U.S. rice variety Presidio is being used to deliver CRISPR/Cas9 and a tRNA-gRNA expression cassette for multiplexed editing.

Flowering time is a key trait to ensure proper heading date in rice, especially when making use of exotic germplasm that is not adapted to local conditions. Many genes affecting flowering time in rice have been previously characterized, largely using single gene mutations, but the interactions between genes are not well understood. Moreover, many published studies focused on *temperate japonica* backgrounds, which may have different genetic effects from the *tropical japonica* germplasm more commonly used in the Southern U.S. Our team performed a genome wide association study (GWAS) for heading date across a diverse germplasm panel and identified significant associations in a region on chromosome 6 containing the known flowering time genes Hd3a and RFT1. We designed guide RNAs to knock out Hd3a and RFT1, both in combination and individually, to better understand their role in modifying flowering time in the Presidio genetic background. Notably, plants having a double mutant knockout of both genes did not flower even 300 days after planting. At the same time, a second multiplex CRISPR construct targeting six additional flowering time genes, namely Hd1, Ghd7, Hd6, OsCOL10, DTH8, and Ehd1, was transformed into Presidio to develop gene edited progeny with different combinations of flowering time gene knockouts. Multiple mutations were observed, and subsequent generations are being analyzed to better understand the roles of these genes in affecting heading date in the Presidio background. One goal of this project is to develop an early-flowering line in the Presidio background to enable shorter generation times for rapid generation advance (RGA) approaches. The early-flowering Presidio, in combination with other techniques such as controlled daylength, small pots, and premature seed harvesting, would then allow for ultra-rapid generation advancement of lines for backcross applications, such as accelerated introgression of exotic alleles. Future approaches can also be explored to use CRISPR technology to enable "flowering on demand", where inducible promoters can be linked to an FT activation system to provide more precise control over the transition to flowering in rice.

Visions of Dale Bumpers National Rice Research Center

Jia, Y.

Over the past two and a half decades, the scientists and researchers at DB NRRC have made significant contributions that boosted disease resistance and quality in rice. The outcomes of our research have the potential to combat malnutrition and improve public health. The Genetic Stocks Oryza (GSOR) collection includes approximately 33,000 rice accessions and GSOR has distributed over 160,000 seed packets since its inception in 2003. GSOR strengthens rice research programs by distributing about 8000 packets per year to US and international researchers. Vast and diverse collections of rice varieties have been evaluated to search for genes and valuable traits, such as disease resistance, nutrition, and stress tolerance. The development of molecular markers associated with these genes has facilitated their rapid integration into breeding programs, accelerating the development of improved rice varieties. By unraveling the molecular pathways and genetic factors involved, we have gained knowledge to develop innovative strategies for breeding disease-resistant rice varieties that exhibit improved yield potential. For example, the marker for the blast resistance gene *Pi-ta* has been used routinely by all US rice breeders for marker assisted breeding. Thus far, the *Pi-ta* gene has been deployed effectively in over 20 US rice cultivars, leading to hundreds of millions of dollars saved on pesticide applications. By broadening the genetic base of US rice varieties, we aim to achieve a sustainable and environmentally friendly rice production system in the USA that can meet the demands of US consumers and help feed the growing world population. Our dedication to evaluating diverse germplasm, discovering genes and superior alleles, developing genetic markers and enhanced germplasm that can be utilized in varietal development programs, and our research to uncover new mechanisms for rice enhancement reflects our commitment towards addressing the challenges faced by the rice industry. With our vision set on broadening the genetic base to achieve highly productive and sustainable rice cultivar development, we are confident our research will continue to lead to groundbreaking advancements by public researchers for the US rice industry.

Genome Editing for Increased Lysine Content in Rice Grains

Septiningsih, E.M., Rastogi K., Ibarra, O., Molina-Risco, M., Faion-Molina, M., and Thomson, M.J.

Lysine is an essential amino acid necessary for various bodily functions, including protein synthesis, bone health, collagen formation, and wound healing. An inadequate amount of lysine in the human diet can lead to severe malnutrition in children, increase susceptibility to diseases, lower blood protein levels, and impair mental and physical growth. Rice is a staple food for more than half of the people on the planet; however, it has the lowest lysine content among cereals. We aim to develop nutritious rice by increasing the lysine content in rice grains by knocking out the first bifunctional gene in the lysine catabolic pathway.

The synthesis of Lys, along with methionine (Met), threonine (Thr), and isoleucine (Ile), in higher plants occurs through the aspartate (Asp) family pathway, a highly branched metabolic route regulated by a sophisticated feedback mechanism. Its biosynthesis and catabolic pathways tightly control lysine levels in plants. The biosynthesis pathway is inhibited by two crucial enzymes: aspartate kinase (AK) and dihydrodipicolinate synthase (DHPS). A bifunctional enzyme, lysine ketoglutarate reductase/saccharopine dehydrogenase (LKR/SDH), further regulates lysine levels and plays a key role in the degradation pathway. Previous studies have used RNAi to downregulate LKR/SDH, resulting in higher levels of lysine but also resulting in a transgenic product. In the present study, we used CRISPR/Cas9 technology to knock out LKR/SDH, a strategy not previously reported. The goal was to halt Lys catabolism, resulting in higher net Lys levels stored in the grain, thereby improving the nutritional value of rice. A CRISPR/Cas9 vector construct containing sgRNAs of the target genes and the Cas9 gene was incorporated into the Presidio cultivar via *Agrobacterium*-mediated transformation. Transgenic rice plants were generated using the *Agrobacterium* strain EHA105 containing T-DNA constructs. The transformation was carried out on mature Presidio seeds with hygromycin medium as selection. An analysis of transgene copy number was performed using Droplet Digital PCR (ddPCR) to identify lines having a single copy in the genome. Sequencing of the target site was also performed on the T_0 lines to confirm knockout mutations. Selected plants were advanced to the T_1 generation and screened for Cas9 segregation to identify lines having lost the T-DNA introgression, but with a homozygous mutation at the target site. Subsequently, transgene-free edited lines were evaluated for amino acid concentrations using the pre-column derivatization method with 6-aminoquinolyl-N-hydroxysuccinimidyl carbamate. Two T_2 lines were successfully identified with significantly higher levels of lysine content, with up to a 1.9-fold increase in lysine compared to the wild-type Presidio control. Unlike transgenic crops, CRISPR-edited products with a simple deletion and no foreign DNA fall under an exemption in the USDA biotechnology regulatory framework, avoiding the regulatory burden and social stigma associated with GM crops. This approach, therefore, provides a non-GM method to improve the nutritional properties of rice grains with higher levels of lysine.

Pleiotropic Effects of Regulatory Genes Explain Different Frequencies for Red and Purple Pericarp Genotypes in Weedy Rice and in Pigmented Cultivars

Gu, X.Y., Xu, H., Chakraborty, R. Bhattarai, K. Bibi, M., and De Guzman, C.T.

Red pericarp-colored genotypes prevail in wild and weedy rice and are also more frequent than the purple ones in pigmented specialty cultivars. To identify underlying mechanisms of the differentiation, a digenic system for the red (*Rc/rc*) and purple (*Pb/pb*) pericarp genes were evaluated for histological patterns of developing caryopses and pleiotropic effects on seed flavonoids, dormancy, and germination. Non-allelic recombination and epistasis dictated four development patterns of seed pigmentations from 5 to 40 days post anthesis (DPA). The *Rc*- and *Pb*-controlled pigments were synthesized in the lower epidermal cells but compartmented in the cells and lignified wall area, respectively, after 10 d. Four flavan-3-ols (catechin, epicatechin and their dimeric procyanidins) and anthocyanins (AC) were detected in the *Pb* and *Rc* systems, respectively, with catechin being most abundant. Transcription data from the 5-d pericarps confirmed that *Rc* and *Pb* regulated shared and specific pathways for the flavan-3-ol or AC biosynthesis. Both *Rc* and *Pb* affected seed dormancy and germination velocity of the dormancy-released seeds, dimensions and weight of brown rice, and the brown/rough rice rate. *Rc* and *Pb* differ in the size or direction of genic effects (G) on the seed traits, and some of them were also modified by the epistatic or G-by-E (development times) effects. This research suggests that seed pigment traits promote plant adaptation to local environments through pleiotropic effects of the regulatory genes. The pleiotropic traits detected could help explain different frequencies for the red- and purple-pigmented genotypes reported for the non-domesticated and cultivated rice.

Genome-Wide Association Mapping of Agronomic and Grain Quality Traits in Rice

Maulana, F., De Leon, T.B., Sharma, N., Zaunbrecher, G.M., and Harrell, D.L.

Understanding the genetic mechanisms that influence agronomic and grain quality traits in rice is crucial for marker-assisted breeding. This study aimed to map quantitative trait loci (QTL) and identify single-nucleotide polymorphism (SNP) markers linked to these traits through a genome-wide association study (GWAS). We utilized a total of 380 genetic materials, which included released varieties, advanced breeding lines, and historical varieties from the Rice Experiment Station of the California Cooperative Rice Research Foundation, Inc. Phenotyping was conducted during the summer seasons of 2023 and 2024 at the Rice Experiment Station in Biggs, California. The population underwent genotyping using targeted genotype-by-sequencing (tGBS), resulting in the identification of 105,415 SNP markers. We collected data on various agronomic traits, such as grain yield, days to 50% heading, plant height, lodging potential, as well as milling yield and grain quality attributes. The study revealed phenotypic variability for both agronomic and grain quality traits. Using different statistical models, we identified multiple significant QTL associated with these traits across various chromosomes. Some QTL were located on chromosomes previously reported to harbor QTL for the same traits in rice. Candidate gene analysis showed high sequence similarities between some significant loci and known candidate genes related to agronomic and grain quality traits. This study provides valuable insights into the genetic basis of these traits in rice, and the identified SNP markers may be utilized for marker-assisted selection (MAS) in rice breeding programs.

Progress of Japonica Hybrid Rice Breeding

Du, H.

It is well known that indica hybrid rice has achieved great success in China. However, japonica hybrid rice in China has had little success. Difficulties of japonica hybrid breeding lie in three major aspects: yield advantage over conventional cultivars, quality, and hybrid seed production. In recent years, a new type of hybrid has been developed called xian-geng (indica-japonica) hybrid rice. These new hybrids have high yields, acceptable quality but generally low yield of seed production. These indica-japonica hybrids are developed using three-line systems, where the female parents are mainly japonica type. It is called "japonica A – indica R" system. In general, japonica type females have three major disadvantages: low rate of stigma extrusion, low tillering ability, and later flowering time during the day than that of the indica males, which limit the seed production yield.

With both indica and japonica germplasm, a series of new male sterile lines (S-lines) have been developed in the 2-line system. These lines have indica flowering characteristics but japonica type amylose. High rate of stigma extrusion, strong tillering and proper flowering time provide conditions for good seed production yield. Japonica type amylose of S-lines will ensure japonica type quality of the hybrids when crossed with typical japonica male parental lines. Genetic distance between female and male parental lines conditions strong heterosis. In other words, utilization of these male sterile lines as female parents and typical japonica male parents will break through obstacles in yield, quality, and seed production simultaneously. This indica female – japonica male system provides an effective approach to eliminate the bottleneck of hybrid seed production.

Unraveling Genetic Loci Associated with Flag Leaf and Panicle Traits in US-Based Diverse Rice Germplasms

Singh, G., Das Jyto, S. Harper, C.L., and Talukder, S.K.

Flag leaf and panicle traits are the major contributors to increasing rice grain yield. To understand the genetic background of the traits, genome-wide association study (GWAS) analysis is a powerful approach that uses natural genetic and phenotypic variations. The present study was conducted in the greenhouse and a research field of Texas A&M AgriLife Research Center at Beaumont, TX, USA, with the aim of identifying genomic regions controlling the variabilities of flag leaf and panicle architecture in rice through GWAS using whole genome sequencing (21x) based molecular markers. A set of 390 rice varieties/lines/ were planted in 2023 (greenhouse) and 2024 (field) following an Augmented Randomized Complete Block Design with three replicated checks. Data were recorded for flag leaf length (FLL), flag leaf width (FLW), and panicle length (PL). A wide range of variations were observed for the three traits in both environments. The population average and range of FLL, FLW, and PL were 28.4 cm, and 16.2 to 48.6 cm, 1.5 cm and 1.0 to 2.4 cm, and 19.6 cm, and 12.3 to 40.1 cm, respectively in the greenhouse condition. In the field experiment, the population means and ranges of FLL, FLW, and PL were 28.1 cm, and 15.4-49.4 cm, 1.4 cm and 0.9-2.1 cm, and 20.1 cm and 13.2-29.1 cm, respectively. The adjusted means of both years were used to perform GWAS analysis using FarmCPU model. MTAs (marker-trait associations) with LOD scores >6.00 and PVE (phenotype variance explained) >5% were considered significant MTAs. A total of 26 significant MTAs (10 for FLL, 12 for FLW, and 4 for PL) were identified in the greenhouse study. Similarly, 15 significant MTAs (3 for FLL, 8 for FLW, and 4 for PL) were identified in the field study. Candidate gene analysis of the identified MTAs is underway to identify the significant putative genes controlling the studied traits. Germplasms exhibiting higher PL, superior FLL and FLW traits, will be identified at the end of this study and will be incorporated into the rice breeding program to enhance the genetic gain.

UAS-Based Phenotyping for Nitrogen Response in Rice: Predictive Modeling and Uncovering Genomic Variation

Jyoti S.D., Singh, G., Solano, R., Harper C.L., Yang, Y., Bera, T., Wang, J., Tarpley, L., Samonte, S.O.PB., Zhou, X.G., Septiningsih, E.M., and Talukder, S.K.

A tremendous amount of nitrogen fertilizer is used for rice cultivation worldwide. Excessive use of nitrogen fertilizer harms the environment and negatively impacts the sustainability of rice farming. For this reason, screening rice germplasm for better nitrogen response is crucial for developing nitrogen-efficient rice. However, conducting large yield trials for nitrogen response requires significant time and effort. In this context, unoccupied aerial system (UAS) based phenotyping can save significant time and effort in breeding programs. This study collected RGB image-based vegetative indices from rice genotypes grown under three different nitrogen levels (0%, 50% and 100%) throughout the growth period. The temporal vegetative indices from 0% added nitrogen plots were used to train a model using deep learning algorithms to classify genotypes for nitrogen response from vegetative indices. Three models, namely convolutional neural network (CNN), long-short term memory (LSTM), and combined CNN and LSTM model, were used for predictive modeling. Initially, all three models showed around 0.67 accuracy in test sets. The models will be fine-tuned for increased accuracy. In addition, five vegetative indices, namely Brightness Index, Excessive Green, Excess Green Minus Excess Red, Normalized Red Blue Difference, and Visually Atmospherically Resistant Index from all three treatments, were used to fit a fully random linear model. BLUP values from these models were used for a genome-wide association study. A total of 259 significant SNPs were identified from these indices. Later, this SNP information will be used to identify candidate genes related to the nitrogen response of rice.

Identifying the Optimal Developmental Stage and Salinity Level for Assessing Salt Tolerance During the Reproductive Phase in Rice

Kondi, R.K.R., Pruthi, R., Chapagain, S., Chaudhury, C., Rana, P., and Subudhi, P.K.

Rice, a major cereal crop grown and consumed globally, is highly vulnerable to different biotic and abiotic stress. Among the various abiotic stresses affecting rice, salinity ranks as the second most significant, following drought. Among the growth stages, the seedling and reproductive phases are particularly sensitive to salinity stress. However, compared to the seedling stage salinity stress during the reproductive stage poses a greater threat due to drastic reduction on grain yield. To address this challenge, plants have evolved distinct stage-specific resistance mechanisms to cope with salinity stress effectively. However, salt tolerance during the reproductive stage remains underexplored due to a lack of standard phenotyping techniques, genetic variability, and incomplete understanding of stage-specific mechanisms. This study examined the effects of three levels salt stress (EC 6, 8, and 10 dS/m) in three rice genotypes (TCCP, Jupiter, and Cheniere) at different growth stages (before booting, booting, and flowering) . A comprehensive approach employing ANOVA, stress tolerance indicators, and multivariate statistical tools was used to evaluate performance of genotypes to identify optimal screening conditions for salt tolerance.

Our results showed significant effects of genotype, salinity levels, and developmental stages on most rice traits. TCCP demonstrated superior performance across various salinity levels and stages, making it an

excellent donor for salt tolerance. It experienced the least damage from saline stress at the flowering stage, particularly at EC levels of 6 and 8 dS/m. GGE biplot analysis identified the flowering stage at 6EC as the most discriminative and informative for measuring genotype performance under salt stress. This work highlights the need for stage-specific screening techniques and provides valuable information for breeding salt-tolerant rice varieties.

Investigating the Effects of Diffusible Signals from Different Plant Growth-Promoting Bacteria on Rice

Long, S., Fritz, H.G., Calhoun, M., Bommes, A., Neuhaus, D., Hoggard, S., and Mukherjee, A.

Plants form associations with beneficial microbes, including arbuscular mycorrhiza (AM), rhizobia, and plant growth-promoting bacteria (PGPB). In these associations, the host plants benefit from improved growth in exchange for carbohydrates for the microbe. Studies in legume-rhizobia symbiosis (LRS) and AM symbiosis have shown that a molecular dialogue between the symbiotic partners is required to initiate these interactions. Furthermore, genetic and biochemical studies identified the plant and microbial signals and the host genetic pathways involved in these symbioses. For instance, 'Nod factors' are secreted by rhizobia bacteria during LRS, and 'Myc factors' are secreted by AM fungi during mycorrhizal symbiosis. Interestingly, the direct application of these microbial signals on plants can promote their growth, and naturally, these are already commercialized. The same level of understanding doesn't exist for interactions between plants and PGPB. One recent study showed that diffusible signals from *Azospirillum brasilense*, a PGPB, stimulated growth in *Arabidopsis thaliana*. We established an experimental system where diffusible signals from *A. brasilense* could promote rice growth. We are currently investigating if diffusible signals from other PGPB, such as *Azotobacter vinelandii* and *Azorhizobium caulinodans*, can be recognized and perceived by rice, leading to enhanced growth. In the future, we will identify the underlying transcriptomic changes regulating the effects of these microbial signals on their host plant. We expect plant genes encoding receptor kinases, transcription factors, and hormone pathways to be differentially expressed. Our results will identify the host genetic pathways regulated by the microbial signals. In the long term, we plan to identify the chemical nature of these microbial signals, which can have important implications for improving agriculture sustainably and preventing human health concerns.

Heat Stress Response in Rice Genotypes: Pollen Morphology, Pollen Viability, and Biochemical Changes

Rana, P., Kondi, R.K.R., Chaudhary, C., and Subudhi, P.K.

Climate change has played a significant role in the increase in global temperatures, which has, in turn, affected both the productivity and quality of rice crops. Rice is particularly vulnerable to heat stress during the flowering stage, which can impair pollen viability and pollen fertility, disrupting the fertilization process. This leads to reduced yields and lower grain quality.

This study evaluates the impacts of heat stress by examining pollen morphology, pollen viability, and biochemical changes in three rice genotypes: N22, Cocodrie, and Akitokomachi. Heat stress treatment was applied for 5 days at 100.4°F (38°C) from 12:00 PM to 5:00 PM with a relative humidity of 70%. Morphological and biochemical assessments were conducted to understand the effects of heat stress on these genotypes. Pollen morphology and viability were analysed microscopically to observe structural changes and viability loss due to heat stress. Biochemical changes in leaves were measured, including oxidative stress markers such as malondialdehyde and antioxidant enzyme activities superoxide dismutase, catalase, and peroxidase. In addition, chlorophyll content was assessed to evaluate the impact of heat stress on photosynthetic efficiency.

Microscopic analysis of pollen revealed significant structural alterations under heat stress, highlighting the vulnerability of pollen to high-temperature conditions. Biochemical results showed increased MDA levels, indicating oxidative damage, while antioxidant enzyme activities varied across genotypes, reflecting differences in their heat stress responses. Chlorophyll content decreased under heat stress, further confirming the detrimental effects of high temperatures on photosynthesis. These findings underscore the importance of pollen resilience, antioxidant defense mechanisms, and photosynthetic stability in conferring heat stress tolerance in rice. This study provides valuable information for breeding programs aimed at developing heat-tolerant rice varieties with stable yield performance to mitigate the impacts of climate change.

Uncovering Genes in a Rice Germplasm Collection Towards Breeding for Genetic Improvement

Yabes, J.C., Samonte, S.O.PB., Sanchez, D.L., and Prodhan, Z.H.

Rice (*Oryza sativa*) sustains the daily caloric intake and nutritional demand of more than half of the world's population. However, extreme weather conditions, the emergence of new pests and diseases, water scarcity, and soil nutrient depletion constantly pose a threat to global rice production. Breeding for rice genetic improvement to address these challenges is vital. The availability of genetic resources and the advances in high-throughput sequencing technologies help facilitate genetic characterization through understanding the genetic diversity and variation within a germplasm collection. Hence, through whole genome sequencing, the goal of this study is to identify potential parents possessing genes that are tightly linked with important agronomic traits such as nutritional enhancement, grain quality, yield and yield-contributing traits, and tolerance to biotic and abiotic stresses.

A Specialty Rice and Stress-tolerant (SRS) panel comprising of 285 diverse rice cultivars and advanced breeding lines was assembled and planted in the greenhouse. The panel primarily included aromatic (jasmine- and basmati-type), high anthocyanin, high amylose content, and high protein content grain types, and also included cultivars with tolerance to abiotic and biotic stresses. Leaf tissue samples were collected 30 days after sowing and high-quality DNA was extracted using Qiagen DNEasy Plant Mini Kit. The samples were sent to Texas A&M AgriLife Genomics and Bioinformatics Service where DNA quality testing was conducted prior to performing whole genome sequencing using Illumina NovaSeqX 1.5B sequencing platform and using the sequence data of the IRGSP Build5 pseudomolecules as reference. Sequence data will be subjected to quality control and filtering prior to further analysis. The genome sequence will be used to analyze the genetic diversity and population structure of the SRS panel. To understand the population structure and evolutionary relationship of the germplasm, a phylogenetic tree by unweighted neighbor-joining method will be constructed. SNPs and structural variations will be characterized, and the gene presence- and absence variation will be determined as a component of genetic diversity. Functional analysis and validation will be carried out to determine the genes that are present in the germplasm. Once identified, accessions harboring the genes of interest will be integrated into the breeding program for genetic improvement.

Effects of Delayed Harvest on Milling Quality of Clearfield Rice

Guo, M., Beaty, B.A., Bulloch, J.A., Hale, K.F., Carr, E., and Sha, X

Rice (*Oryza sativa* L.) is distinct from other major row crops in the United States due to the necessity of postharvest milling, making head rice yield (HRY) a critical factor for maximizing economic returns. In Arkansas, the largest rice-producing state in the U.S., achieving optimal harvest timing is often challenging due to unpredictable weather, labor shortages, and logistical constraints. Delayed harvesting typically results in lower harvest moisture content (HMC), which increases grain brittleness and fissure development, ultimately leading to milling losses. This study investigated the effects of delayed harvest on the yield performance of selected Clearfield (CL) long-grain and medium-grain rice lines.

A randomized block design (RBD) was implemented at the University of Arkansas Rice Research and Extension Center, with three replicates for each treatment (normal harvest and delayed harvest), evaluating 35 CL long-grain and 5 CL medium-grain lines and checks, which in total encompassing 240 experimental plots. All plots were drill-seeded on April 10, emerged on April 19, and flooded on June 14. Harvests were conducted on September 25 (normal harvest) and October 9 (delayed harvest). The study evaluated key metrics including HMC, total rice yield (TRY), and HRY. Results showed that delayed harvest significantly reduced HMC in both long-grain and medium-grain lines. Under normal harvest conditions, HMC ranged between 15–20%, with an average of 17.38%, while delayed harvest resulted in values between 11–14% and average of 12.49%. This reduction in HMC corresponded with substantial decreases in HRY, with losses of 7.20% and 7.17% observed for long-grain and medium-grain rice, respectively. A significant correlation was found between HMC and HRY ($R^2 = 0.32$, $p < 0.0001$), while TRY remained almost unaffected, indicating that late harvest primarily only impacts head rice yield.

This research demonstrates the critical importance of timely harvesting for maintaining milling quality and ensuring economic viability in rice production, as even a two-week postponement can result in significant reductions in milling quality and subsequent economic losses. These results provide valuable insights for rice producers and processors in developing harvest management strategies that optimize both yield and milling quality.

Identification of Rice Genes Involved in Chalkiness, Seed Traits, and Disease Resistance

Jia, Y., Box, H., Jia, M.H., Braithwaite, P., and Burnett, J.

Understanding how plants utilize limited resources for reproductivity, quality, and disease resistance can improve the efficiency of rice breeding. Quality traits are desirable now more than ever due to years of low-quality grains. The developmental mechanism of grain traits such as chalk is greatly unknown but the ability to map it over chromosomes is where we begin this story. Desirable traits are important for a visually appealing food. Consumers are visual and lines with poor milling quality, although they may have strong yields, are disappointing visually and result in losses for industry and farmers. By mapping desired genes, the information enables selection for both quality and high yielding lines in future breeding.

In this study a recombinant inbred line population of 250 individuals was derived from a cross of a widely used indica restorer variety MingHui63 and a temperate japonica variety M202. This population was used to Biparental map phenotypes and identify their locations on each chromosome. Population data for chalk, branch count, grain length, grain width, and thousand grain weight data were analyzed. Identified an allele that occurs on chromosome 2 alongside the major blast resistant Pi-b homolog. A better understanding of how these traits work together will lead us into a future of better rice breeding.

Whole Genome Sequence Analysis Reveals Genomic Differences Among Two Salt-Tolerant Rice Genotypes, Pokkali and TCCP, and a Susceptible Genotype IR29

Chaudhary, C., Kondi, R.K.R., Rana, P., and Subudhi, P.K.

Soil salinity is a prevalent abiotic stress that poses significant challenges to food security and sustainable agriculture. Salt stress hinders crop growth and productivity in most crop plants including rice. Developing salt-tolerant rice varieties is the most logical approach for enhancing rice productivity in salt-affected soils. This study was conducted to understand the molecular basis of salinity tolerance by analyzing whole genome sequences of two salt-tolerant rice genotypes, Pokkali and TCCP, and a salt susceptible genotype IR29. The highest number of genotype-specific SNPs and InDels was observed in IR29/Pokkali, and IR29/TCCP, followed by Pokkali/TCCP. The frequency of transition substitutions was higher than transversion-type substitutions across all genotypes. We aim to highlight TCCP as a potential salt tolerant donor in breeding programs due to its beneficial traits compared to Pokkali by analysing changes at the genomic level. Further, we analysed genes associated with domestication, adaptation, and abiotic stress tolerance. Our study included genes for pericarp color (*Rc),* grain shattering (*SH4)*, flowering (*Hd1, Ehd1*, *Ghd7*, *Hd3a,* and *RFT1)*, awn development (*An-1),* plant architecture (*PROG1)*, and potassium transport (*HAK5)*. We explored the genetic variation and their consequences, including the conserved domains, within key genes across the three genotypes. These genomic resources will contribute to rice improvement by revealing the molecular mechanisms underlying important agronomic, adaptive, and domestication traits.

QTLs Associated with Defense-Primed Resistance to Bacterial Panicle Blight

Cortes, J.D., Ontoy, J.C., Acharya, A., Bruno, J.S., and Ham, J.H.

Bacterial panicle blight (BPB), caused by *Burkholderia glumae,* has emerged as an important rice disease in tropical and semi-tropical regions, including the southeastern United States. It is characterized by light to dark discoloration of emerging panicles, leading to reduced grain quality and yield. As there is no reliable chemical measure for managing BPB, culturing disease resistant varieties is a crucial alternative disease management strategy for this disease. However, only a few U.S. cultivars show partial resistance at a moderate level, with no major resistance genes or quantitative trait loci (QTLs) identified. Recently, we found that seed-priming using biological agent A257 effectively suppressed BPB and other major rice diseases.

To understand the genetic background of rice resistance to BPB induced by seed-priming with A257, a recombinant inbred line (RIL) population consisting of 164 lines was developed by crossing the moderately resistance medium-grain variety Jupiter with the susceptible variety Bengal. The RIL population was treated with A257 and planted at the H. Rouse Caffey Rice Research Station (Rayne, LA) in three replications. Following inoculation with the virulent *B. glumae* strain 336gr-1, phenotypic evaluation was conducted 14-days post-inoculation, using a 0-9 disease severity scale.

In 2021, the average disease score for the population was 6, with 2.3 to 8.9 range, while in 2023 the average score was 6.3 with 2.3 to 8.3 range. QTL analysis was conducted using inclusive composite interval mapping (ICIM) and using 1000x permutation to identify statistical significance. In 2021, two minor QTLs were identified: one on chromosome 1 (qTBPB1.1) and the other on chromosome 4 (qTBPB4.1), which explained 4.88 % and 9.25 % of phenotypic variance (PVE) respectively. In 2023, a major QTL was identified on chromosome 4 (qTBPB4.2), flanked by SNP markers SNP33326877 and SNP33600878, with an 11.27% PVE and LOD of 5.52. This QTL was close to the flanking markers of qTBPB4.1 (SNP33074445 and SNP33086592) identified in 2021, as well as a minor QTL (qBPB4.2) detected from the same population without seed-priming with 5.5% PVE and a LOD of 2.12. This suggests that a different set of QTLs are associated with enhanced BPB resistance by seed-priming.

Integration of Breedbase into Rice Breeding for Improved Management and Analysis of Data

Dartez, V.B., Hernandez, C., Angira, B., and Famoso, A.N.

Plant breeding programs require extensive and meticulous data management. The incorporation of advanced breeding methodologies into large-scale variety development programs has increased the need to store and repeatedly retrieve historical data. Cataloguing, retrieval, and analysis of data can be cumbersome and prone to errors when performed by hand or in numerous spreadsheets. By integrating the use of Breedbase (a comprehensive breeding management and analysis software) into our rice breeding program, we have more efficiently created trials, crosses, seed lots, and field books, stored and analyzed phenotypic and genotypic data, linked accessions to their respective metadata, and searched for and downloaded large amounts of data. Breedbase was developed at Cornell University and is the same platform used to develop the rice marker and sequence database “Ricebase”. Breedbase is customizable and able to record additional properties/metadata, images, documents, spreadsheets, etc. that may be pertinent to an accession.

The LSU Rice Breedbase database is a web-based, open-source software that operators can use to interact with the collected data as well as analytical tools. Breedbase is easily integrated to other breeding and software tools, including PhenoApps (Rife and Poland, 2014), and can be further enhanced through custom Shiny apps to meet a program’s specific needs. To efficiently manage and incorporate molecular markers into the breeding process, Breedbase features a marker database for genome-wide and trait markers. Other major features of Breedbase include cross, accession, and pedigree creation and storage, trial design (both single and multi-location), seed lot maintenance, phenotypic trait organization, genotyping plate management, location and weather station tracking, and label and barcode generation. Going forward, we intend to implement and/or develop other Breedbase analysis tools, such as GRM spatial adjustments, genomic predictions, and multi-location trial analysis.

By integrating Breedbase into our breeding program, we have saved valuable time in all aspects of our day-to-day tasks and can more easily access and analyze current and historical data. It has also allowed us to access data from anywhere with internet access and in any time-sensitive situation. This poster highlights some of the features of Breedbase that are most relevant to our applied breeding program.

19Y3128, An Improved High Yielding Calrose with Premium Grain Quality, Cooking, and Eating Characteristics

De Leon, T.B., Sharma, N., Maulana, F., Zaunbrecher, G.M., and Harrell, D.L.

In 1981, the station released the M-401 which is a late-maturing premium medium grain. It was then followed by the release of M-203 and M-402 in 1988 and 1999, respectively. More recently, M-211 was released in 2020. All four lines were considered premium quality in terms of cooking and eating qualities for sushi preparation and everyday rice consumption. In the pipeline, a breeding line designated as 19Y3128 with premium cooking and eating qualities is being considered for possible variety release in 2026 until sufficient data is generated to provide its superiority over current medium grains in commercial production. Four-year statewide variety performance of 19Y3128 indicated an overall additional 1% and 6% yield advantages over M-211 and M-206, respectively. In 2021, 19Y3128 was entered in statewide variety trials and had an average of 9,552 lbs./acre yield compared to 9,143 lbs./acre yield of M-211. In 2022, 19Y3128 continued to show 3% yield advantage over M-211 and had 9,373 lbs./acre yield. However, in 2023, 19Y3128 yielded 1% lower than M-211 and in 2024, both 19Y3128 and M-211 had an average yield of 9,294 lbs./acre. Agronomically, 19Y3128 has excellent seedling vigor similar to M-206 and M-211. Plant height of 19Y3128 is 2-cm taller than M-211 and it reaches 50% to heading at 91 days like M-211. Line 19Y3128 has lower lodging potential than M-206 and lower panicle blanking than M-211. In terms of grain quality, two-year preliminary data indicated that 19Y3128 has superior milling yield trend similar or better than M-206. It has lower percent chalky kernels compared to M-211 especially during 2022 when California experienced an unusual heatwave during grain filling stage. Analysis of grain chemistry also indicated that 19Y3128 has similar amylose content like all other medium grains but with lower protein content and higher taste value than M-206. Furthermore, external blind test for milling, grain quality, and sensory evaluations indicated the superior grain characteristics, cooking, and eating qualities of 19Y3128 over current medium grains. With yield advantage, grain quality, cooking, and eating qualities desirable for a medium grain rice, 193128 is currently being purified in head rows for foundation seed increase.

Screening the Presidio/*Oryza rufipogon* Rice Advanced Backcross Population for Reaction to Leaf Blast Disease Using Two Techniques

Grunden, Q.P.H., Eizenga, G.C., and Jia, Y.

The ancestral species of cultivated rice (*Oryza sativa*), *O. rufipogon* and *O. nivara*, are collectively referred to as the *Oryza rufipogon* Species Complex (*ORSC*) and are a potential source of novel alleles for rice improvement, especially tolerance to biotic and abiotic stresses. Unfortunately, many *ORSC* accessions shatter seed, exhibit sterility when crossed with *O. sativa* and several produce limited seed.

Blast disease, a major fungal disease of rice worldwide, is caused by *Magnaporthe oryzae*. To determine if any of the 94 accessions included in an *ORSC* collection carried a novel blast resistance gene/allele, the collection was screened with three of the most virulent US blast races (IA1, IB49 and IB33) using a modified seedling inoculation technique to accommodate accessions with few seed and have more uniform seedling development for inoculation. Modifications to the standard procedure were dehulling and sterilizing the *ORSC* seeds, placing the seed on an Orchid tissue culture media in a Magenta box, growing the plants under 12-hr light/12-hr dark for about 10 days (3-4 leaf stage) in an incubator, transplanting 3-4 seedlings into 6 x 6 cm pots placed in trays for inoculation, and rating on a 0 (resistant) to 9 (susceptible) scale. From these screenings two accessions were resistant to IB49 and IB33, and one *O. rufipogon* accession (IRGC103404) from Bangladesh was resistant to all three races. An advanced backcross (ABC) mapping population was developed using this *O. rufipogon* as the donor parent and Presidio, a US long grain cultivar, as recurrent parent. The 244 $BC_2F_{3:4}$ backcross inbred lines (BILs) comprising the population were screened with blast races IA1, IB49 and IB33 by inoculating seedlings, grown in soil, without the tissue culture step.

Due to limited BIL seed, the Spot Inoculation Method was used to evaluate this population for reaction to blast races IB54 and IE1K. Briefly, steps in this method include placing filter papers containing fungal mycelia on oatmeal agar plates and incubating under a 28-hr light/8-hr dark cycle at 24ºC for seven days; transferring hyphal tips to oatmeal agar and incubating for 12-hr to produce conidia; harvesting conidia in a sterile 0.25% gelatin solution and determining the concentration of conidia using a hemacytometer. Lastly, Tween 20 was added to the conidial suspension to promote attachment to the leaf surface. Filter paper was placed into a 23.5 x 23.5 cm square petri dish, and four 5-cm young leaf segments were cut and placed into the petri dish. Sterile water was used to saturate the filter paper. Using a multichannel pipet, four equal sized 5-µl droplets of the conidial suspension were placed on each leaf segment. The petri dish was maintained at 21º to 24ºC under continuous fluorescent light for 24-hr after which the droplets were removed by blotting with a laboratory tissue. Disease reactions were rated based on the development of the necrotic lesions (7 to 10 days) using a 0 (uniform dark brown spot) to 4 (large spot lesions with sporulated mycelia and conidia) scale. To date, three BILs were rated as resistant to IB49, IA1 and IB33. Currently the BILs are being screened for reaction to races IB45 and IB54 using the seedling method. Once the ratings for the six races are complete, comparisons will be made between the ratings using these two methods.

The Effect of Harvest Moisture Content on Milling Yields of Arkansas Medium Grain Rice

Hale, K.F., Guo, M., Sha, X., Beaty, B.A., and Bulloch, J.A.

Rice milling yields that include total milled and whole milled (commonly known as head rice) is the key determining factor of the value of harvested paddy rice. Previous research has revealed that the harvest moisture content (HMC) has a huge impact on milling yields of both long grain and medium grain rice. However, information is lacking on the HMC effect on most recently released Arkansas medium grain varieties.

In this study, we evaluated 8 Arkansas medium grain rice varieties at the University of Arkansas' Rice Research and Extension Center (UA-RREC) near Stuttgart. Starting at about 30% HMC, rice samples were hand-harvested with a hand sickle twice weekly until all samples reached about 12% HMC. Immediately after harvest, each sample was threshed, cleaned, measured for HMC, are then dried to about 12% HMC for storage at room temperature prior to milling. Two sub-samples of 100 grams of rough rice were taken from each harvested sample and were milled by using a Zaccaria PAZ-100 sample mill. The milling data were recorded and analyzed using regression procedures of the R. Our results indicated that HMC has significant effect on head rice yield (HRY) of Arkansas medium grain rice. As HMC decreases, esp. below 20%, the HRYs dramatically decline. However, there were great differences in reactions to HMC among different medium grain varieties. Titan and Taurus appeared to be most sensitive and with a rate of reduction of 2.09% and 1.76% for every 1% drop in HMC. Meanwhile, ProGold M3 is found to be most tolerant to the HMC reduction. This research provides Arkansas medium grain rice growers with the most updated and relevant information.

An Improved Premium Quality Short Grain Rice

Maulana, F., De Leon, T.B., Sharma, N., Zaunbrecher, G.M., and Harrell, D.L.

Line 21Y2031 is an improved premium quality short grain rice developed at the Rice Experiment Station through pedigree breeding. This experimental line is characterized by its high yield, smooth hulls, early maturity, semi-dwarf stature, good seedling vigor, and superior grain quality. In statewide yield trials, line 21Y2031 consistently outperformed the check varieties, Calhikari-203 (CH-203) and Calhikari-201 (CH-201). On average, it yielded 10,781kg ha^{-1} (9,619 lbs./A), compared to 9,939 kg ha^{-1} (8,867 lbs./A) for CH-203 and 8,764 kg ha^{-1} (7,819 lbs./A) for CH-201, resulting in yield advantages of 8% and 23%, respectively. Additionally, line 21Y2031 showed an earlier heading time of 2-7 days compared to the check varieties across statewide locations, reaching 50% heading in an average of 83 days, while CH-203 and CH-201 required 84 and 85 days, respectively. It also demonstrated good seedling vigor, scoring 4.9 on a scale of 1-5 (with 1 being poor and 5 being excellent), which is higher than that of the check varieties. When harvested at a moisture content of 18-22%, line 21Y2031 had an average milling yield of 67% head rice and 72% total rice. Its kernels also exhibited superior characteristics, including less chalkiness, increased translucency, longer length, and greater weight. Importantly, the grain quality attributes of line 21Y2031, such as appearance, physicochemical properties, cooking, taste, and overall eating qualities, are comparable to those of the check varieties, meeting the standards for premium quality rice.

Genome-Wide Association Mapping of Agronomic and Grain Quality Traits in Rice

Maulana, F., De Leon, T.B., Sharma, N., Zaunbrecher, G.M., and Harrell, D.L.

Understanding the genetic mechanisms that influence agronomic and grain quality traits in rice is crucial for marker-assisted breeding. This study aimed to map quantitative trait loci (QTL) and identify single-nucleotide polymorphism (SNP) markers linked to these traits through a genome-wide association study (GWAS). We utilized a total of 380 genetic materials, which included released varieties, advanced breeding lines, and historical varieties from the Rice Experiment Station of the California Cooperative Rice Research Foundation, Inc. Phenotyping was conducted during the summer seasons of 2023 and 2024 at the Rice Experiment Station in Biggs, California. The population underwent genotyping using targeted genotype-by-sequencing (tGBS), resulting in the identification of 105,415 SNP markers. We collected data on various agronomic traits, such as grain yield, days to 50% heading, plant height, lodging potential, as well as milling yield and grain quality attributes. The study revealed phenotypic variability for both agronomic and grain quality traits. Using different statistical models, we identified multiple significant QTL associated with these traits across various chromosomes. Some QTL were located on chromosomes previously reported to harbor QTL for the same traits in rice. Candidate gene analysis showed high sequence similarities between some significant loci and known candidate genes related to agronomic and grain quality traits. This study provides valuable insights into the genetic basis of these traits in rice, and the identified SNP markers may be utilized for marker-assisted selection (MAS) in rice breeding programs.

The Genetic Stocks Oryza (GSOR) Germplasm Collection

Moser, J., Huggins, T.D., Rice, A., and Jia, Y.

The USDA Genetic Stocks – Oryza (GSOR) Collection at DBNRRC is part of the U.S. National Plant Germplasm System (NPGS) and serves as genebank and distribution center for genetic mutants and molecularly characterized genetic resources for the rice research community. GSOR was established in

2003 to give researchers who develop populations, often through grant funding, a place to deposit seeds of these populations. GSOR currently maintains ~33, 000 accessions from 39 populations, of which about 70% were deposited by Dale Bumpers scientists. The GSOR program is responsible for storing, maintaining, documenting, and distributing (free of charge) these materials to the scientific community for use in genetic and genomic research. Since 2003, GSOR has distributed 156,665 accessions to the domestic (105,350) and international (51,315) rice research community. Ultimately these materials will support additional genetic research that aid in the understanding of the genetic control of traits that can be used to enhance the development of new cultivars that meet the needs of the U.S. rice industry.

Enhancing Genetic Gain for Yield and Grain Quality via Recurrent Selection at Texas A&M AgriLife Research

Ponce, K.S., Samonte, SO.PB., Sanchez, D.L., and Wilson, L.T.

Identifying superior genotypes from a large population is one of the main bottlenecks of breeding programs. Increasing the frequency of favorable alleles in the breeding population increases the chance of identifying promising genotypes. Population improvement via recurrent selection has been proven effective in the continuous accumulation of positive alleles, thereby enhancing the additive genetic variance and therefore the rate of genetic gain. This strategy will be implemented in the Specialty Rice Breeding Program at Texas A&M AgriLife Research to improve traits related to yield and grain quality. Starting with its breeding for high-amylose rice types, 12 diverse elite parents will be intermated following a half-diallel mating design to develop the base population (cycle 0 selfing generation 0 – C_0S_0). The population, starting at the 3rd selfing generation (S_3), will be subjected to early-generation testing for yield-related and grain-quality traits over multiple cycles of selection. This will allow the early elimination of undesirable genotypes, the advancement of lines that pass selection criteria, and the reduction of resources needed compared to evaluating a large number of genotypes. The selected best lines will be used as parents to generate the next population cycle (cycle n selfing generation 0 – C_nS_0). The means for grain yield and quality in each cycle will be compared to assess realized genetic gain.

Screening for Potential Basmati-Type Rice Lines at Texas A&M AgriLife Research

Prodhan, Z.H., Samonte, S.O.PB., Sanchez, D.L., Perdiguerra, K.N.C., Bocco, R., Talukder, S.K., and Wilson, L.T.

Basmati rice is a premium-quality rice mostly grown in the Indian subcontinent, but it dominates fine rice markets in the United States. The U.S. imports aromatic rice, which includes Basmati rice, ranks 2nd and is expected to rise. Although a few Basmati-type lines have been developed in the U.S., they cannot compete with the demand for imported Basmati rice. Hence, a significant effort concentrating on Basmati-type rice breeding is required to reduce the economically detrimental trend of rising imports of Asian aromatic rice. This research aims to screen some potential Basmati-type rice lines of the specialty rice breeding program at the Texas A&M AgriLife Research Center, Beaumont, Texas.

In this study, 15 rice cultivars that are available in the USDA-ARS Germplasm Resources Information Network (GRIN) were used; among them, 12 are Basmati rice, one U.S.-developed photoperiod-insensitive, early-maturing, semidwarf, aromatic, long-grain, basmati-type cultivar, one internationally renowned long-grain, non-basmati rice variety having excellent grain quality, and one Texas-grown, long-grain, semi-dwarf rice cultivar. The morpho-agronomic, physicochemical, and grain quality data were analyzed to select the superior cultivars that might be used as parents for producing high-quality Basmati-type rice.

The initial results demonstrated that the plant height ranged from 32.7±0.6 (Presidio) to 72.3±3.2 cm (Basmati Nahan), days to heading from 79 (Basmati Medium) to 119 days (Basmati 10), and panicle length from 18.0±3.0 (Sada Gulab) to 33.3±1.5 cm (Basmati Pardar). Agronomic data, along with the grain quality parameters of the tested cultivars will be presented in the poster. This benchmark information will be useful in selecting breeding materials and planning breeding strategies for improving the grain quality of Basmati-type rice suitable for the U.S. rice-growing environment.

Developing Jasmine-Type Rice Lines at Texas A&M AgriLife Research

Sanchez, D.L., Samonte, S.O.PB., Perdiguerra, K.N.C., Prodhan, Z.H., Bocco, R., Yan, Z., Talukder, S.K., and Wilson, L.T.

Rice imports in the United States are on an upward trend, mainly due to the increasing consumer demand for aromatic (Jasmine and Basmati) varieties from Asia. To date, US-grown aromatic rice makes up less than 1% of the market share. The Specialty Rice Breeding Program at Texas A&M AgriLife Research aims to develop competitive jasmine-type rice lines adapted to US field conditions.

Jasmine rice cultivars were obtained from the USDA-ARS Germplasm Resources Information Network (GRIN) and were crossed with US cultivars. The breeding lines derived from these crosses were phenotypically screened for heading date (not later than seven days after Presidio's heading date), intermediate plant height, high tillering, and none to minimal disease incidence. Marker-assisted selection was conducted starting at the F3 generation to identify breeding lines possessing the *fgr* gene, which confers aroma. In addition, the lines were screened using molecular markers for semidwarf height, glabrousness, blast and narrow brown leaf spot resistance, and grain quality genes.

In 2024, 16 F6 to F12 jasmine-type Texas Inbred Lines (TILs) and 13 hybrids were evaluated in a replicated preliminary yield trial at the Texas A&M AgriLife Research Center in Beaumont. Five TILs and all 13 hybrids performed better than the checks. Among the TILs, TIL24067 was identified as a high-yielding jasmine-type rice line with good phenotypic rating.

Genetic Characterization and Phenotypic Evaluation of NeoTrinity Lines

Sanchez, D.L., Samonte, S.O.PB., Perdiguerra, K.N.C., Prodhan, Z.H., Bocco, R., and Zhou, X.G.

Trinity is a rice variety developed by the Texas A&M AgriLife Research Center at Beaumont and was released in 2022. It has excellent grain quality and favorable agronomic traits but lacks the *Pib* gene, a major blast-resistant gene that gives the rice plant broad-spectrum resistance to the rice blast pathogen. To address this, the *Pib* gene was transferred into Trinity after 2-3 cycles of backcrossing. In each backcross, the presence of the *Pib* gene was verified using the 'Pibdom' DNA maker, and only plants displaying the resistance marker were selected. The genetic similarities of the backcross lines were compared to Trinity using genome-wide markers from the LSU80 QA/QC Rice PlexSeq SNP Panel.

Twenty-seven BC_2F_1 plants containing the *Pib* gene were selected in 2022. One hundred thirty-nine selfed progeny (BC_2F_2) were screened for the *Pib* marker in 2023, and 44 BC_2F_2 plants were homozygous for the *Pib* blast resistance gene. The genetic similarities of these 44 BC_2F_2 plants ranged from 82% to 95%. The 27 BC_2F_1 plants were also backcrossed to Trinity to increase their genetic similarity to Trinity. In 2023, 35 BC_3F_1 plants were identified to possess the *Pib* resistance gene. The genetic similarities of the selected BC_3F_1 lines to Trinity ranged from 90% to 96%. The selected backcross progeny were also evaluated for the following traits: plant height (*sd1*), pubescence (*GLR1*), grain size (*GS3* and *SLG7*), amylose content (*Wx*), gelatinization temperature (*Alk/SSIIa*), aroma (*fgr1/badh2*), other blast resistance genes (*Piz, Pi33, Pi43, and Pita2*), and narrow brown leaf spot (*Cercospora janseana*) resistance (*CRSP2.1*). All the backcross plants possess the alleles for semi-dwarfness and glabrousness. They also possess grain quality alleles for long and slender grains, intermediate amylose content, low to intermediate gelatinization temperature, and are non-aromatic.

The selected BC_2-derived lines were multiplied in the 2023-2024 winter nursery in Puerto Rico. These lines, now at BC_3F_4 generation, were evaluated in a replicated preliminary yield trial in Beaumont during the 2024 growing season. Sixteen NeoTrinity lines yielded better than Trinity. The BC_3-derived lines are currently being advanced and evaluated in the greenhouse to determine the progenies that are homozygous for *Pib*.

Assessing the Response of Tropical Japonica Accessions Under Alternate-Wetting-Drying Conditions Through Hyperspectral Analysis

Sells, L., Huggins, T.D., Edwards, J.D., Rice, A., and Moser, J.

Spectra-radiometry captures the interaction of spectral wavelengths and matter in the form of wavelengths and amplitudes. The reflectance of different wavelengths of light by the plant canopy, a key indicator of plant health, is influenced by its' optical properties to produce a unique signature. The reflected spectra of plant canopies provide information that can be used to assess a range of parameters, including green biomass, photosynthetic size, water status and environmental stresses. Spectral reflectance can be measured with hyperspectral cameras or spectroradiometers which have a typical spectral range of 350-1100 nm. The understanding of optical properties of plant canopies has facilitated the development of a series of assays known as spectral reflectance indices (SRI). These SRI include the normalized difference vegetation index (NDVI), which measures green biomass of canopy; photochemical reflectance index (PRI), which estimates solar radiation use efficiency; water index (WI) and normal water index 1 (NWI-1), which both estimate the water status of the canopy.

Alternate-wetting-drying (AWD) was applied to a field of 134 tropical *japonica* accessions. AWD is a management technique in rice used to reduce irrigation by allowing fields to naturally dry down and not remain under constant flood. In this study, the spectra of 134 tropical *japonica* accessions were collected under AWD conditions to screen for individuals with traits that can be beneficial for production under reduced irrigation. The spectral data showed variation in the reflectance spectra of the accessions across two dry downs. Specific wavelengths were extracted from the spectra and used to estimate several SRIs including NDVI, PRI, WI and NWI-1. The response of the accessions to AWD compared to the flood treatment was significantly different for NDVI, PRI, WI and NWI-1. The data also indicated that the accessions under AWD had varied responses according to NDVI, PRI, WI and NWI-1. Several accessions, Mato Grosso, Quinimpol, Leah, and IITA 130, were some of the accessions that were less affected by the AWD treatments according to NDVI, PRI, WI and NWI-1. These accessions were some of several with green canopies at the second dry down cycle. The SRI show potential to be reliable tools to select materials for tolerance to stress from production under reduced irrigation conditions.

The Impact of Heat Stress on Reproductive Stage in California Rice Cultivars

Sharma, N., Martin, J., De Leon, T.B., Maulana, F., Zaunbrecher, G.M., and Harrell, D.L.

In 2022, the North Sacramento Valley experienced a severe heatwave during rice grain filling, leading to increased chalkiness in most California rice varieties. This significantly reduced the quality of Calrose varieties, impacting their market value. The elevated number of chalky kernels lowered the overall grain quality of Calrose varieties from U.S. No. 1 to U.S. No. 2 or higher. To address this issue, the Rice Experiment Station initiated a breeding program focused on developing heat-tolerant rice. A literature review revealed limited availability of heat-tolerant rice varieties. This suggests the potential for genetic improvement in this trait. However, before embarking on rice breeding work, it is imperative to understand the level of heat tolerance or heat sensitivity existing in our breeding lines and rice germplasm. Since grain quality is a complex trait, it is essential to identify heat tolerant lines in our gene pool before introducing new germplasm in the breeding pipeline.

In this study, we evaluated advanced breeding lines for heat stress tolerance in a greenhouse experiment. Plants were subjected to elevated night temperatures during the grain-filling stage. After 100% panicle emergence, the greenhouse temperature was set to a high night temperature of 28 °C for 12 hours and a day temperature of 22 °C. The treatment continued until the harvest, and the grain quality was assessed using a Vibe scanner. Results indicated that most of our breeding lines were sensitive to heat stress, with medium and short grain lines exhibiting higher sensitivity. Chalkiness levels ranged from 9.5% to 81.0% in medium grains and 4.0% to 83.9% in short grains. Long grain lines showed some tolerance, with chalkiness ranging from 1.7% to 76.0%. The long grain lines 19Y1018, 20Y1009, 20Y1010, 20Y1029, 22Y1107, Calaroma-201, and L-208 demonstrated lower chalkiness compared to their control counterparts. For medium grains, M-105 also exhibited improved heat tolerance. These findings highlight the need for enhancing heat stress tolerance in the California rice breeding program and emphasize the importance of sourcing new germplasm from outside the region.

Presence of HPPD Inhibitor Sensitive 1 Gene Mutation in Weedy and Conventional Rice

Zaunbrecher, G.M., Yeltatzie, G.B., Blank, T., Espino, L., De Leon, T.B., Brim-Deforest, W., and Harrell, D.L.

The pro-herbicide benzobicyclon is a 4-hydroxyphenylpyruvate dioxygenase (HPPD)-inhibitor and is used in the control of several annual grasses, sedges, broadleaves, and aquatic weeds in flooded rice. Studies on benzobicyclon tolerance indicate a cultivar specific tolerance pattern with *japonica* more tolerant than *indica* and *aus* cultivars. The tolerance to benzobicyclon is conferred by a fully functional HPPT Inhibitor Sensitive 1 (HIS1) gene. In susceptible *indica* plants, a 28bp deletion in the third exon of the HPPD inhibitor gene (his1) results in loss of function due to an early stop codon and a severely truncated protein. However, certain members of the *aus* subspecies do not possess the deletion but have been shown to be sensitive to the herbicide. Previous studies developed Kompetitive Allele Specific PCR (KASP) assays for SNPs located in the second intron of HIS1 shared between *indica* and *aus* cultivars but not found in *japonica*. KASP results were compared to field data and were able to reliably predict herbicide tolerance in plants with HIS1 but were only 53% reliable in the his1 plants.

The current study was undertaken to determine the presence of the 28bp deletion in various weedy and conventional rice accessions. Selected accessions will then be field tested to determine if the deletion correlates with field susceptibility to benzobicyclon herbicide. Traditional PCR primers flanking the deletion site were developed and ran on 67 weedy rice accessions from across the US, including 19 entries unique to California, as well as historical and current domestic and international varieties.

ABSTRACT OF PAPERS FROM PANEL ORAL PRESENTATIONS: AGRONOMY AND RICE CULTURE

Panel Chair: Manoch Kongchum

Moderators: Bruce Linquist, Dustin Harrell, and Manoch Kongchum,

Hybrid Rice Selection for Carbon Net Negative Emissions in Drill Seeded Rice

Adviento-Borbe, M.A.A., Quinones, C., Mendez, K., Larazo N., Larazo, W., and Massey, J.H.

Rice environment with its genotypic variability, farmers' practices and climatic changes are challenges of rice farming. We conducted studies on the potential of hybrids in reducing CH_4 and N_2O emissions. This study demonstrates that a combination of approaches will likely be needed to improve the resilience of irrigated rice.

The use of low greenhouse gas (GHG) emitting rice cultivars can effectively enhance net negative CO_2 equivalents (CH_4 and N_2O emissions) in rice fields. Rice hybrids have higher productivity per day than inbred cultivars and need lesser time in the field with reduced irrigation levels. This renders the hybrid rice technology to be highly effective in reducing GHG emissions from rice paddies. Two field studies were conducted in rice experimental research farm located in Harrisburg, AR to explore the potential to emit low GHG emissions of high yielding hybrids under continuously flooded (FLOODED) and/or furrow (FURROW) irrigation. Grain yields and CH_4, N_2O, and CO_2 emissions using vented flux chamber method were measured from 7 hybrids (RT7521 FP, RT7421FP, RT7321FP, RT3202, RT7302, RT7331MA) and 4 inbreds (CLL16, OZARK, TAURUS, PVL04). Grain yields were 6.2 to 15 Mg ha^{-1} and increased by about 46% in all hybrids than in inbreds under FLOODED irrigation but decreased by 3% to 6% under FURROW irrigation due to water stress. Seasonal CH_4 emissions ranged from -0.25 to 101 kg CH_4-C ha^{-1} and mainly contributed to the total global warming potential (GWP) in FLOODED irrigation. But with multiple dry cycles under FURROW irrigation, total GWP was mainly from total N_2O emissions (98%). RT7521FP and RT3202 had the lowest net CO_2 eq. among all cultivars while OZARK emitted the lowest among inbreds. N_2O and CO_2 emissions were not affected by genotypes. Yield-scaled GWP of RT7521FP and RT3202 were also the lowest under FLOODED or FURROW irrigation (87 to 292 kg CO_2 eq. Mg^{-1} season^{-1}) because of lower CH_4 emission and higher grain yields. Our findings demonstrate that while it is possible to bring CH_4 emissions to ambient flux levels through hybrid selection and reduced flooding days, tradeoffs between N_2O and grain yields were realized and critical in the implementation of hybrids and reduced irrigation methods. Here, breeding hybrids under water stress and suboptimal N application with low CH_4-emitting characteristics of RT3202 and RT7521FP may have the potential to develop climate resilient rice with both high yield performance and lowest GHG emissions.

Reduction of Greenhouse Gas Emissions and Grain Arsenic Through Water-Saving Technologies in Drill Seeded Rice

Adviento-Borbe, M.A.A., Rohila, J.S., Pinson, S.R.M., Huang, Y., Pedrozo, R., Moser, J., Larazo, N., Box, H., Sookaserm, T.B., Braithwaite, P., Grunden, E., Everette, J., Moore, P.A., Baba, K., Yamaguchi, N., and Jia, Y.

Flooded rice has great potential to mitigate greenhouse gas (GHG) emissions and arsenic in the grain through water saving strategies. We evaluated GHG emissions, grain yield, and grain arsenic from drill seeded Koshihikari and Saber cultivars managed under continuously flooded and multiple dry down irrigation practices.

Non-continuous flooding irrigation can reduce greenhouse gas emissions (GHG) and levels of inorganic arsenic (iAs) in milled rice. A three-year field study was conducted to assess the reduction of GHG emissions and milled grain iAs content of two cultivars (KOSHIHIKARI and SABER) following multiple dry downs (Alternate wetting and drying: AWD, Midseason drain: (MSD) and continuously flooded irrigation: (FLOODED). Methane, N_2O and CO_2 emissions were measured using the vented flux chamber method equipped with gas chromatograph while iAs levels were measured using inductively coupled plasma atomic emission spectroscopy (ICP-AES). Grain yields ranged from 5.8 to 10.1 Mg ha^{-1} and were not affected by irrigation. Seasonal CH_4 emissions ranged from 34 to 1,079 kg CH_4-C kg ha^{-1} season^{-1} and were mainly affected by irrigation (P = <0.0001). While N_2O and CO_2 emissions were independent of either irrigation or cultivars and ranged from 0.16 to 3.6 kg N_2O-N ha^{-1}season^{-1} and 6 to 18 Mg CO_2-C ha^{-1}season^{-1}, respectively. Total seasonal CH_4 emissions were reduced by 32% to 65% in MSD and AWD treatments, respectively with greatest reduction in multiple dry downs (AWD) treatments. Although N_2O emissions in AWD and MSD increased by about 2 times compared to FLOODED treatments, N_2O emissions were not affected by genotypes. Across all years and treatments, total CH_4 emissions largely constituted global warming potential (GWP) by about 87% and GWP values were reduced by about 43% under AWD and MSD treatments for both cultivars. In all years and treatments, iAs content in milled rice ranged from 0.067 to 0.116 mg kg^{-1} and 0.128 to 0.297 mg kg^{-1} in brown rice. Compared to CODEX recommended limits for iAs, both levels of iAs in brown and milled rice grains contained less than the threshold limits for human consumptions. However, for baby foods, only grain samples under AWD treatments contained less iAs levels than 0.10 mg kg^{-1} iAs limit. Our results highlight the multiple benefits following AWD irrigation which include decrease GWP without yield penalty or increase in iAs levels in milled rice. However, adoption of these practices will require careful consideration to tradeoffs such as yield decline, increase N_2O emissions and grain iAs content in commercial rice fields.

Balancing Productivity and Emission Reductions in Texas Organic Ratoon Rice Farming

Bera, T., Yang, Y., Dou, F., Zhou, X.G., and Wilson, L.T.

Organic ratoon rice farming presents a unique opportunity to combine high productivity with environmental stewardship. By leveraging sustainable practices such as cover cropping and organic amendments, this system holds the potential to improve soil health, enhance biodiversity, and support long-term agricultural resilience. However, balancing productivity gains with the reduction of greenhouse gas (GHG) emissions remains a critical challenge, particularly as organic rice production continues to expand in the U.S., where domestic supply struggles to meet growing demand. Optimizing ratoon cropping systems is essential to reducing reliance on imports while minimizing environmental impacts and promoting sustainable practices.

To investigate these dynamics, a field trial was conducted at the Texas A&M AgriLife Research Center in Beaumont, Texas. The study evaluated the effects of rice cultivars (inbred 'Presidio' and hybrid 'XP753'), crop rotations (cover crop vs. winter fallow), and five nitrogen (N) rates (0–135 kg/ha) on GHG emissions and rice productivity in an organic system. Nature Safe® (13-0-0) served as the organic N source, with alfalfa (*Medicago sativa*) hay substituted for cover crops to simulate nitrogen-fixing benefits.

Results highlighted trade-offs between productivity and GHG emissions in organic ratoon rice systems. Cover cropping increased grain yield by 34–47%, while hybrid XP753 outperformed inbred Presidio by 72–97%. CO_2 emissions were similar between organic and conventional systems but increased with higher N rates, except for XP753 with cover cropping. Conventional management had the lowest CH_4 emissions, whereas cover cropping raised CH_4 emissions by 80% compared to winter fallow. While conventional systems had lower CH_4 emissions, they were among the highest CO_2 emitters. Global warming potential (GWP) and greenhouse gas intensity (GHI) were lowest under conventional management across all crop cycles, followed by XP753 with cover cropping. These results emphasize the need for strategic nitrogen management and cultivar selection to balance productivity with emission reductions.

Methane Emissions from Climate-Smart Rice Production Practices in Southwest Louisiana

Kongchum, M., Wang, J., Tubana, B.S., Jeong, C., Zhang, X., and Fluitt, J.S.

A climate-smart practices project was established for evaluating greenhouse gas emissions and rice yield in three producer farms in southwest Louisiana at Gueydan, Kaplan, and Hathaway. The practices included standard practice (farmer practice), alternate wetting and drying (AWD) water management, cover crop rotation, and fertilizer management. The cover crop was planted in November 2023 using the mixture 70:30 seedling ratio of Austrian peas and cereal rye and it was terminated in February 2024 before planting rice. The rice cultivar in Gueydan and Kaplan was PVL03, and RT7331 MA. Permanent flood started immediately after applying nitrogen (N) fertilizer (at 4- to 5-leaf stage). In the AWD treatment, the field was drained at about 3 weeks after permanent for a period of 7-10 days. Gas chambers and boardwalks were installed before flooding. Gas samples were collected weekly from the first day of flooding until harvesting. Rice yield was harvested using a Wintersteiger combine harvester with 6 replications in each treatment. The harvested area for each replication was 165 m2 (1.5 x 110 m) for the Gueydan and Kaplan locations. The harvesting at Hathaway was performed in whole plot for each treatment by a commercial combine harvester.

In the cover crop treatment at the Gueydan site, rice stand was significantly lower than other treatments. The highest yield was observed in the standard practice (8,920 kg/ha) but it was not statistically different from the AWD (8,851 kg/ha). The lowest yield was in the cover crop treatment (7,130 kg/ha). At the Kaplan site, the highest and lowest yields were also in the standard practice (4,708 kg/ha), and cover crop treatment (4,456 kg/ha). Rice yield at Hathaway in the standard practice, AWD, and cover crop treatments were 9,271; 9,458; and 8,920 kg/ha, respectively.

At the Gueydan site, the methane and nitrous oxide emissions were observed in the farmer practice treatment. The highest methane flux from this treatment was detected at 87 days after planting (DAP), and 52 DAP for nitrous oxide. The lowest methane emission was in the AWD treatment. At Kaplan, the lowest methane emission was also in the AWD. There were no differences in methane emissions in all treatments at the Hathaway site. Nitrous oxide emissions from Kaplan and Hathaway were significantly lower than the Gueydan site in all treatments.

Even though rice yield and greenhouse gas emissions were not consistent from all three locations, the AWD practice showed potential to reduce methane emissions with insignificant impact on the grain yield.

Planting Date Considerations for the Upper Mid-South

Chlapecka, J.L., Rhodes, L.N., and Hunt, C.M.

As planting dates have been pushed forward for rice (*Oryza sativa* L.) and especially soybean (*Glycine max*), the key rotational crop of Mid-Southern rice, it is imperative to define the optimal time for planting rice. A study was initiated in 2022 and continued into 2023 and 2024 in southeastern Missouri to evaluate the optimum planting date for rice in the upper Mid-South. Five planting dates spaced approximately 3-weeks apart from mid-March to mid-June were included for all years, with a sixth planting date occurring in late February for the 2024 trial. Planting date trials utilized the same set of cultivars that were entered into the Missouri Cultivar Trials, so entries were varied slightly depending upon seed availability from participating companies. Nine hybrids and 16 varieties were utilized in 2022, 13 hybrids and 17 varieties in 2023, and 7 hybrids and 17 varieties in 2024. These represented over 95% of Missouri's commercial rice production.

Results generally indicate that earlier planting results in greater yield potential. However, while earlier planting generally results in greater yield potential, a significant decrease is not realized until May planting. Yield potential in all years began a sharp decline as we entered the mid-May to mid-June timeframe, which was more severe for inbred varieties and less severe for hybrids. In 2024, the average yield of inbred varieties decreased from 9,445 kg/ha to 8,152 kg/ha to 6,404 kg/ha from April 25 to May 21 to June 14. Similarly, average hybrid yield decreased from 11,334 kg/ha to 10,392 kg/ha to 8,263 kg/ha over the same dates. Data suggest that in the upper Mid-South we should strive to plant rice between late-March and May 1 and focus on planting inbred varieties first. However, an alternative way to view this data set is that planting up until the first of May does not typically result in decreased yield potential, which is very helpful for those wishing to plant soybean in April. Therefore, future plans are to include both rice and soybeans within the same planting date trial to allow for direct analysis of which planting order might be more advantageous.

Seeding Rate and Nitrogen Fertilization of Hybrid Rice Cultivars in Arkansas

Hardke, J.T., Frizzell, D.L., Clayton, T.L., Castaneda-Gonzalez, E., Hartley, H.E., Smith, T.M., and Roberts, T.L.

Hybrid rice cultivars are planted on over 60% of Arkansas rice acres each year. Selecting an optimal seeding rate is important to minimize seed cost associated with hybrids while selecting optimal nitrogen (N) strategies is important to maximize production potential. Traditionally, hybrids are recommended to be planted at 111 seed/m^2 (10.3 seed/ft^2) or 25 kg/ha (22.5 lb/acre) on silt loam soils, with seeding rates increased based on soil texture, land condition, and planting date. Meanwhile, current N management recommendations for hybrids are to apply 134-168 kg N/ha (120-150 lb N/acre) at the preflood timing followed by 34 kg N/ha at the late boot stage. New hybrid releases need to be evaluated for their responses to seeding rate and nitrogen application to ensure optimal rice management recommendations.

For seeding rate trials, the RiceTec hybrids RT 7302, RT 7321 FP, RT 7331 MA, and RT 7421 FP were drill-seeded at three locations each year from 2022-2023. Trials for each hybrid at each location were independent randomized complete block designs. These locations included the University of Arkansas System Division of Agriculture's Northeast Research and Extension Center (NEREC) near Keiser, AR; the Pine Tree Research Station (PTRS) near Colt, AR; and the Rice Research and Extension Center (RREC) near Stuttgart, AR. For seeding rate trials, each hybrid was seeded at 43, 65, 86, 108, and 129 seed/m^2 (4, 6, 8, 10, and 12 seed/ft^2). For seeding rate studies, it was not uncommon for highest grain yields to be achieved at seeding rates lower than 108 seed/m^2. However, this most often occurred when stand densities occurred within the recommended range of 54 to 86 plants/m^2 (5 to 8 plants/ft^2). This suggests that current seeding rate recommendations continue to be adequate, but that growers may be able to rely on lower seeding rates if they are still capable of achieving recommended stand densities.

For nitrogen trials, RT 7302, RT 7321 FP, and RT 7421 FP were drill-seeded at the same locations as seeding rate trials at a uniform seeding rate of 118 seed/m^2 (11 seed/ft^2). Trials for each hybrid at each location were independent randomized complete block designs. Preflood N rates included 0, 67, 101, 135, 168, and 202 kg N/ha (0, 60, 90, 120, 150, and 180 lb N/acre) and were followed by applications 34 kg N/ha at late boot (full exsertion of the flag leaf with leaf collar visible). Two additional treatments were included of 135 and 168 kg N/ha preflood but did not receive a late boot N application in order to evaluate the benefits of the late boot applications. For nitrogen studies, 135 kg N/ha or higher preflood N rates were generally required to achieve the highest grain yields. For comparison of preflood N rates with and without boot N applications, the boot N application generally resulted in higher grain yields regardless of preflood N rate; however, head rice yields were only improved by the addition of boot N for higher preflood N rates. These results suggest current preflood N recommendations for hybrids are adequate to produce optimal yields, but that the boot N application needs further evaluation for its utility with newer hybrids.

Exploring No-Till Options in California's Direct Seeded Rice Systems

Linquist, B., Taaime, N., Godbey, M., Espino, L., and Brim-Deforest, W.

California rice systems are predominantly water-seeded. Given the increase in water shortages, exploring alternative water saving practices is necessary. No-till drill seeding has the potential to reduce water use for at least two reasons. First, using soil moisture more efficiently. In conventional systems, fields are tilled to dry out soil to prepare a nice dry seedbed. This water could instead be used to establish a rice crop. Second, reducing evaporation losses during the first month of the season. During the first month of the season when the crop is establishing, most of the water losses from water-seeded rice are from evaporation (E). The transpiration (T) component is very small. In no-till systems, the fields are flushed one time after planting and then no standing water will be on the field until permanent flood about 4 weeks later. Other benefits from NT planting include early planting, no additional tillage costs, likely less weed pressure, and any rainfall during Apr and May and before a permanent flood is beneficial. There are also potential challenges which include equipment costs, getting heavy clay soils to close around the seed, and identifying the optimal planting time to take advantage of soil moisture without rutting up the field.

No-till planting has not been evaluated in California; however, beginning in 2023, we began evaluating this practice. The practice was tested on two general types of seedbeds. First, a strict no-till system where rice was grown the previous season and there were no tillage operations after harvest. In this scenario, the straw was chopped and left on surface or baled/removed. Second is planting into a stale seedbed that was prepared the previous season. A seedbed could be established in the summer (Summer Prep) if the field is left fallow or in the fall (Fall Prep) after harvest.

In 2023 and 2024 we evaluated these systems in a replicated trial on-station at the Rice Experiment Station. We evaluated yield response to N, the use of enhanced efficiency fertilizers water use, greenhouse gas emissions (GHG), and weed/pest incidence. We had the following treatments which we compared to a conventional water-seeded (CWS) system: (1) previous year was summer fallow and fields were well worked and leveled (Summer Prep-stale seedbed – NT-SPSS), (2) previous years straw was bailed (NT-B), and (3) previous years straw was chopped (NT-C). We will discuss yield results, N response, water use, GHG emissions and pest pressure across these treatments.

Effects of Management Practices and Abiotic Stressors on Rice Yield and Grain Quality

Wilson, L.T., Samonte, S.O. PB., and Yang, Y.

This paper addresses the effects of management practices and abiotic stressors on rice yield and quality, discusses underlying bases for inbred and hybrid grain quality. Multi-decadal analyses conducted on heat unit accumulation and atmospheric [CO_2] confirms that the Texas Gulf Coast environment has undergone major warming from 1991 to 2023. During this same period, atmospheric [CO2] has steadily increased, while main and ratoon crop rice grain yields have increased. In contrast, main crop whole grain milling yield reached a peak in the early 2000's then steadily decreased through to 2023, with a similar pattern but a lower quality observed for the ratoon crop. The percentage of broken main crop grain decreased to its lower average in 2001 but steadily increased (worsened) reaching its highest average in 2023. The pattern for ratoon crop grain is much more variables and higher, but it has recently converged with that of the main crop. Main crop and ratoon crop total milling yields peaked in 2021 and 2012 respectively then began to decrease. Main crop USDA long grain rice grade is described by a concave polynomial with the highest quality (lowest number) reached in 1995-1996. In contrast, ratoon crop grade steadily improved from 1997 to 2023. Both management practices (cultivar type – inbred versus hybrid and harvest day of year) and climatic variables significantly affected grain yield and quality. Main and ratoon crop grain yield and each of four grain quality traits worsen the latter the rice crop is harvested.

Development of a Method for the Determination of the Nitrogen Status of Rice Leaves Using Reflectance in the Short-Wave Infrared (SWIR) Range

Lamichhane, S., Mohammed, A.R., Dou, F., and, Tarpley, L.

The objective of this study is to develop a method for determining leaf nitrogen (N) status using reflectance in the shortwave infrared (SWIR) range of 1100-2500 nm. Unlike the method using reflectance changes in the visible near infrared (VNIR) range of 400-1100 nm, a widely used non-destructive method for estimating leaf N status in crops, reflectance in the SWIR range is not affected by the status of other nutrients and environmental factors. Ten rice varieties of different backgrounds, including indica and japonica, were grown in Beaumont, Texas, under a wide range of N fertilizer conditions of 0, 112, and 224 kg/ha. SWIR hyperspectral reflectance was collected from individual leaves using an Ocean Optics NIRSpec with a controlled light source. The relationship between leaf spectra and nitrogen concentration was determined using two approaches: a) All Possible Ratios (Tarpley et al., 2000), and b) Contiguous Waveband Clustering followed by Partial Least Squares Regression (PLSR). A good linear relationship between SWIR reflectance and rice leaf N concentration was obtained over a wide range of leaf N concentrations and across different genotypes, indicating the applicability of this method in determining the nitrogen status of rice.

The Effects of Nitrogen on Ratoon Yield and Head Rice Yield in Texas

Trevino, M., Dou, F., Li, X., and Tarpley, L.

Ratoon rice crop has been a vital component for the rice cropping system in the state of Texas as well as South Louisiana. Although, information is lacking on the nitrogen (N) application for the best ratoon production. Two field studies were conducted with widely planted rice (Oryza sativa L.) cultivars at Eagle Lake, Texas to determine the effects of N management in ratoon crop (RC) on RC yield. In 2012 and 2013, one cultivar (Presidio) was adopted to determine the effects of RC N management on ratoon yield and head rice yield. In 2016 and 2017, CL153, CL163, CL272 and Presidio were adopted to examine the effect of N management on ratoon yield and head rice yield. N applied at preflood after MC harvest considerably improved RC yield. Application of 99 kg N $ha{-1}$ at preflood after MC harvest was practically adequate for RC regrowth, development and approaching the yield potential for Presidio. RC could produce quite high average grain yields of 5.90 to 6.53 t $ha{-1}$ in 2012 and 2013, respectively. Main nor ratoon crop N management had a significant effect on RC head rice yield. Considerable RC head rice yields (55–65%) were observed in all four cultivars and 4 years except for CL272 in 2016. These results indicate that rice ratoon crops with appropriate N could produce a considerable grain yield and an expectative head rice yield.

Effect of Water and Residue Management on Soil Health

Limmer, M.A., Rosado, B., Bamidele, S., and Seyfferth, A.L.

Maintaining soil health is critical for long-term crop productivity, but measurements of soil health may need to be adapted for rice. Soil health metrics were developed for upland crops, and it is unclear to what extent they apply to rice and the flooded conditions under which most rice is grown. For example, while a loam is considered preferable for most upland crops, clayey soils hold the flood well during rice growth. Concerns about aggregate stability in upland crops may not apply to flooded rice. Nutrients such as Fe and Mn, which can be limiting in some upland crops, are prevalent under flooded conditions. Flooded conditions can also limit carbon mineralization and should promote soil organic matter accumulation. Collectively, it is unclear to what extent soil health parameters designed for upland crops can be applied to rice cultivation. Additionally, it is unknown how water and residue management affect soil health parameters in rice cultivation.

In a 3-year field study we measured various soil health indicators and how they were affected by water and residue management. We grew hybrid rice (*Oryza sativa* L. 'CLXL745') in 2x2 m rice paddies at the University of Delaware. Twelve of the paddies were subjected to varying residue managements, where paddies received either no residue, rice straw, burned rice straw, or rice husk. Each residue was incorporated into the soil annually at a rate equivalent to its production. Twelve additional paddies were grown under differing water managements: flooded, safe AWD (dry down to 15 cm below ground surface), severe AWD (dry down to 30 cm below ground surface), and nonflooded. Soil samples were collected each year prior to planting and after harvest. Each soil sample was analyzed for physical indicators, chemical indicators, and biological indicators. Physical indicators included soil texture, bulk density, and aggregate stability. Chemical indicators included soil pH and Mehlich-3 extractible nutrients. Biological indicators included soil organic matter, permanganate oxidizable carbon (POxC), and beta-glucosidase activity. Weekly measurements of porewater chemistry and methane emissions were also taken to better understand the biogeochemical processes occurring under each treatment.

Many of the soil health indicators were not substantially affected by the residue or water management treatments. Notable significant effects include straw return significantly decreasing bulk density. Straw also increased wet aggregate stability, soil organic matter, POxC, beta-glucosidase activity, and Mehlich-3 potassium. Water management had differing effects, with more flooded treatments increasing Mehlich-3 manganese, iron, and zinc. In addition to the typical soil health indicators, both straw return and more flooded conditions led to higher methane emissions, and flooded conditions also led to higher polished grain arsenic. Collectively, existing soil health indicators do not capture all the relevant biogeochemical processes in rice, so the definition of soil health in rice systems needs a different framework.

State of the Science in the Pit-Less Tailwater Pump Furrow Irrigated Rice System

Henry, C.G., Reba, M.L., Burcham, T.N., Newberry, N., Mayberry, N., Adviento-Borbe, M.A.A., Knight, C.C., Parker, R.E., and Martin, H.L.

Furrow-irrigated rice (FIR) systems are becoming popular with rice growers, but little work has been done to improve the system compared to flooded culture production systems. A novel irrigation system, the pit-less pump Variable Flow Tailwater Recovery System (VFTWRS) shows promise as an innovation for Furrow Irrigated Rice for water savings and yield stability. A study was conducted in 2023 and 2024 at the Northeast Rice Research and Extension Center, near Greenfield, Arkansas to evaluate the system on commercial sized fields. Two large fields mapped as Henry silt loam (coarse-silty, mixed, active, thermic Typic Fragiaqualfs) were planted to RiceTec 7521 Full page (RT7521FP). Two fields were used both greater than 20 hectares in size on 91 cm in 2023 and 76 cm beds in 2024. All agronomic practices except N fertilizer and irrigation were conducted the same in the two fields. The VFTWRS field was fertigated into the return irrigation system with a hydrated calcium ammonium nitrate double salt and urea ammonium nitrate solution (YaraLiva® UCAN®-23). Drains were end blocked to hold water in both fields, but the VFTWRS field returned the tailwater to the top of the field using lay-flat pipe. For the VFTWRS field, irrigation was applied continuously, and N fertilizer was applied as needed using small over-fertilized reference areas and a handheld GreenSeeker™ Normalized Difference Vegetative Index sensor. Nitrogen (N) fertilizer was applied through the irrigation system when readings indicated a ratio over 1.05. For the control field, irrigation was applied every 3-5 days or if soil moisture monitoring indicated irrigation was needed. The control field received 50 kg N/ha (45 lbs N/ac) four times during the growing season.

The average yield for the VFTWRS field was 9,353 kg grain/ha (185.5 Bu/ac) compared to the control yield of 9,257 kg grain/ ha (183.6 Bu/ac). The water use for the VFTWRS field was 894 mm/ha (14.25 ac-in/ac) compared to 1230 mm/ha (19.6 ac-in/ac) for the control field. The average nitrogen used on the VFTWRS field was 110 kg N/ha (98.5 lbs N/ac) compared to the control application of 201 kg/ha (180 lbs N/ac). The partial factor productivity of yield divided by applied nitrogen in the VFTWRS was 84 kg grain/kg N compared to the control's NUE of 46 kg grain/kg N. In 2023, the tailwater was held too deep and stunted the bottom of the field reducing the yield and planter skips occurred in the tailwater field both years that may have also contributed to lower yields.

The VFTWRS has undergone commercialization to optimize the product for manufacturing and simplify the installation and relocation of the system between fields as was done in this study. The patented system is also a practice available through the United States Department of Agriculture Natural Resource Conservation Service contracts. The opportunity to use liquid N fertilizers to more closely match plant needs shows promise for FIR while still reducing water use and nitrogen input costs. Further studies are needed to better develop recommendations for fertigation in FIR as the authors believe from work in other studies and fields that the yield potential is higher for the VFTWRS than was found in this study.

Logistics of Irrigation Pump Shut Off and Well-Switching: A Case Study

Massey, J.H., Lima, G.B., Flores, J.H.N., Faria, L.C., and Johnson, A.B.

Irrigation seasons are hectic in the Mississippi Alluvial Plain (MAP) where the majority of approximately four million hectares of soybean, rice, maize, cotton, and peanut are irrigated using over 80,000 groundwater wells. With farmer input, this study created a 'synthetic' irrigation season for a farm that uses 43 groundwater wells to irrigate approximately 1100 ha row crops. This was done to estimate the numbers and timings of two key well operations: switching the well from one field to another and shutting off the irrigation pump once an irrigation cycle is completed. The distances driven to operate the wells throughout the 91-day season and excess pumping associated with delayed pump shut off were also estimated. Results suggest that the farmers drove approximately 9900 km to perform 780 well operations comprised of 398 well-switching and 382 pump shut off tasks. About 3000 km (37%) were driven to completely shut off the irrigation pumps once the irrigation events were complete. About 190 pump shut off operations occurred between 1900 to 0700 hours when the farmers were technically "off-duty," resulting in excess pumping equivalent to ≈7% of total pumping (40,892 hours). Thus, use of pump control technology to remotely shut off these wells could reduce driving by 37% and excess pumping by up to 9% when potential delays in on-duty tasks are accounted. Three working equations, determined a priori as a check for the well operation estimates, will be useful when evaluating the economics and labor savings of remote irrigation pump shut off.

Testing Rice Irrigation Water Savings Practices at the Field Scale: Challenges and Lessons Learned

Moreno-García, B., Henry, C.G., Reba, M.L., Massey, J.H., and Runkle, B.R.K.

Globally, rice is a large water consumer, and it is estimated to be responsible for 30 % of global water withdrawals. Arkansas is the largest rice producer in the US and the associated water demand is triggering groundwater depletion in some critical areas.

In this study, three water-saving practices were implemented in eight rice farms in Arkansas during four consecutive growing seasons (2021-2024): Furrow Irrigated Rice (FIR), where rice is grown in beds; Multiple Inlet Rice Irrigation (MIRI), where water is delivered in each paddy of a field with levees instead of the traditional cascade down paddies; and Alternate Wetting and Drying (AWD), where fields are under wetting-drying cycles.

In each farm, two fields were chosen to do a paired field study. There were 20 paired fields of the MIRI treatment compared to the cascade system and 3 paired fields of FIR compared to the cascade system. The AWD technique was practiced in zero-grade fields (no grade) and was compared to a continuously flooded zero-grade field (9 pairs). Soil type, planting dates, cultivars and other management practices were the same in each pair of fields. Flowmeters were used to track the amount of water applied and yield values were reported through yield monitors or farmer estimations based on truck load weights. Field sizes ranged from 7-54 ha.

The MIRI treatment showed on average 21 % of water savings compared to the cascade treatment (n=13 after excluding outliers). The low number of replicates of the FIR and AWD treatment in addition to some technical and farm-level challenges made it difficult to derive strong conclusions about these treatments. The results showed high interannual and inter-field variability. Different challenges relating to farmer capacity, weather, or soil properties, among others, were identified as responsible for the high variability:

- Differences in the soil composition between the paired fields. For example, some fields had double the clay content as compared to their paired field.
- The high variability in water use between fields and years is sometimes in the same magnitude as the expected water savings.
- Some of the treatments ended up being a different treatment than planned (e.g. unintentional AWD or not being able to do drying downs because of the rain).
- Challenges with flowmeter performance: leaks or propellers getting stuck when using surface water with debris.
- Farmers manage irrigation considering the whole farm. Sometimes they need to “pump through” a field in order to use tailwater in other fields. This practice represents a challenge when studying water savings at the field level.

In summary, these four-year results suggest that the water practices have potential to reduce irrigation applications but do not yet provide robust conclusions owing to the challenges of on-farm research. Future research should investigate farm-level systems and practices because this is ultimately how farmers manage irrigation.

Two-Year Studies of Raising Fish in Rice Fields in Arkansas

Jia, Y., Green, B., and Fuller, A.

Rice fish co-culture is a production system which synergistically generates essential carbohydrates and protein, benefiting the environment and increasing the financial returns for food producers. Two studies were conducted in 2023-2024 to investigate suitability of raising Koi carp, an ornamental variant of common carp (*Cyprinus carpio*), in current flood rice paddies with rice Eclipse, a Sushi rice variety, grown in Arkansas, USA. Various traits and parameters were assessed to evaluate the performance of the co-culture system including water quality, fish growth parameters, soil and water temperature, rice stem characteristics, rice yield, essential elements and hazardous metals, and greenhouse gases (CH4, N2O and CO2) parameters. Preliminary analysis showed that rice yield could be doubled with fish because of biofertilizer and the control of biotic stressors. In 2023, net income of fish is $9254/hectare and $7442/hectare in 2024. Results of the above-mentioned traits and feasibility of rice – fish co-culture in the southern USA will be presented.

Arkansas Irrigation Yield Contest

Henry, C. G.; Parker, R.E.; Clark, T.

Groundwater withdraws are not sustainable in the mid-south region. Previous research and Extension programs in the region have focused on demonstration and paired comparisons to promote the adoption of Irrigation Water Management Practices in rice. There is almost no data that documents water user efficiency of rice, from working farms, a metric for sustainability. Additionally, Natural Resource Conservation Service incentive programs are available for structural and management practices, but education about how to alter water management is lacking in the region. The "Most Crop per Drop" contest was developed to promote awareness of irrigation water management using contest winners to promote their own ideas and successes to their peers.

In 2018 a crop irrigation contest was developed to document water use efficiency and practices that farmers utilize to conserve water. This integrated research and Extension program works with producers through a contest format. Water use is measured with propeller flow meters, rainfall is estimated with computer models, and a yield check of 3 acres is done to document water use efficiency (WUE) for each entrant. The irrigator with the "Most Crop per Drop" awarded. The goal of the contest is to document irrigation water management practices and provide a platform for irrigators to share their own success and approaches to irrigation water management. The contest is supported by the industry, in the five years of the program, Ricetec, McCrometer, Seametrics, Irrometer, Delta Plastics, Agsense (Valmont Industries), Trellis, Crop X, Farm Logs, the Arkansas Soybean Promotion Board, the Arkansas Corn and Grain Sorghum Board, provide cash or product prizes for the winners upwards of around $20,000 for the first place winner. Each contestant is provided a report card anomalously showing their performance with respect to yield and WUE relative to the other contestants. This report card provides feedback to each irrigator.

Contestants enter a 30 acre or larger field and request for a meter to be installed before any irrigation. Portable tube, propeller style meters are installed on the field so it cannot be removed without tampering. Rainfall is estimated using rainfall estimation software for each field from emergence to crop maturity. A minimum yield of at least 180 bushels per acre is required for winners to ensure realistic yield goals are being entered into the contest. Thus, both a high yield and high water use efficiency must be obtained to win the contest.

Average water use efficiency for all rice contestants for the years 2018 through 2023 was 5.25 bushel/inch, while the average yield was 203 bpa. First place winners used the flooded rice production system in 2018, 2019 and 2020. In 2021, the highest water use efficiency was achieved using furrow irrigation utilizing a novel pit-less tailwater recovery system. The six-year average water use efficiency for flooded rice was 5.45 bushels/ac-inch and the average water use efficiency for furrow irrigated rice was 5.13 bushels/ac-inch. The lowest water use efficiency for any individual rice field was a furrow irrigated field with 1.51 bushels/ac-inch. The highest yield for all rice recorded during the study period in furrow irrigated rice was 266 bpa and the lowest yield for any rice entry came from a furrow irrigated rice field with a yield of 125 bpa. The 6 year average water use efficiency of all recorded cultural practices are: alternate wetting and drying 6.6, Flood 5.46, Furrow 4.83, and multiple inlet rice irrigation 4.5. Support from and participation by Extension agents as well as NRCS staff has helped the contest to develop in Arkansas. Results of winners, practices and management styles observed have indicated that the level of management applied plays a key role in the success of the winners.

Water Management Impacts on Rice's Methane Emissions in Arkansas

Runkle, B.R.K., Reba, M.L., Moreno-García, B., Leavitt, M., Reavis, C.W., Mahbub, R.B., and Richardson, W.P.

The sustainable intensification of rice farming is necessary to simultaneously meet human food needs and reduce environmental impacts of agricultural production. Because rice is conventionally flooded in a manner that creates anoxic growth conditions, rice production is responsible for 8-11% of all anthropogenic emissions of CH_4, a greenhouse gas that is 25-30 times more potent for the atmosphere than CO_2 on a mass basis. Cultivation practices that minimize the number of days the rice fields are flooded, such as irrigation using the alternate wetting and drying (AWD) technique instead of continuous flooding, can potentially reduce CH_4 emissions. However, comparing between studies is difficult due to differences in timing and duration of flooded periods in different experimental designs. Thus, we have lacked modeling methods to estimate seasonal methane emissions from the duration and extent of inundation. Current approaches that use emission factors count only the number of dry-down periods, but they often treat the rest of the inundated periods the same, whether shorter or longer in duration.

We recently derived an empirical relationship between the length of each flooding event and the methane emissions associated with that event ($r^2 > 0.77$; rmse < 5 kg ha^{-1} per flooding event; Leavitt et al., 2023, Agriculture, Ecosystems and Environment). The model was created by field-scale CH_4 emissions measurements taken with the eddy covariance technique at different fields in Arkansas, home to ~50% of US rice production. This micrometeorological method provides a field-scale emissions estimate from quasi-continuous measurement that are gap-filled using locally measured environmental drivers to generate a seasonal emissions estimate.

To follow and expand on that study, which focused on two rice fields under 5 production seasons, we will evaluate and improve this relationship with data from a number of other production fields and growing seasons. The expanded dataset will contain measurements with different soil textures, contain a variety of production seasons with different dry-period timing and durations, flooded event durations, and litter management strategies to test its transferability.

We aim to derive, test, and scale a relationship between the duration of flooding and cumulative emissions associated with each flooding event, and to assess whether a single empirical relationship is sufficient or whether it should have weighting factors for different production conditions. The result will be a scalable predictive model of methane emissions that can be used to characterize the methane-saving benefits of different irrigation strategies for US rice production.

Impacts of Water Savings Irrigation Practices on Metals in Rice

Seyfferth, A.L., Limmer, M.A., Runkle, B.R.K., Moreno-Garcia, B., and Reba, M.L.

In contrast to continuous flood management, climate-smart irrigation practices like alternate wetting and drying (AWD) or furrow-irrigation ('row rice') can save water and limit emissions of methane, a potent greenhouse gas. While these water-saving irrigation strategies are effective, they can also affect metal concentrations in rice grain. How water management affects uptake and grain concentrations of micronutrients like zinc and iron, as well as toxic elements like arsenic, cadmium, and mercury, are important for ensuring a healthy food supply.

We use experimental and field-collected data to understand how water savings strategies affect micronutrient metals and toxic metal(loid)s in rice grain. Experimentally, we grew rice (*Oryza sativa* L. var. Jefferson) in six experimental rice paddy plots (2 x 2 m) that were subject to a range of soil water to achieve a range of soil redox conditions from flooded (strongly reducing) to nonflooded (oxic) in a two-year study. We monitored greenhouse gas emissions, porewater chemistry, yield impacts, and concentrations of metal(loid)s in rice grain. We found that growing rice under less flooded (more oxic) conditions strongly decreased methane emissions and concentrations of arsenic and mercury species in rice grain, but increased concentrations of grain cadmium. These toxic elements were manipulated by water irrigation strategies without affecting the micronutrient zinc in grain, but slight declines in grain yield were observed as paddies were drier. These findings likely represent a worst-case scenario as the soils were highly weathered and acidic as well as coarser textured, so the impacts of water management were likely greater than would be observed in field conditions.

We also measured the concentrations of cadmium and arsenic species in rice grain obtained from production-scale fields subject to six water management strategies in rice-growing regions in the Mid-South U.S. The water management strategies tested were two severities of furrow irrigation, three severities of AWD, and flood management. Flooded conditions led to the lowest grain cadmium and highest grain arsenic concentrations; the grain inorganic arsenic concentrations were higher than the Codex limit and the proposed action plan for baby food. AWD management had grain inorganic As concentrations higher than the baby food action plan limit but lower than the Codex limit. Furrow-irrigated rice resulted in inorganic arsenic concentrations that were lower than the action level proposed for baby food, and these treatments had the highest grain cadmium concentrations, but they were much lower than regulatory limits.

Taken together, our data show that water savings strategies are effective at minimizing methane emissions and grain arsenic and mercury concentrations, but that cadmium should also be monitored to ensure its concentration is below safety limits. Our data set suggests that the soil tested here is not a concern for cadmium even at the driest conditions, but soils that have higher cadmium content or soils that are acidic may require more monitoring under furrow-irrigation.

ABSTRACTS OF STUDENT PANEL POSTERS: AGRONOMY AND RICE CULTURE
Panel Chair: Felipe Dalla Lana

Using an App with Machine Learning for Early Detection of Blast in Rice Crops

Agenjos-Moreno, A., Simeón, R., Cerezo, B., Rubio, C., Uris, A., Castiñeira-Ibañez, S., Ricarte, B., Tarrazo-Serrano, D., and San Bautista, A.

The disease caused by *Pyricularia oryzae* is one of the main threats to rice cultivation worldwide, especially in vulnerable varieties such as *Bomba*. This pathogen, first identified in China in 1637, can cause yield losses of up to 65%, seriously compromising food security, given that rice is a staple food for millions of people.

Environmental concerns about using phytosanitary products have led to the search for innovative alternatives to prevent *Pyricularia oryzae* resistance to fungicides. Among these, technological tools such as remote sensing, Big Dat*a* analysis, and Machine Learning (ML) techniques stand out, facilitating early and accurate detection of diseases in the field. Applying these technologies makes it possible to identify affected areas and make decisions to optimize crop management.

This study analyzed plots of *Bomba* rice between 2020 and 2023 to assess the impact of *Pyricularia oryzae* and model yields. Sentinel-2 satellite data were used, which provided images of spectral bands in the visible, near infrared and SWIR. In addition, vegetative indices such as NDVI, RVI, NDRE, and IRECI were used to monitor disease incidence. All the bands were useful in identifying healthy and affected plots 30 and 45 days after sowing (DDS). The RVI and IRECI indices also stood out as tools to identify affected plots.

The temporal analysis showed that plots affected by *Pyricularia oryzae* had lower biomass from early stages, detected by spectral reflectance, especially in the NIR and Red Edge bands. These differences allowed plots to be classified more accurately into three levels according to their estimated yield (High; Medium; Low, $kg \cdot ha^{-1}$), facilitating integrated disease management strategies. The integration of agronomic and satellite data with Machine Learning techniques, such as the KNN (K nearest neighbors) algorithm, made it possible to calculate and group yields with an accuracy of up to 84%. This model showed better results at 35 DDS using bands B4 (665 nm), B7 (783 nm), and B11(1610 nm); at 50 DDS with B3 (560 nm), B4 (665 nm), B8 (842 nm) and B11(1610 nm); and at 80 DDS when considering all bands. Variable reduction by principal component analysis (PCA) was essential to optimize model performance. Therefore, an algorithm is developed from which, by introducing the geographical reference and the day of sowing, we obtain as a result a figure that represents the pixels of size 10x10 m in which the classification of the three levels is shown more graphically according to the intervals as mentioned earlier obtained.

In conclusion, using remote sensing and ML represents a significant advance in managing diseases such as *Pyricularia oryzae* and yield optimization in *Bomba* rice. This digital approach reinforces Precision Agriculture by providing data-driven decision-making tools, minimizing environmental impact, and ensuring crop sustainability.

Mississippi River Basin Healthy Watersheds Initiative Overview for Rice Fields in the Northeast Arkansas Region

Covington, K., Reba, M.L., Massey, J.H., Payne, G.K., Pieri, A., Barker, T.

The Mississippi River watershed covers 3.1 million square kilometers, 40% of the continental United States, providing a source of drinking water, food, industrial and recreational uses, and critical wildlife habitat. Land-use within the watershed is largely agricultural, and with modern-scale farming, an influx of nutrients and sediment runoff from these areas have caused the water quality within the river to decline and created a significant hypoxic zone in the Gulf of Mexico. To assess what areas of the watershed need improvement, and if efforts to improve the watershed are making headway, the Mississippi River Basin Healthy Watersheds Initiative (MRBI) was created. MRBI uses a series of edge of field monitoring sites across the Mississippi River Basin to collect water samples and agronomic practice data from agricultural fields throughout the year. Data on field discharge, dissolved nutrients, and sediment were used to calculate event based and annual loads. Sampling sites are typically built in a paired system with a control (conventional production system for the area) and treatment field (using various conservation practices). The loads from these fields are then compared to assess the effectiveness of the conservation practice. This study evaluated the effectiveness of conservation treatments at four production scale rice fields in Mississippi County, AR in 2022.

Evaluation of Starter Nitrogen, Nitrogen Sources, and Timings in Delayed Flooded Rice

Fluitt, J.S. and Kongchum, M.

Current research at the LSU AgCenter Rice Research Station showed that a single nitrogen (N) application at four- to five-leaf before permanent flooding was optimal compared to post-flood N application treatments regardless of the rate and time of application. Environmental conditions in early drill-seeded rice such as cold weather or dry soil conditions at planting could prolong the time from emergence to the four- to five-leaf growth stage. Starter N fertilizer applications can be applied to help promote the growth and development of the plant before the pre-flood N application. A field study was conducted at the LSU Rice Research Station near Crowley, Louisiana to evaluate the efficiency of starter nitrogen fertilizers on multiple rice varieties. Starter N fertilizer sources in this research were ammonium sulfate (21-0-0-24S) and urea (46-0-0) with variable pre-flood and midseason N rates. In addition, three rice varieties; CLL19, PVL04, and Titan were evaluated for grain yield. Results averaged across all three varieties showed yield increased with starter N applications as compared to the treatments without starter N. The average yield was not different between urea and ammonium sulfate treatments.

Enhancing Soil Health in Louisiana Rice Production: The Impact of Mixed Cover Crop Cultivation and Nitrogen Application on Soil Health Parameters

Guardado, K., Wang, J., Fultz, L., Gambino, C., Stout, M., and Subudhi, P.

Soil health is a fundamental aspect of sustainable agricultural practices and cover crop integration has been shown to improve soil health in different crop production systems. However, limited information is available as to how cover crops affect rice production especially in Louisiana's subtropical climate. In this study, research was conducted to assess the impacts of implementing a mix of legume-grass winter cover crops - comprising Austrian winter pea, sodbuster radish, Cosaque black oat - along with different nitrogen (N) rates on key soil health indicators, nutrient cycling, and productivity in a flooded rice system. The cover

crop mix was planted in October 2023 and terminated in February 2024. Soil samples were taken at cover crop termination and after rice harvest, then were analyzed for soil microbial community, β-glucosidase (BG) activity (carbon enzyme), soil organic carbon (SOC), total N, soil respiration, and various nutrient statuses. Results showed general impacts of cover crops on soil health parameters. Correlations among different parameters were performed. By exploring the interactions among these parameters, we expect to seek understanding on how cover crops can serve as a beneficial practice in rice production. Specific results will be presented and discussed.

Critical Thresholds of Alternate Wetting and Drying on Greenhouse Gas Emissions and Rice Yield

Lasar, H.G.W., Petrowicz, H.L., Dou, F., Gentry, T., and Bronson, K.

Water table level is among the key factors affecting greenhouse gas (GHG) emissions in rice paddies. Among water management practices, alternate wetting and drying (AWD) irrigations has shown promise; however, its effectiveness in mitigating GHG emissions while maintaining maximum rice yield remains inconclusive. This study aims to identify a critical AWD threshold that effectively reduces GHG emissions while maintaining comparable yields to continuous flooding systems. Here, we investigated the effect of varying AWD intensities – 100%, 75%, and 50% field water holding capacity (FWHC) – as well as the continues flooding across different soil types on GHG emissions and rice yield. Our findings revealed that AWD at 100% and 75% FWHC did not result in substantial yield reduction. Conversely, AWD at 50% FWHC led to a significant decrease in yield, particularly in clay soil. We anticipate that the varying AWD intensities will have notable effects on CO_2, CH_4, and N_2O emissions.

Furrow and Flood-Irrigated Rice Yield Response to Phosphorus and Potassium Fertilization

Mengez, G.A.L., Drescher, G.L., Roberts, T.L., Hardke, J.T., Sarfaraz, Q., Prado, M.P.R., French, K.S., and Vickmark, H.E.

Rice (*Oryza sativa* L.) grown under furrow and flood-irrigated systems requires specific nutrient management strategies to maximize grain yield. Therefore, to evaluate furrow- and flood-irrigated rice yield response to phosphorus (P) and potassium (K) fertilization, field studies were established in 2023 and 2024 at the Pine Tree Research Station, in Colt, Arkansas. Fertilizer-P and -K rates (0, 34, 67, 101, 135, and 168 kg P_2O_5 and K_2O ha^{-1}) were applied preplant and incorporated prior to rice establishment, with triple superphosphate and muriate of potash as the source of P and K, respectively. At maturity, rice grain yield was determined using a small plot combine. Preplant soil samples categorized soil-test P and K as Very Low in the furrow-irrigated and Low in the flood-irrigated rice in 2023. In the consecutive year, the soil-test values were in the Low in the furrow system, and Optimum and Very Low categories in the flooded system for P and K, respectively.

Although there were no significant ($P > 0.10$) differences, numerical increases were observed for P treatments in both years. In 2023, the irrigation methods exhibited consistent yield increases up to 67 kg P_2O_5 ha^{-1}, with the flooded and furrow-irrigated rice showing a 12% and 25% increase, respectively, relative to the control plots. In 2024, a yield increase of 25% from the control was observed when 168 kg P_2O_5 ha^{-1} and 135 kg P_2O_5 ha^{-1} were applied in the flooded and furrow systems, respectively.

In the K trials, no significant differences were observed in 2023. Yield in the flooded system ranged from 9,547 to 10,644 kg ha^{-1}, with the greatest yield observed at 101 kg K_2O ha^{-1}, showing an increase of 1,097 kg ha^{-1} compared to the no-fertilizer-K control. Similarly, the furrow-irrigated system increased from 6,878 to 8,437 kg ha^{-1}, achieving the highest at 67 kg K_2O ha^{-1}. In 2024, significant differences ($P \leq 0.10$) were reported only in the flooded-irrigated rice. Yield was maximized with 168 kg K_2O ha^{-1}, increasing yield by 19% over the control, but without significant difference between the rates. In the furrow system, numerical differences were observed, and yield was maximized with 135 kg K_2O ha^{-1}, increasing yield by 9% over the control.

These results highlight the importance of understanding P and K dynamics under both irrigation methods to optimize rice production, particularly in soils with low nutrient levels. The higher numerical yields observed in flooded systems underscore the potential benefits of this irrigation method in enhancing nutrient availability and uptake efficiency.

On-Farm Storage Reservoirs: Evaluating Water Quality and Greenhouse Gas Emissions

Mondragon, M., Reba, M.L., Massey, J.H., Adviento-Borbe, M.A.A., and Pieri, A.

On-farm storage reservoirs perform a demanding role in sustainable agriculture by capturing and storing water during the rainy seasons for efficient utilization in crop irrigation. However, these reservoirs can also impact the environment through changes in the release of greenhouse (GHG) emissions and in water quality. In regions with declining groundwater resources, like the Lower Mississippi River Basin, understanding and management of surface water is increasingly significant. Through systematic sampling and monitoring, the project aims to optimize reservoir functionality for agricultural use and minimize their environmental impact. And evaluate the relationship between water quality and greenhouse gas emissions to inform strategies for sustainable water management.

Reservoirs are a significant source of greenhouse gas emissions, including methane (CH4), nitrous oxide (N2O), and carbon dioxide (CO2), which impact global climate change. However, the high spatial and temporal variability of GHG emissions from reservoirs has made it challenging to produce consistent emissions estimates. Additionally, on-farm storage reservoirs also have the potential to trap and transform potential contaminants, such as nitrate, causing degradation in water quality and potential toxicity. Commercial on-farm reservoirs in the Cache and Grand Prairie regions of Arkansas, areas that are critical due to their declining groundwater resources, were used for this study. The research employs systematic sampling to analyze the GHG dynamics and emissions from thirty reservoirs- half in the Cache and half in the Grand Prairie. To minimize variability, all sites are ideally collected on the same day every three weeks throughout the 2024 year to ensure all reservoirs are assessed during the same conditions. For water quality monitoring, water samples are taken every six weeks starting June 2024 synchronizing with the GHG sampling schedule. This approach enables the comprehensive assessment of both GHG emissions and water quality dynamics, aiming to improve understanding of the environmental impacts of on-farm reservoirs in groundwater-constrained regions. The data results will provide critical insights into how reservoir management practices can be adapted to reduce environmental impact and promote more sustainable water usage, contributing to better long-term agricultural and environmental outcomes

Methane Emissions Dynamics in Arkansas Rice Production: Effects of Different Water Management Practices and Soil Texture Gradient

Osoko, T.O., Moreno-García, B., Pimentel, J., Gómez-Prats, M., Reba, M.L., Adviento-Borbe, M.A.A., and Runkle, B.R.K.

Two main types of irrigation water management techniques used in rice agriculture in Arkansas are continuous flooding (CF) and alternate wetting and drying (AWD). The CF method has shown high methane emissions due to the anaerobic conditions from the flooding while the AWD method has been proven to mitigate methane emissions as the dry down periods create aerobic conditions in the rice paddies. Also, methane emissions have been seen to be relatively lower in soils with a higher clay content due to lower gas diffusion than in coarse texture soils (compared to sandy soils) with similar soil C inputs. The aims of the study are to quantify how methane fluxes change across AWD and CF water management methods, as well as how they change across a soil texture gradient (10%, 15%, 30%, 40% and 60% clay contents), and to study the spatial variability of methane fluxes. We hypothesized that methane emissions will decrease under alternate wetting and drying (AWD) water management method and will decrease with increasing clay content. We test whether within-season spatial variability is correlated to biomass (which may increase fresh photosynthates as a methane source) or soil organic matter (which may increase labile carbon availability for methanogenesis).

This study is the first of a three-year project and was done in Lonoke, AR during the summer of 2024 in 5 fields (with clay content and treatment as follows: 10%-AWD, 15%-CF, 30%-AWD, 40%-AWD and 60%-CF) from May to September using the Licor LI-7810 gas analyzer and smart chamber. We measured six of twelve collars at each site on a weekly basis and cumulated emissions via linear interpolation of each measurement day's average flux value. From our results, methane emissions were mostly lower in fields under AWD than in fields under CF while emissions were inversely related (although not significant) with clay content (R2 = 0.46, $p = 0.211$). Two of the fields under AWD management (30%-AWD and 40%-AWD) were low in seasonal methane emissions while fields under CF management showed high (15%-CF) and moderate (60%-CF) methane emissions. In addition, methane emissions were higher in fields with the lowest clay content (10% and 15% clay), and lower in fields with high clay content (30%, 40% and 60% clay). Also, in trying to understand the reason for the variability among sampling locations, each collar's biomass was sampled destructively at harvest time for a dry weight value. We found a significant positive relationship (R2 = 0.37, $p < 0.001$) between average methane emissions and biomass at the collar scale.

From the results of our study, AWD water management practice was effective in reducing methane emissions, thereby supporting our hypothesis. Although fields with low clay content showed high methane emissions and vice versa, there was no statistical significance in the relationship between methane emissions and clay content. Since this poster shows the results from the first growing season of a three-year project, we conclude that more experimental data from the next two growing seasons is needed to test our hypothesis and determine the relationship between methane emissions and field clay content.

Sustainability Implications of Agricultural Practices for Rice in the Arkansas Delta: A Field-to-Market Approach

Palumbo, M.A., and Reba, M.L.

Continuously flooded and recirculating tailwater systems for rice production were compared using the Field-to-Market Fieldprint Calculator. The study site was a farm in Northeast Arkansas. Taking into account management and site conditions, the Fieldprint Calculator compared sustainability metrics to standards at various spatial scales in a spidergraph report.

Irrigation is essential for crop production in Arkansas. Annual precipitation averages approximately 130 cm (51 inches), more than is required to meet crop demands in the Mid-South. However, the timing of rainfall does not coincide with critical water use stages in crop development. As a result, approximately 67% of the 6 million acres of Arkansas farmland is supplied with supplemental irrigation pumped primarily from groundwater supplies. As crop irrigation water demands continue to increase, improving irrigation water use efficiency (IWUE) becomes increasingly critical to ensure groundwater sustainability.
Recirculating tailwater systems, which capture runoff and recycle water back to the field, offer a solution to reduce water waste and limit runoff potential. These systems help conserve water use and may provide economic benefits for farmers by reducing the need for additional irrigation sources. Additionally, improving soil health can increase IWUE and help sustain agricultural productivity. The use of both conservation tillage and cover crops have been shown to improve soil structure, enhance water retention, and promote soil biodiversity, supporting better crop yields and reducing the need for irrigation. However, the adoption of these conservation practices often faces challenges. Producers are hesitant to change long-established methods due to initial costs and potential risks.

This poster explores the potential of these water and soil management practices in Arkansas, emphasizing the role of recirculating tailwater systems, conservation tillage, and cover crops in promoting sustainable agricultural practices in the state. Sustainability metrics such as water use efficiency, soil health, and biodiversity were compared across various spatial standards using the Fieldprint Calculator to compare the impacts of conservation agriculture practices to conventional methods.

Effects of Different Nitrogen Rates on Yield, Nitrogen Use Efficiency, and Greenhouse Gas Emissions Under Alternate Wetting and Drying Management

Petrowicz, H.L., Dou, F., Lloyd, A.W., Lasar, H.G.W., Ranasinghe Hetti Arachchige, N.H., Gentry, T., Wilson, L.T., Yang, Y., and Tarpley, L.

Alternate wetting and drying (AWD) management remains a promising method for reducing greenhouse gas (GHG) emissions in rice production. However, AWD may also result in additional losses of nitrogen (N) that may not otherwise occur under continuous flooding (CF). To balance profitable yield, N use, and GHG emissions, effective N management is essential for producers and climate smart practices. A field study was conducted to determine the optimum N application rates for rice under AWD management in Southeast Texas, along with the resulting effects on yield, nitrogen use efficiency (NUE), and GHG emissions. A high-yielding long-grain rice variety, DG263L (*Oryza sativa* L.), was planted following a randomized complete block design for the 2024 season. The AWD management treatment was applied at a 15-cm level during the tillering stage to the panicle differentiation stage. Urea fertilizer was applied to each field using a tractor-mounted fertilizer spreader, with five different N rates: 0 kg N ha^{-1}, 135 kg N ha^{-1}, 168 kg N ha^{-1}, 202 kg N ha^{-1}, and 235 kg N ha^{-1}. Static chambers were placed in three of the N treatments (0 kg N ha^{-1}, 168 kg N ha^{-1}, and 235 kg N ha^{-1}) with 4 replications each. Results indicate that N application rate and yield (kg ha^{-1}) share a quadratic relationship in both the AWD and CF models, each with a strong fit ($R^2 > 0.8$). The anticipated results will provide insights into optimum N application for rice under AWD management in Southeast Texas.

Incorporating Remote Sensing to Improve Understanding of Climate-Smart Agricultural Practices in Midsouth Rice Production

Reba, M.L., Price, M.A., Nowlin, J., and Torbick, N.

The increasing unpredictability of climate conditions presents significant challenges to agriculture, particularly in water-intensive crops like rice. In Arkansas, where rice production plays a crucial role in the state's agricultural economy, integrating climate-smart practices are essential for sustaining crop yields and managing water resources. This project focuses on documenting the impact of climate-smart practices on rice production in the context of a rice/soybean rotation system in northeastern Arkansas.

By leveraging remote sensing technologies and field-based soil moisture monitoring, this research aims to enhance our understanding of water usage and soil moisture dynamics at the field scale. The project combines advanced drone imagery, collected weekly using ASU College of Agriculture UAV equipment, with in-situ water level sampling above and below ground. These efforts are designed to refine and validate water level and soil moisture mapping algorithms in collaboration with remote sensing experts. Data processing is conducted in the Spatial lab, supporting the development of more precise models for sustainable water management in rice production.

By conducting weekly drone flights, we were able to closely monitor plant health and stress levels throughout the growing season. When compared to satellite imagery, the results were strikingly similar. This technology offers significant benefits for farmers, enabling more efficient irrigation timing and the ability to identify problematic areas in the field that might otherwise go unnoticed.

Monitoring Rice Canopy Development with Remotely Sensed Visible to Near-Infrared Reflectance

Richardson, W.P., Guan, K., Reba, M.L., and Runkle, B.R.K.

The implementation of various management practices in rice production (e.g., irrigation timing, fertilizer and pesticide applications) is inherently tied to specific growth stages (e.g., tillering and heading) and the current status or health of the crop, both of which are typically monitored by visual scouting of individual fields. Similarly, potential yield-limiting stresses on the crop such as high nighttime temperatures and inadequate soil moisture availability may be more or less relevant to the crop depending on what growth stage the crops are in. However, frequent visual scouting of entire fields can be challenging given the large size of typical fields and the fact that many fields planted on different dates may be managed by a single farming operation. Therefore, remote monitoring of canopy growth stages and crop status has the potential to greatly streamline and enhance the efficacy of management decisions in rice crops. Furthermore, the human eye only sees a limited range of reflected light (i.e., the visible region from 400 to 700 nm) compared to the full spectral range of incoming light from the sun. Much of this "invisible" light contains important information on how rice plants are currently functioning; for example, healthy plants absorb much of the light in the visible region to power photosynthesis, while near-infrared light is strongly reflected, as it has no use to the plants. Thus, automated, spectrally resolved monitoring of rice fields can help growers time the implementation of management practices without the need for exhaustive manual scouting of fields.

In this work, we made ground-based observations of canopy growth stages, visible to near-infrared reflectance (400 to 900 nm) with a hyperspectral instrument, leaf area index, canopy photosynthesis, and other variables related to field conditions (e.g., water table depth) at a commercial rice field in Arkansas. Our objectives were to: (1) identify regions of the reflectance spectrum that respond to changes in growth stages, (2) compare ground-based reflectance to satellite observations to test our ability to extend reflectance-based growth stage detection to other fields, and (3) examine canopy responses to water management strategies during different growth stages through their impact on photosynthesis.

We found that near-infrared reflectance of vegetation reached a maximum just prior to heading, while a plant pigment-specific metric (the chlorophyll carotenoid index) peaked just prior to flowering. Furthermore, the onset of flowering coincided with maxima in vegetation indices related to the red-edge region (700 to 740 nm). Many vegetation indices started to decline after flowering, reached a plateau during the start of grain filling, and steadily declined after rice grains reached the hard stage. Because many farmers rely on the DD50 management program to estimate when key growth stage changes will occur, we then compare our reflectance-based indicators of growth stage changes with those based on the typical DD50 protocol. This comparison will demonstrate how reflectance information can complement traditional approaches commonly used by farmers. We compare ground-based spectral data with that from high resolution satellites such as Sentinel and Planet to verify their agreement and then assess the ability of satellite-based metrics to track growth stage changes in neighboring rice fields under contrasting water management regimes where we made additional ground-based observations. Finally, we look at the response of crop photosynthesis and reflectance in these fields across different growth stages to look for possible signs of stress induced by unintentional dry downs in one field. Our findings will help translate remotely sensed observations into actionable information for farmers to further optimize management decisions and maintain rice crop productivity.

Use of Remote Sensing Data and IBER Software for Flood Modeling and Irrigation Management in Rice Cultivation

Simeón Brocal, R., Agenjos-Moreno, A., Cerezo, B., Rubio, C., Tarrazó-Serrano, D., García-Serra, J., Manzano, J., González-Pavón, C., and San Bautista, A.

Rice can be cultivated under conditions of constant submersion, periodic flooding, or fluctuating water levels, depending on the area of production, irrigation systems and the availability of water resources. Water and its management are of great importance for the optimal cultivation of rice. Irregularities in the leveling of rice fields can lead to variations in water depth. This results in inconsistent water levels, which can significantly affect water circulation and crop yields within a field, especially in large paddy fields.
The water circulation in the fields depends on water inlets and outlets, flow rate and leveling. Effective water management should facilitate the germination of the seeds, and during cultivation, the water depth must be maintained at optimal levels, and proper circulation should be ensured to prevent ponding water. The farmer needs to understand this information to perform proper leveling and ensure efficient water use.

This study was carried out in a *JSendra* rice field during 2023 and 2024 in Valencia (Spain), to analyze the usefulness of the IBER hydraulic simulation program and remote sensing data about Sentinel-2, to obtain detailed information about the dynamics of water circulation within the plot, such as the extent and duration of flooding, as well as the spatial distribution of water levels across the field. The plot was leveled to zero elevation in 2023 and with a slight slope in 2024. Data were collected on terrain elevation, inflow and outflow rates, dissolved oxygen in the water, and yield maps, to understand the impact of leveling on water circulation and the final crop yield.

The temporal analysis of Sentinel-2 data across all its bands and pixels of 10 x 10 showed a linear correlation of R^2=0.75 between the NIR band (B8; 842 nm) and the terrain elevation five days after flooding. The simulation of crop flooding in the IBER program aids in understanding the impact of terrain leveling. Additionally, the parameters such as water depth and flow velocity were correlated with water depth and oxygen concentration data that was measured in field.

In conclusion, remote sensing data have demonstrated their value in identifying topographical variations within a plot through the interaction between water and soil reflectance. The results from the IBER model can simulate plot flooding and provide reliable indicators for water depth and crop oxygenation. This integrated approach supports farmers in optimizing field leveling and improving their understanding of water circulation and management in rice cultivation.

Estimated Soil Health Response to Long-Term Regenerative Rice Production in Eastern Arkansas

Vickmark, H.E., Roberts, T.L., Drescher, G.L., Weisflog, D.A., Prado, M.P.R., & Mengez, G.A.L.

Increasing soil health is one of the most important factors for maximizing crop yields, and many traditional agricultural management practices deplete soil health over time as soil carbon is removed from the system. For this reason, regenerative agricultural practices, such as conservation tillage, implementation of cover crops, and the addition of organic fertilizers, are growing in popularity. The objective of this research is to investigate the effects of long-term regenerative management in a zero-grade, flood-irrigated rice production system of eastern Arkansas. While this study is still in its infancy, results of similar studies can be used to estimate the potential changes in soil health parameters from baseline concentrations after long-term implementation of cover crops (CC) and no-tillage (NT).

This research was established in 2022 as a randomized complete block design with three reps of seven different combinations of tillage, residue management, CC implementation, and incorporation of biochar. Prior to the first rice planting of this study, baseline soil samples were collected at six different depths (0-10, 10-20, 20-40, 40-60, 60-80, and 80-100 cm) and analyzed for multiple soil health parameters, including, but not limited to, bulk density (BD), soil organic matter (SOM), soil organic carbon (SOC), and total nitrogen (TN). When utilizing a global meta-analysis on the long-term effects of CC implementation on various soil health parameters, calculations projected up to a 20% increase in SOC from baseline values with the addition of CCs. A separate study investigating soil health in long-term, NT rice was used to project up to a 24% increase in SOC from baseline after 10 years of NT. Given these projections, it can be predicted that the long-term implementation of CC and NT in this study can sequester up to 932 MT C ha^{-1}, a massive C sequestration potential. In the future, the results of this study can verify whether these predictions are accurate.

ABSTRACTS OF PANEL POSTERS:
AGRONOMY AND RICE CULTURE
Panel Chair: Manoch Kongchum

Influence of Nitrogen Rate on Performance of Selected Varieties in Arkansas

Castaneda-Gonzalez, E., Clayton, T.L., Frizzell, D.L., Smith, T.M, Hartley, H.E., Roberts, T.L., and Hardke, J.T.

The variety by nitrogen (N) studies conducted by the University of Arkansas System Division of Agriculture are designed to analyze the response of new rice cultivars to N fertilization and validate or adjust current N fertilizer rate recommendations across soils and environments. Studies were conducted during 2022-2024 at three locations in Arkansas: The Northeast Research and Extension Center (NEREC) near Keiser (clay soil), the Pine Tree Research Station (PTRS) near Colt (silt loam soil), and the Rice Research and Extension Center (RREC) near Stuttgart (silt loam soil). Twelve varieties were evaluated across a range of N fertilizer rates as kilograms of N per hectare (kg N ha-1): 0, 67, 101, 135, 168, 202, and 235 kg N ha-1 (67 kg N ha-1 treatment omitted on clay soil and replaced with 235 kg N ha-1 treatment). The N rate response of the varieties CLL18, Diamond, Ozark, PVL03, and Taurus with three years of data are presented. Results of these studies will be used to update current rice N recommendations for Arkansas.

Response of Selected Rice Cultivars to Planting Date, 2022-2024

Clayton, T.L., Castaneda-Gonzalez, E., Frizzell, D.L., Hartley, H.E., Smith, T.M., and Hardke, J.T.

In Arkansas, the rice planting window ranges from late March through June and exposes cultivars to an array of different environmental conditions that affect plant growth and ultimately grain yield. From 2022 to 2024, from late March through early June, four to six plantings were made in two locations each year, the University of Arkansas System Division of Agriculture's Rice Research and Extension Center (RREC) near Stuttgart, AR and the Northeast Rice Research and Extension Center (NERREC) near Harrisburg, AR. The cultivars grown were CLL16, CLL18, CLM04, DG263L, Ozark, PVL03, RTv7231 MA, Taurus, and Titan, and the hybrids RT 7331 MA, RT 7401, RT 7421 FP, RT 7521 FP, and RT XP753. In 2022, late March through mid-April were optimal at the RREC while early April through mid-April were optimal for the NERREC. In 2023 at the RREC, the optimum dates were early April and early May, while at the NERREC the optimum dates were early and mid-April. In 2024, late March through mid-April through mid-May were optimal at the RREC while early April through mid-April were optimal for the NERREC. While all cultivars follow these general trends, it should be noted that individual cultivars respond differently to planting dates, particularly with late planting dates.

Arkansas Rice Performance Trials, 2022-2024

Frizzell, D.L., Garrison, H.H., Casteneda-Gonzalez, E., Clayton, T.L., Smith, T.M., and Hardke, J.T.

Cultivar selection is a critical decision annually for rice producers. The Arkansas Rice Performance Trials (ARPT) are conducted each year across Arkansas to evaluate the performance of commercial rice cultivars at experiment stations and commercial fields to provide information on agronomic factors such as disease resistance, lodging, plant stand, plant height, grain yield, and milling yield across a range of environmental conditions, growing practices, and soil types. A cultivar's performance across multiple years can also provide information about a cultivar's adaptability to potential environmental changes from year to year. The 17 cultivars included in the ARPT from 2022 to 2024 were the conventional (non-herbicide-tolerant) long-grain varieties DG263L, Diamond, and Ozark; the Clearfield long-grain varieties CLL16, CLL18, and CLL19; the Provisia long-grain variety PVL03; the MaxAce long-grain variety RTv7231 MA; the MaxAce long-grain hybrid RT 7331 MA; the FullPage long-grain hybrids RT 7421 FP and RT 7521 FP; the conventional long-grain hybrids RT 7302, RT 7401, and RT XP753; the conventional medium-grain varieties Taurus and Titan; and the Clearfield medium-grain variety CLM04. Studies were conducted on research stations in Arkansas, Mississippi, Poinsett, and St. Francis counties and in grower fields in Clay, Desha, Greene, Jackson and Lawrence during 2022 to 2024. Additional sites included southern Arkansas County (2023-2024), Lonoke County (2022), and Faulkner County (2024). During the study years 2022 to 2024, grain yield was 211 kg/ha (188 bushels/acre) averaged across all locations, cultivars, and site years. Cultivars with the highest grain yield averaged across all locations and years include RT 7302, RT 7401, RT XP753, RT 7521FP, RT 7331 MA and RT 7421 FP. DG263L was the highest-yielding non-hybrid from 2022-2024. The average milling yield across cultivars, locations and years was 52/72 (%HR/%TR). The varieties CLM04, Ozark, CLL19, PVL03, and Taurus produced the highest head rice yields averaged across locations and years. For each cultivar, percent head rice was similar between 2022 and 2023 and lower during 2024 and percent total rice was consistent between years and cultivars.

The Importance of Accurate Soil Sampling and Its Representativeness for Fields Studies in Commercial Rice Farms

Gomez-Prats, M., Moreno-García, B., Reba, M.L., and Runkle, B.R.K.

Accurate soil sampling is crucial for success and reliability in water-saving studies, particularly in commercial rice fields. These studies often begin with the USDA-NRCS soil survey maps as a reference for field selection and experimental design. While these maps are useful for initial planning, their generalized data can fail to capture accurate values for soil properties at the field levels as well as the intra-field variability. These limitations frequently lead to discrepancies between map-based classifications and field observations, compromising the reliability of study outcomes.

A water-saving study on eight commercial rice farms in Arkansas during four consecutive growing seasons (2021-2024) highlighted these challenges. For example, in 2023, two adjacent fields were selected based on their classification as having similar soil textures according to soil survey maps. One field was assigned to the conventional irrigation practice (continuous-flood delivered using cascade distribution; CASC) as a control, while the other field was managed under an irrigation water-saving practice (continuous flood using multiple-inlet distribution; MIRI). However, soil sampling revealed significant differences in texture, especially in clay content: the control field had 26.80% clay, whereas the water-saving field had 15.67%. This disparity, undetected in the initial map-based soil survey, had a direct impact on the study results. The control field, with higher clay content, demonstrated greater irrigation efficiency, while the water-saving field underperformed, highlighting the critical importance of soil texture in irrigation practices

This case study underscores the importance of accurate and representative soil sampling to capture inter-field variability, particularly in clay content. Relying solely on generalized soil survey maps without further soil analysis can lead to unsustainable field pairings and flawed experimental results. A well-designed soil sampling protocol, including sufficient samples to optimize study design, whether by increasing sample locations, quantities, or depths, is recommended for ensuring robust data and minimizing variability that can affect study outcomes.

In conclusion, accurate soil sampling is particularly crucial when comparing fields for water-saving studies, as fields appearing similar on maps may exhibit significant differences in physical properties. These discrepancies can influence irrigation efficiency, determining the success or failure of such studies. By addressing these challenges through robust soil analysis, researchers can improve the reliability of water-saving studies and promote sustainable agricultural practices in commercial rice farms.

Influence of Seeding Rate on Performance of New Rice Cultivars

Hartley, H.E., Frizzell, D.L., Clayton, T.L., Castaneda-Gonzalez, E., Smith, T.M., and Hardke, J.T.

The objective of the rice cultivar and seeding rate study aims to assess the response of new rice cultivars to various seeding rates, with the goal of providing sound seeding rate recommendations to growers throughout the rice-growing regions of Arkansas. This research was conducted at three locations: the Rice Research and Extension Center in Stuttgart (silt loam soil), the Pine Tree Research Station in Colt (silt loam soil), and the Northeast Research and Extension Center in Keiser (clay soil). During the 2022-2023 seasons, four rice varieties were evaluated: PVL03, Ozark, RTv7231MA, and Taurus, which were seeded at rates of 54, 108, 215, 323, and 431 seeds/m^2 (5, 10, 20, 30, and 40 seeds/ft^2). Current recommendations for seeding rates for varieties are 323 seed/m^2 (30 seed/ft^2) with increases for factors including soil texture and seedbed condition. However, results from these studies suggest that lower seeding rates (such as 215 seed/m^2) may also produce optimal yields. Small plot research studies do not always encounter the same stand establishment issues as large fields, so caution should be used when interpreting these results for reductions in seeding rate recommendations. However, the use of insecticide and fungicide seed treatments are now common (including in these studies) and may help to explain continued improvements in stand establishment and the ability to safely reduce seeding rates below current recommended levels.

Is Mid-Season N Application Necessary in the Drill-Seeded, Delayed Flood Rice System?

Kongchum, M., Fluitt, J.S., and Harrell, D.L.

A split nitrogen (N) application (before flooding and mid-season) is the most common practice for N fertilizer applications in drill-seeded, delayed flood rice. The first application before flooding is usually applied at the 4- to 5-leaf growth stage and the second is applied at mid-season when rice reaches panicle initiation (PI). Previous studies from 2014-2023 indicated that the total amount of N fertilizer required for the split-application is higher than that needed when applied as a single pre-flood application. The objective of this study was to evaluate rice yield from different N fertilizer application methods (single pre-flood and split between pre-flood and PI).

The experiment was established in 2024 with three rates of N (135, 168, and 202 kg N/ha). Nitrogen application methods were either: 1) a single pre-flood application, and 2) a split application applied pre-flood and at PI (85/50, 118/50, and 152/50 kg N/ha). Three rice varieties (CLHA03, PVL04, and Fitzgerald) were drill-seeded at a seeding rate of 270 seeds/m2 (approximately 68 kg/ha). Urea was used as the N source. Plot size was 1.42 x 4.88 m (7 rows, 20-cm apart). The treatments were arranged in RCB with four replications. Grain yield was measured from the whole plot and converted to a 12 % moisture content. The maximum yield for CLHA03 (10,108 kg/ha) and PVL04 (9,753 kg/ha) was observed in the treatment that received a single pre-flood N fertilizer application at a rate of 168 kg N/ha, while the maximum yield of Fitzgerald was observed with a single pre-flood rate of 202 kg N/ha (9,846 kg/ha). The lowest yield for all three varieties was found using the split N application of 85/50 kg N/ha. Results showed that the single pre-flood N application had a higher yield potential than the split N application when the same total amount of N for all three rice varieties was applied.

Evaluating Winter Cover Crops in California Rice Systems

Leinfelder-Miles, M., Baez Vega, C., Rosenberg, S., Espino, L., Linquist, B., and Brim-DeForest, W.

Winter cover cropping is not widely implemented in California rice systems, particularly on soils with high clay content and/or limited drainage. These conditions can make it challenging to terminate and incorporate cover crop biomass in time to prepare fields for rice production. Rather, typical winter management in California rice systems is to flood fallow, which improves straw decomposition, mitigates pest pressure, and provides waterfowl habitat. Nevertheless, cover crops may provide an opportunity to introduce plant diversity, including nitrogen-fixing legumes, into the system where rice may be grown over multiple seasons without rotation. The potential benefits of cover cropping include increased soil organic matter, reduced off-season nitrogen losses, and/or reduced seasonal nitrogen inputs, but research is needed to evaluate different cover crop species for adaptability to the rice growing environment. The objectives of this research were to evaluate winter cover crops for stand establishment, biomass production, soil carbon and nitrogen dynamics, and impacts to subsequent rice yields.

A three-year trial began in Fall 2022, with sites in Butte, Colusa, and San Joaquin counties, California. The sites differ in soil and climate conditions, with the Butte and Colusa sites having mineral soils with high clay content, and the San Joaquin site having high organic matter (approximately 28%). Across the sites, rice is grown without rotation, and the typical winter season management is flood-fallowing. At each location, ten winter cover crop species plus two species mixes were evaluated against an untreated control in 18-m^2 plots in a randomized complete block design. Plots were hand-broadcasted and then raked to incorporate seed. Data collection included early-season plant stands, monthly ground cover assessments, and end-of-season cover crop biomass carbon and nitrogen inputs. In addition to the small plot variety evaluations, a mixed species cover crop was planted at each location to a commercial-scale field, and soil organic matter, total soil nitrogen, nitrate-nitrogen, and rice yield were compared to an adjacent winter flooded field (untreated control). The field-scale evaluations were either drill-seeded or broadcasted and then harrowed.

During the 2022-2023 winter season, cover crop establishment was challenged by early-fall rainfall that delayed planting, record-setting seasonal rainfall, and bird predation of cover crop seed. Data collection was limited. The Colusa site had the most successful establishment, and end-of-season soil coverage was highest for oats (*Avena sativa*). Both the 2023-2024 and 2024-2025 winter seasons started off dry, and cover crop planting at all sites occurred by mid-November. During the 2023-2024 season, turnip (*Brassica rapa*) had the highest early-season plant stand at all sites, but it did not survive well after mid-season heavy rainfall. By the end of the season, purple vetch (*Vicia benghalensis* L.), woollypod vetch (*Vicia villosa* ssp. *dasycarpa*), balansa clover (*Trifolium michelianum*), and bell bean (*Vicia faba*) were the best performing species. The 2024-2025 season is still under observation. In the field-scale evaluations, we have observed no change in soil organic matter, soil nitrogen status, or rice yield due to cover cropping. The lack of observable benefits and the challenges faced with stand establishment could impede grower adoption of cover cropping in California rice systems.

A Five-Year Summary of the University of Arkansas Rice Research Verification Program

Mazzanti, R.S., Hardke, J.T., and Watkins, K.B.

Rice (*Oryza sativa, L.*) production is constantly changing as new cultivars are released, and new production challenges arise. Producers continue to request the University of Arkansas System Division of Agriculture field-test existing technology to determine the profitability of rice production based on recommended practices. In 1983, the Arkansas Cooperative Extension Service and the Arkansas Rice Research and

Promotion Board initiated the Rice Research Verification Program (RRVP). The RRVP is an interdisciplinary effort between growers, county Extension agents, Extension specialists, and researchers. The RRVP is an on-farm demonstration of all the research-based recommendations required to grow rice profitably in Arkansas. The trends in yields, management decisions, and impacts will be presented.

The specific objectives of the program are:

- To verify research-based recommendations for profitable rice production in all rice producing areas of Arkansas.
- To develop a database for economic analysis of all aspects of rice production.
- To demonstrate that consistently high yields of rice can be produced economically with the use of available technology and inputs.
- To identify specific problems and opportunities in Arkansas rice production for further investigation.
- To promote timely implementation of cultural and management practices among rice growers.
- To provide training and assistance to county agents with limited expertise in rice production.

Each RRVP field and cooperator was selected prior to planting. Cooperators agreed to pay production expenses, provide crop expense data for economic analysis, and implement Extension recommended production practices exclusively in a timely manner from seedbed preparation to harvest.

Since the program's inception 41 years ago, RRVP yields have averaged 903 kg/ha (18 bu/acre) above the state average. The most recent 5-year RRVP average stands at 1110 kg/ha (22 bu/acre) above the state average. The consistently higher yield averages of the program in comparison to the state average can mainly be attributed to intensive cultural management and integrated pest management.

Greenhouse Gas Emissions from Furrow Rice Using Tailwater Recovery System

Mendez, K., Quiñones, C., Larazo, N., Larazo, W., Adviento-Borbe, M.A.A., Dhakal, M., Massey, J.H., and Krutz, J.

Multiple irrigation frequency through the tailwater recovery system decreases but may increase greenhouse gas (GHG) emissions in furrow rice. This study aimed to assess the impacts of a novel water-saving irrigation technology on grain yield and GHG emissions. An experiment was conducted in farmer's field located at Egypt, Arkansas, with six replication and laid out an RCBD design. PVL04 was cultivated under two irrigation management methods: Multiple inlet rice irrigation continuously flooded (FLOODED) and tailwater recovery systems (RECIRCULATING). Throughout the cropping season, we measured CH_4, N_2O and CO_2 using the vented flux chamber method and gas chromatograph. Grain yield and yield components were also assessed.

Our findings reveal on average an 80% reduction in seasonal CH_4 emission in Recirculating water irrigation compared to FLOODED treatments. Daily CH_4 emissions for all water management treatments ranged from -18 to 3,418 g CH_4-C $ha^{-1}d^{-1}$ with highest emission in FLOODED treatments. Seasonal CH_4 emissions in FLOODED fields (61.8 kg CH_4-C $ha^{-1}season^{-1}$) were significantly higher by 49.2 kg CH_4-C $ha^{-1}season^{-1}$ compared to RECIRCULATING (12.0 CH_4-C $ha^{-1}season^{-1}$). With frequent dry conditions, RECIRCULATING resulted in significantly high N_2O emission of 3.8 kg N_2O-N $ha^{-1}season^{-1}$. Seasonal CO_2 emissions were significantly lowest in RECIRCULATING (7.2-ton CO_2-C $ha^{-1}season^{-1}$). No significant yield reduction was observed under both irrigation treatments. However, the calculated yield-scaled global warming potential of N_2O and CH_4 emissions was significantly reduced under the RECIRCULATING treatment by approximately 60%. The preliminary results of this study showed that the tailwater recovery system has the potential not only to minimize water use but also to mitigate greenhouse gas emissions in commercial rice fields.

Site Selection of Water Level Sensors for Rice Irrigation Water Management and Automation

Payne, G.K., and Massey, J.H.

Remote water level sensors are an increasingly common component in rice sustainability projects to document water management and are potentially a water and cost saving tool for producers. A significant challenge with implementing this technology is choosing where the sensor(s) should be installed in a levee production system. Having multiple sensors in one field is expensive, but a single sensor may not provide producers with enough data for effective irrigation or documentation. To evaluate if there is an optimal location for water level sensors, a transect of field water tubes was installed across each paddy of a 48 acre, precision-graded rice field near Wiener, AR. Tubes were installed 6.1m (20ft) from the levee center at the top and bottom of each paddy and then at 50%, 66%, 75%, and 84% of the paddy width from the bottom levee center. These distances increased the frequency of measurement locations at the top of the paddy which is more critical in monitoring Alternate Wetting and Drying (AWD) flood management. The 61cm (2ft)-long PVC tubes were installed 25.4cm (10 in) into the soil at each sampling location. The top of each tube and three ground-level locations around it were surveyed to calculate relative elevation at each location. Throughout the production season, depth of water was measured to the nearest 3mm (1/8in) at each tube across the transect.

Although the study field was precision-graded and the levees and levee-gates were carefully installed by the producer, the slope of the water level in each paddy varied. However, the slope of water levels within each paddy remained consistent throughout the season under flooded conditions. This consistency could possibly allow a producer to predict water level in multiple paddies based on a single location, but previous knowledge of the water depth relationship in each paddy would be required. This would be a significant challenge for most producers due to the amount of time and effort required to collect the amount of data needed to understand this relationship in each individual field. Additionally, an AWD dry-down did not occur in the study field, leaving out a critical piece of the sensor location puzzle. Before any broad recommendations should be made, more data under varying conditions is needed.

Greenhouse Gas Emissions of Six Rice Cultivars in Drill Seeded Rice

Quinones, C., Larazo, N., Mendez, K., Larazo, W., and Adviento-Borbe, M.A.A.

The potential to reduce greenhouse gas emissions (GHG) through high-yielding rice cultivars is unknown. Hybrid rice demonstrates a higher productivity in biomass and grain yield, while using less time in the field and reduced irrigation levels as compared to inbred varieties. Thus, hybrid rice technology can be highly effective in reducing GHG emissions from rice fields. This study aimed to investigate the potential of three RiceTec cultivars: RT3202, RT7302, RT7331MA and three inbred cultivars: Ozark, PVL04, and Taurus in reducing GHG emissions under continuously flooded irrigation.

The field trial was conducted at the RiceTec Experimental Research Station in Harrisburg, Arkansas, with three replications arranged in an RCBD design. Methane, N_2O and CO_2 emissions were measured using vented flux chamber and gas chromatograph equipped with autosampler. Grain yields and yield components were also measured. Our results show that during reproductive stage, large CH_4 emissions were measured in RT7331MA, RT7302 and TAURUS cultivars while RT3202 cultivar emitted the lowest. The lowest CH_4 emissions were measured in RT3202 across all cultivars. While OZARK cultivar was the lowest CH_4 emitter among inbreds. In contrast, the total N_2O and CO_2 emissions were independent of the variation of genotypes. Seasonal CH_4 emissions of RT cultivars (RT3202, RT7302, RT7331MA) contributed by about 68% to the total area-scaled GWP while 66% in inbred cultivars (OZARK, PVL04, TAURUS). Among the high-yielding genotypes, RT3202 released the lowest CH_4 emissions resulting in lower area-scaled and yield-scaled GWP. The low CH_4 emissions from RT3202 could be related to shorter days from emergence to 50% heading and/or higher grain weight suggesting re-allocation of non-structural carbohydrates to the grain and possibly less to the roots. The low CH_4-emitting characteristics of RT3202 may provide critical genetic features that can be used for breeding climate resilient rice.

Comparative Analysis of Greenhouse Gas Flux Measurement Techniques in Rice Fields

Ranniku, R., Moreno-García, B., Osoko, T.O., Adviento-Borbe, A., Reba, M.L., and Runkle, B.R.K.

Rice paddies contribute approximately 9% of global anthropogenic emissions of methane (CH_4), a potent greenhouse gas (GHG). Accurate quantification and a comprehensive understanding of CH_4 fluxes are essential for developing effective mitigation strategies to address GHG emissions and their climate impacts. Various methods are used to measure CH_4 fluxes, each differing in their capacity to capture spatial and temporal scale and variability. Common approaches include static chamber techniques, utilizing either manual gas sampling analyzed via gas chromatography (GC), or instantaneous on-site measurements using smart chambers and portable infrared gas analyzers (e.g. from Li-COR, Lincoln, NE). Additionally, the eddy covariance (EC) method provides landscape-scale flux estimates, enabling broader spatial coverage and greater temporal resolution.

While comparative studies have explored EC methods and GC-based static chamber measurements in rice fields, smart chamber techniques employing LI-COR analyzers have not been evaluated alongside other techniques. This study aims to address this gap by comparing daily CH_4 flux measurements across the 2024 growing season in two Arkansas rice paddies. We compared the measurement techniques between two fields – one under continuous flooding (CF) and one under alternate wetting and drying (AWD) irrigation practices. These practices often represent the baseline (CF) and climate-smart (AWD) management practices for carbon-crediting projects, as AWD irrigation is known to reduce CH_4 emissions by 40-80%. This analysis seeks to assess inter-method consistency and identify potential discrepancies between measurement approaches to constrain uncertainty in flux measurements and the resultant carbon crediting.

Preliminary results indicate that CH_4 flux estimates from chambers measured with the LI-COR analyzer exceeded those from EC across the growing season. Average daily CH_4 fluxes were 92.2 ± 26.6 nmol m^{-2} s^{-1} from chambers and 58.2 ± 17.8 nmol m^{-2} s^{-1} from EC in the field under CF, and 36.3 ± 17.5 nmol m^{-2} s^{-1} from chambers and 31.0 ± 10.8 nmol m^{-2} s^{-1} from EC in the field under AWD. Differences between the fluxes were more pronounced during periods of higher emissions in the middle of the growing season. In addition, the difference was greater in the field under CF (average difference 38.41 ± 17.68 nmol m^{-2} s^{-1}) compared to the field under AWD (11.21 ± 13.08 nmol m^{-2} s^{-1}).

We will conduct further analysis to include comparisons with GC-based measurements and among the methods' cumulative seasonal emissions at each site. The result will be an enhanced understanding of CH_4 flux dynamics and improving measurement techniques for rice paddy emissions.

Phosphorus and Potassium Fertilization Influence on Rice Nutritional Status and Grain Yield in Flooded and Furrow Irrigated Systems

Sarfaraz, Q., Drescher, G.L., Roberts, T.L., Hardke, J.T., Smartt, A.D., Weisflog, D.A., Shafer, J.B.

Rice (*Oryza sativa* L.) is a main cash crop in Arkansas and is commonly grown under flood irrigation, but furrow-irrigated rice has increased acreage in recent years due to easier crop rotation. Field studies were established in 2024 to investigate phosphorus (P) and potassium (K) influence on rice yield and leaf nutrient concentrations in flooded irrigated and furrow irrigated rice. Eight field trials conducted at the Pine Tree Research Station were fertilizer-P or -K at 0, 34, 67, 101, 135, and 168 kg K_2O or P_2O_5 ha^{-1}, and rice was grown under flooded and furrow irrigation. Y-leaf and flag leaf samples were collected at 5 weeks post flooding and heading to evaluate P and K concentrations, and grain yield was measured at rice maturity.

Rice relative yield was positively influenced by P fertilization in both flood-irrigated rice trials, where fertilizer-P treatments produced 11% greater yield than the unfertilized control. Furrow-irrigated P trials were not responsive to P fertilization and had an average yield of 7731 and 8283 kg ha^{-1}. Mehlich-3 soil K was low to medium for all four K-trials, and K fertilization positively impacted rice relative grain yield, with average yield increase of 20 and 10% in two locations under flooded and furrow irrigated areas, respectively. Regardless of irrigation method, there was no consistent pattern in leaf phosphorus (P) or potassium (K) concentrations in response to P and K fertilization or relative grain yield. Phosphorus and potassium fertilization can increase rice grain yield at higher fertilizer rates on soils with very low P or K availability. An increase in P concentration in the Y-leaf and flag leaf under one of the furrow- and flooded-irrigated trials was positively associated with rice grain yield. In K-fertilized trials, a positive relationship was observed between leaf K concentration (Y-leaf and flag leaf) and rice grain yield under furrow irrigation in both trials; however, the pattern of increase was not consistent with the K fertilization rate.

Impact of Biochar on Rice Grain Yield and Nutrient Uptake

Scott, C.L., Roberts, T.L., Williamson, S.M., Drescher, G.L., Weisflog, D.A., Hoegenauer, K.A., Smartt, A.D., and Shafer, J.B.

Wood biochar, a carbon (C)-rich byproduct of timber waste pyrolysis is increasing in popularity for use in Arkansas agriculture to potentially improve soil organic matter and other soil health parameters. Little work has been done using wood biochar in rice (*Oryza sativa* L.) production in Arkansas. In 2023, biochar was applied and incorporated prior to planting at rates of 0, 560, 1120, 1681, 2241, and 2802 kg of product per hectare (500, 1000, 1500, 2000, and 2500 lb of product per acre) in a randomized complete block design with four replications in a small plot study at the Pine Tree Research Station (PTRS) near Colt, AR. The following year, 2024, biochar was applied at the same rates and incorporated with shallow tillage (0-10 cm) in the same plots to evaluate the cumulative effect of biochar application on rice production. Plant samples were collected at the 50% heading growth stage to evaluate nutrient uptake. Biochar application had a significant inverse relationship with nitrogen (N, p=0.0124), phosphorus (P, p=0.0364), sulfur (S, p=0.0032), magnesium (Mg p=0.0068), and zinc (Zn, p=0.0370) aboveground nutrient uptake in 2023. The trends toward negative effects on nutrient uptake seen after initial biochar application were not observed the following year. Grain yield was compared at harvest, and no negative effects of biochar application were observed in either year. These results suggest that Arkansas producers seeking the soil health benefits of biochar application can be assured that grain yield will not be negatively impacted by application with either a single application or cumulative application at the above rates. Our goal is to continue this trial in an effort to observe the cumulative impacts of wood biochar application on rice response and soil health.

Yield Responses of Pure-Line and Hybrid Rice to Long-Term Annual Potassium Fertilization

Smartt, A.D., Drescher, G.L., Roberts, T.L., Hardke, J.T., Slaton, N.A., Shafer, J.B., Castaneda-Gonzalez, E., Weisflog, D.A., Sarfaraz, Q., and Williamson, S.M.

Potassium (K) is one of the most limiting nutrients for rice (*Oryza sativa* L.) and substantial yield reductions can occur when produced on soils low in exchangeable K. The likelihood of a positive rice grain yield response to K fertilizer is good when soil-test K is considered Low or Very Low (≤90 mg kg^{-1}). Rice in Arkansas has shown a positive yield response to fertilizer-K applied to rice as late as flag-leaf emergence, indicating the potential to correct in-season K deficiency with a proper and timely interpretation of tissue-K concentrations. Our objective was to evaluate yield responses of pure-line and hybrid rice cultivars to K fertilization in two trials where various K rates (0, 37, 74, 112, and 149 kg K ha^{-1}) have been applied annually. Research was conducted in 2024 at the Pine Tree Research Station (PTRS, Colt, Arkansas) and Rice Research and Extension Center (RREC, Stuttgart, Arkansas) in long-term trials established in 2000 and 2007, respectively, managed in rice-soybean (*Glycine max*) rotation under no-tillage. Each fertilizer-rate main plot was split into sub-plots by drill-seeding (19-cm row spacing) a pure-line cultivar in one half and a hybrid in the other half. CLL19 and Ozark were the pure-lines and RT 7302 and RT 7521 FP were the hybrids at PTRS and RREC, respectively.

Soil-test K in the 0-10 cm depth ranged from 47 mg kg^{-1} without fertilizer-K to 89 mg kg^{-1} with 149 kg K ha^{-1} applied annually at PTRS and from 59 to 135 mg kg^{-1} at RREC. With Very Low (<61 mg kg^{-1}) Mehlich-3 K in the no-fertilizer-K control plots, yields of all cultivars responded to K fertilization. Without K application, CLL19, Ozark, RT 7302, and RT 7521 FP produced 76, 83, 71, and 82%, respectively, of the maximum yields produced when fertilized with K. Grain yields at PTRS were maximized at application rates ≥ 74 kg K ha^{-1}, which averaged 10.0 Mg ha^{-1}, while yields at RREC were maximized with ≥ 112 kg K ha^{-1}, averaging 11.9 Mg ha^{-1}. Grain yields were 12% greater with the hybrid versus the pure-line cultivar, at both locations. Results of the 2024 growing season suggest similar responsiveness of pure-line and hybrid cultivars to K fertilization. Previous years (2020 to 2023) of this study at PTRS, however, consistently indicated hybrids to be more responsive than pure-line rice, with relative yields of hybrids ranging from 11 to 30% lower than the pure-lines. Other recent research in Arkansas, however, showed another hybrid (RT Gemini 214 CL) to be less responsive than pure-line cultivars. Based on inconsistent responses of hybrid rice to K fertilization and the fact that earlier studies predominantly evaluated pure-line cultivars, it is important to continue studying the response of hybrid rice to K fertilization to build a database for proper interpretation of tissue data and potential adjustments to K fertilizer recommendations.

Improving Soil Property Prediction for Rice Paddies from Measured Nutrient Values

Sun, H., Moreno-García, B., Seyfferth, A.L., Reba, M.L., Linquist, B., Kongchum, M., and Runkle, B.R.K.

Paddy soils, classified as anthropogenic soils (Anthrosols) for rice cultivation, account for about 9% of the global cropland area. Soil texture and organic matter (SOM) are pivotal determinants of soil processes and agronomic decision making in rice production systems. As routine laboratory analyses are time-consuming and labor-intensive, Drescher et al. in 2024 proposed cost-effective models for predicting soil texture and SOM using routine soil test data from different crop and forest production systems. However, their applicability to rice paddies has not been explored. Our objective was to determine key soil properties, namely soil clay, sand, and SOM contents, via predictive models that integrate measured soil pH and nutrient data (i.e., P, K, Ca, Mg, and estimated cation exchange capacity (EstCEC)), specifically targeting rice paddy soils.

A soil dataset containing 217 samples collected from different rice fields in Arkansas, California, and Louisiana was split into training (80%, $n = 173$) and testing (20%, $n = 44$) sets using a clustering analysis. A subset of 147 samples from Arkansas was used to compare the performance of our models with those of Drescher et al. When using testing sets to validate models, a clay prediction model with high accuracy was obtained when using pH, P, K, Ca, and Mg ($R2 = 0.84$; $RMSE = 68.14$ g kg-1). A negative correlation was found between sand and pH ($r = -0.39$; $p < 0.001$), yielding a model with moderate accuracy ($R2 = 0.36$; $RMSE = 89.94$ g kg-1). SOM prediction model using only EstCEC proved to be the best model ($R2 = 0.80$; $RMSE = 4.28$ g kg-1).

Comparison of model performance with the Arkansas rice paddy soil dataset exhibited that our models provided improved predictions over the models developed by Drescher et al. except for the prediction of sand. The prediction of soil textural class using our models achieved a respective overall accuracy of 85% compared to Drescher et al. (67%), which the accuracy was defined as the ratio of correctly classified samples to the total number of measured samples. SOM prediction model also improved $R2$ from 0.78 to 0.84. The unique characteristics of high clay content and carbon sequestration in paddies were captured by our models, contributing to better predictions than those of upland soils. Sand's low ability to retain nutrient especially in low-sand-content paddies made the weak accuracy; our samples covered a narrower range of sand content (0.40 % to 30.5 %) relative to Drescher et al. (0 to 87.5 %). Future model improvements may require information on management practices and historical production, soil ages, and climate conditions. Our findings offer valuable insights into the roles of soil texture and SOM in agricultural decision-making for rice production systems and provide a possible tool by which to efficiently and inexpensively estimate some key soil physical and chemical properties.

Assessing Phosphorus Use Efficiency in Rice Varieties Grown in Florida

VanWeelden, M.T., Bhadha, J., Manirakiza, N., and Melkani, S.

Approximately 10,000 ha of flooded rice are grown on histosols in Florida's Everglades Agricultural Area (EAA). Flooded rice provides several benefits to the agricultural system, including reductions in soil subsidence, nutrient depletion, and soil-borne arthropod pests. Relatively low available phosphorus (P) in histosols, combined with rising fertilizer costs, highlight the need to identify rice cultivars compatible for these soil conditions. This project aims to (1) determine P use-efficiency among rice cultivars grown in Florida, and (2) provide Florida rice growers with a list of recommended cultivars that are compatible in fields without fertilizer inputs.

A small-plot trial was planted within commercial rice fields, containing 45 rice varieties. The trial was organized using a randomized complete block design with three replications. Rice varieties were assigned to plots 8 meters long and 2 meters wide. Before planting, composite soil samples were collected at each plot at a depth of 0-15 cm as pre-samples. The rice trial was subjected to standard commercial practices. At harvest, composite soil samples were collected in addition to 10-15 mature rice plants per plot. Soil samples were analyzed for Mehlich-3 P, while plant tissue samples were analyzed for total P (TP). All plant and soil samples were analyzed at the UF Soil, Water, and Nutrient Management Lab in Belle Glade, FL. Tissue concentrations of P were compared among rice varieties using generalized linear mixed models. Additionally, P use and uptake efficiency were assessed among the rice varieties to identify those with the highest efficiency in utilizing and absorbing P from the soil.

The phosphorus-use efficiency index (PUEI) values across various rice varieties shows that Titan and RU1902207 exhibited the highest PUEI values, at approximately 0.0295 and 0.0296 respectively, indicating superior efficiency in phosphorus use relative to other varieties. On the lower end, 19T-238-13 has one of the lowest PUEI values at about 0.0165. Notably, varieties such as Diamond and RU2102158 also demonstrate high PUEI, both exceeding 0.0285, suggesting these varieties might be better suited for conditions where phosphorus availability is a limiting factor. This result provides valuable insights into the genetic variability of phosphorus use efficiency among rice varieties, which could be critical for enhancing crop performance in phosphorus-limited soils.

Empowering Young Scholars in Nitrogen Management for Organic Ratoon Rice

Weathington, M., Vernon, J.D., Bera, T., Yang, Y., Dou, F., Zhou, X.G., and Wilson, L.T.

Organic ratoon rice production in Texas offers a sustainable farming approach that emphasizes organic inputs, enhances soil health, and improves biodiversity. Practices such as cover cropping and organic amendments increase soil fertility and productivity. Despite the growing organic rice acreage in the U.S., which has expanded six-fold since 1995, domestic supply still lags market demand. Enhancing ratoon cropping systems can reduce reliance on imports and support U.S. rice farmers' economic growth.
Nitrogen (N) availability is a critical factor in organic rice systems, particularly for ratoon crops, which have unique nutrient requirements compared to main crops. To address this, a field trial was conducted at the Texas A&M AgriLife Research Center in Beaumont, Texas, evaluating the effects of rice cultivars (inbred ‘Presidio’ and hybrid ‘XP753’), crop rotations (cover crop vs. winter fallow), and five N rates (0–135 kg ha^{-1}) on soil N availability and rice productivity. Nature Safe® (13-0-0) was used as the organic N source. Alfalfa hay (*Medicago sativa*) was used as a substitute for cover crops to simulate nitrogen-fixing benefits, as repeated attempts to establish cover crops were unsuccessful due to the wet winter conditions and poor drainage in the clayey soil.

Results demonstrated that cover cropping significantly enhanced soil N availability compared to winter fallow. The effects of rice cultivars varied across growth stages, with Presidio initially showing higher soil N availability, which was later surpassed by XP753. Soil N availability increased with higher nitrogen rates but plateaued at 101 kg N ha^{-1}. A key component of this project was the active involvement of undergraduate student interns, who gained hands-on experience in soil sampling, processing, and nitrogen management for organic rice production. These interns not only developed technical skills but also deepened their understanding of sustainable agricultural practices. By engaging in real-world research, they are being equipped to become future leaders and advocates for sustainable farming, promoting innovative practices that address the challenges of modern agriculture. This practical training underscores the importance of fostering the next generation of agricultural scientists and practitioners dedicated to advancing environmental stewardship and food security.

Multi-Year Correlation of Post Flood Crop Sensor Readings with Rice Y Leaf Total Nitrogen and Yield

Williamson, S.M., Roberts, T.L., Drescher, G.L., Smartt, A.D., Smith, D.A., Scott, C.L., and Hardke, J.T.

As technology advances the development of real-time, handheld crop sensors can offer valuable insights on a crop’s potential response to in-season fertilization. However, little work has been done to directly correlate values obtained from crop sensors to plant nitrogen (N) content or subsequent yields. Various pureline and hybrid rice cultivars were evaluated from 2022 to 2024 using the Trimble GreenSeeker handheld crop sensor at various growth stages including 3, 4, and 6 weeks post flood and at boot. Plant samples were collected on the same day as GreenSeeker readings from Y leaves at the 3, 4, and 6 weeks post-flood timings and flag leaves at boot. GreenSeeker readings proved to have a statistically significant (P <0.0001) relationship with both plant sample total N concentrations and relative yield at all sampling times, however both relationships observed decreasing correlation coefficients and R-squared values as the sampling time post-flood increased. This trend suggests that crop sensor readings as early as 3 weeks post flood and as late as boot can be good predictors of yield response. A clear advantage of earlier GreenSeeker readings is that producers have the opportunity to diagnose potential N deficiencies early enough to make salvage fertilizer applications if needed to maximize yield potential.

Achieving Low Greenhouse Gas Emissions in Non-Flooded Rice Through Effective N Fertilizer Management

Woodruff, R., Larazo, N., Larazo, W., and Adviento-Borbe, M.A.A.

The rice production practices are linked with notable increase in greenhouse gas emissions (GHG): methane (CH_4) and nitrous oxide (N_2O), which contribute to climate change. Given the critical role of rice on global food supply, current concern is to implement sustainable rice farming practices with innovative technologies that minimize climate change impacts while promoting environmental sustainability.

A field study consisted of two rice irrigation: continuously flooded, CF and furrow, FR irrigation; and two fertilizer treatments: urea vs. sulfate enriched urea fertilizer (urea_S) at 168 kg N ha^{-1} rate were investigated from 2022-2024 to assess the impacts of urea_S fertilizer on grain yield, GHG emissions and global warming potential (GWP) in rice under FLOODED and FURROW irrigation treatments. Methane and N_2O fluxes were measured using a vented flux chamber technique. Across fertilizer N and irrigation treatments, grain yields ranged from 10.5 to 11.9 Mg ha^{-1} and were similar under irrigation and fertilizer N treatments (P = 0.196). Though not statistically significant, there was about a 10% increase grain yield in urea_S compared to urea treatment. Across years and N treatments, daily CH_4 emissions were low during tillering stage, peaked at 50% heading and decreased thereafter in FLOODED treatments, while CH_4 emissions were below 200 CH_4-C g $ha^{-1}d^{-1}$ except when rain events increased in FURROW treatments. Daily N_2O emissions ranged from 0 to 41 N_2O-N $ha^{-1}d^{-1}$, increased after N fertilization and during transition from flooded to dry soil conditions for both FLOODED and FURROW treatments. Seasonal CH_4 emissions were reduced by ca. 96% in FURROW treatment and independent of N fertilization while seasonal N_2O emissions were influenced by N fertilizers and frequency of irrigation or rain events through changes in soil water content. Total seasonal global warming potential (GWP) was mainly attributed to seasonal CH_4 emissions (91%) in FLOODED treatments and on wet year (2023). For FURROW treatments, total GWP was mainly constituted by seasonal N_2O emissions in 2022 and 2024. Although the lower GWP values were measured in FURROW treatments, differences in GWP values between fertilizer N treatments were not significant (P = 0.554). Results suggest that altering irrigation and N fertilization strategies can influence the balance between CH_4 and N_2O emissions in rice cultivation, with sulfur-enhanced urea showing potential for reducing overall GHG emissions without compromising the yield potential.

Enhancing Yield and Water Use Efficiency with Pit-Less Tailwater Recovery in Farrow-Irrigated Rice

Darikandeh, D., Henry, C.G., Clark, T., Pimentel, J.P., and Ghar, P. N.

Furrow-irrigated rice (FIR) systems are becoming popular with rice growers, but little work has been done to improve the system compared to flooded culture production systems. Little is known about how yield, water can impact the overall profitability and milling yields in this production system. One technology that is showing promise is a pit-less variable-flow tailwater recovery system (VFTWRS). A 3-year study (2020–2022) evaluated the performance of different irrigation treatments on Dewitt silt-loam soil at the University of Arkansas's Rice Research and Extension Center near Stuttgart, Arkansas. The field was equipped with a VFTWRS, which recirculates water from the bottom of the field to the top. Irrigation treatments included continuous VFTWRS and irrigation intervals of every 3, 5, 7, 10, and 14 days.

Results showed that the continuous VFTWRS irrigation treatment achieved the highest 3-year average yield of 190.45 Bu/ac (21,319 kg/ha), compared to other irrigation treatments. Average yields of 175.1 Bu/ac, 171.9 Bu/ac, 158.9 Bu/ac, and 147.0 Bu/ac were found for the 3, 5, 7, 10 and 14-day irrigation treatment intervals. While numerically higher by 15 Bu/ac, the yield was not significantly different from the 3 and 7-day intervals.

Irrigation applications were 9.96 ac-in/ac (253.18 mm) for the 14 day and 16.14 ac-in/ac (410 mm) for VFTWRS. While application volumes of the 7, 10 and 14 day were less, 14.2, 12.5 and 9.9 ac-in/ac for the higher interval timings respectively, yields of the 10 and 14-day irrigation were significantly less than the other treatments. Thus, to achieve the same TWUE as the VFTWRS one could expect a significant yield penalty for the 10 and 14-day intervals. Total water use efficiency (TWUE) was highest for the longest interval (14-day) and the VFTWRS treatment, with 6.77 Bu/in (12.10 kg/mm) and 6.57 Bu/in (11.70 kg/mm), respectively. TWUE of the 3 day was significantly lower than the VFTWRS and 14 day (4.95 Bu/in).

Head rice (HR%) was numerically highest for the VFTWRS treatment (58.4%) but was not significantly different from the other treatments except for the 14-day (54.7%) interval. Total rice yield results were the same as the head rice yield, with the VFTWRS (68.4%) having the highest numerically but not significantly different result, from the other treatments except the 14 day interval (65.7%).

Should a 15 Bu/ac higher yield be realized for VFTWRS, over conventional FIR, the additional benefits of significantly less water use (6 ac-in/ac) and a significantly higher TWUE than a 3-day irrigation interval show this is an improved FIR system. Prior work has reported a 16.7 Bu/ac yield penalty between furrow irrigated rice and flooded rice. This study suggests that the VFTWRS may close this yield gap for those who desire to move to a furrow irrigated culture, while also providing lower irrigation demands and higher water use efficiencies for rice farmers.

Greenhouse Gas Emissions in Bangladeshi Rice Cultivation: Impact of Water Management Practices

Habib, M.A., Islam, S.M.M., Nayak, S., Chandel, A., Bhosale, S., Salvo, S., and Singh, V.K.

Direct-seeded rice (DSR) is a promising method for reducing water use, labor, and greenhouse gas (GHG) emissions compared to transplanted rice. However, its impacts on rice yield and GHG emissions in Bangladesh are not well documented. This study conducted multi-location field experiments in Rajshahi and Rangpur during the late Boro and Aus seasons of 2023 – 2024. The experiments compacted dry DSR, transplanted rice with flooded irrigation (TFR), and transplanted rice with alternate wetting and drying irrigation (TAD) on rice yield and GHG emissions. Methan (CH4) emissions were measured using a closed gas chamber technique and analyzed with a gas chromatograph. Results showed that DSR significantly reduced CH4 emission by 11 – 21% in Rajshahi and 23 – 40% in Rangpur compared to TAD and TFR. Higher emission factors, yield-scaled emissions, and global warming potential (GWP) were found in TFR compared to DSR and TAD. Total CH4 emissions and GWP varied significantly between Rajshahi and Rangpur. However, DSR reduced grain yield by 21 – 28% in Rangpur, while yields were comparable among treatments in Rajshahi. The Rajshahi site had significantly higher yields than Rangpur. The study highlights the trade-offs between environmental benefits and crop productivity in different regional contexts.

ABSTRACTS FOR PANEL ORAL PRESENTATIONS: PLANT PROTECTION

Panel Chair: Blake Wilson

Moderators: Felipe Dalla Lana and Blake Wilson,

Managing Pyrethroid Resistant Rice Stink Bug

Bateman, N.R., Newkirk, T.B., Lytle, M.J., Thrash, B.C., Floyd, C.A., Cook, D.R., Towles, T.B., Felts, S.G., Plummer, W.A., Davis, T.A., Maris, P.G., Linn, J.B., and Fletcher, W.A.

Rice stink bug is a major pest of heading rice and can cause both quality (peck) and yield loss. Since 2020 control failures with lambda-cyhalothrin have become more common throughout the Mid-South. Lambda-cyhalothrin has been the most common insecticide used for management of rice stink bug for over 20 years. This is mainly due to its cost effectiveness, and at the time high efficacy was observed with this product. As more failures were observed throughout the southern rice growing region, actions were taken to determine the best management practices for rice stink bug in the presence of resistance.

Since 2021, assays have been conducted from northeast Louisianna though the southern region of Missouri. In Arkansas and Missouri petri dish assays were conducted across multiple locations each year. These assays suggested that even with a 4x field rate of lambda-cyhalothrin only 60% control was achieved with respect to rice stink bug efficacy. Vial assays conducted in Mississippi in Louisianna saw an average resistance ratio of approximately 200 in 2023 compared to an average of 2 in 2010. While assays methods differed among states, all had similar results in that lambda-cyhalothrin is severely lacking control of rice stink bug.

Additionally, field studies were conducted in 2021 and 2022 in Arkansas to determine what currently labeled products and some products that may receive label in the future best protect growers from damage caused by rice stink bug. In general, pyrethroids (lambda-cyhalothrin and zeta-cypermethrin) provided better control of rice stink bug than the untreated control but were not as good as dinotefuran or thiamethoxam + lambda cyhalothrin. This same trend was observed for ‘peck’ and milling samples. Dinotefuran and thiamethoxam + lambda-cyhalothrin both provided a better return on investment compared to all other products tested. Both pyrethroids test had a negative return on investment compared to not treating at all.

This work has led to recommendations changing for rice stink bug in the mid-South. Currently it is recommended to use dinotefuran for best control and return on investment. Further studies need to be conducted to determine if thresholds need to be adjusted with the increased price of dinotefuran compared to lambda-cyhalothrin.

Evaluating Varietal Resistance for Managing the Rice Delphacid in Texas Rice

Bernaola, L., Sarkar, N., and Pearson, R.A.

The rice delphacid (RD), *Tagosodes orizicolus* (Muir), is a major pest of rice in Texas. This invasive pest was first detected in Galveston County in 2015, and since then it has spread statewide, causing yield losses and increasing pest management costs. When numbers are plentiful, nymphs and adults produce hopperburn and crop failures, with severe outbreaks such as the 20% loss recorded in 2015 and 2022. In addition, the planthopper is a vector of rice hoja blanca virus. In 2024, RHBV was first detected in Texas in over 1,800 acres of ratoon rice, causing symptoms such as white leaf, panicle deformation, and plant death, with potential for severe yield loss. Given the limitations of current management practices, testing host-plant resistance provide promising avenues to improve RD management.

To explore host plant resistance, eight U.S. commercial rice varieties were evaluated in two greenhouse experiments for oviposition preference to the RD females. Results showed that RT75321FP and Jupiter varieties were highly susceptible, with the highest egg counts. Integrating these findings with field efficacy data can inform the development of sustainable pest management strategies. By combining resistant varieties with optimized insecticide use, RD impacts can be mitigated, safeguarding the rice industry of Texas and the US.

Cultural Practices for Managing Stem-Boring Lepidopterans in Rice

Stout, M.J., Khan, M.D., Villegas, J.A., Sharma, J., and Wilson, B.E.

Rice in Texas and southwest Louisiana is attacked by a complex of stem-boring Lepidopterans. The economic importance of stem borers as pests in Louisiana rice has increased over the past decade due to the invasion and establishment of the Mexican rice borer, *Eoreuma loftini*. Currently, management of borers in U.S. rice relies almost exclusively on treatment of seeds with the insecticide chlorantraniliprole (Dermacor® X-100, Corteva Agriscience, Indianapolis, IN). Complete reliance on a single insecticide is not a sustainable management strategy, and for this reason field trials of alternative management tactics have been conducted over the last decade. Several cultural practices have the potential to contribute to a management program for stem borers in rice, including early planting, silicon soil amendment, stubble management, and high seeding rates. Selected results from experiments investigating the efficacy of these cultural practices against stem borers will be presented.

Management of Rice Water Weevil in Mississippi Rice

Towles, T.B., Cook, D.R., Lipsey, H.L., and Lytle, M.J.

The rice water weevil (*Lissorhoptrus oryzophilus*) is a significant pest of rice in the midsouthern United States. Numerous trials were conducted in Mississippi and Arkansas to manage this pest and prevent substantial economic losses. Trials focused on preventative approaches, primarily in the form of insecticidal seed treatments (ISTs). Preliminary findings suggest that the addition of a diamide-based seed treatment, cyantraniliprole, significantly impacted rice water weevil densities in rice cores. Additionally, rice yields were significantly higher when a diamide seed treatment was utilized compared to a fungicide-only treatment. Mississippi recommendations include the utilization of a cyantraniliprole-containing seed treatment or the combination of cyantraniliprole and a neonicotinoid seed treatment.

Monitoring for Armyworm in California Rice and Relationship Between Number of Adults Caught in Pheromone Traps and Larval Counts

Espino, L., Grettenberger, I., and Leinfelder-Miles, M.

The armyworm, *Mythimna unipuncta*, is an occasional pest of rice in California. A large outbreak occurred in 2015. Since then, infestation severity has fluctuated. To determine the need for an insecticide application, managers rely on visual estimates of defoliation. However, armyworm defoliation can occur quickly and escape detection. To improve detection, the use of pheromone traps was investigated.

Armyworm moth populations were monitored using pheromone traps in 15 rice fields in the Sacramento Valley and three rice fields in San Joaquin County, California, between 2018 and 2023. Larval populations were monitored in four to seven rice fields in the Sacramento Valley between 2021 and 2023 by searching 10 minutes or 0.3 m^2. Two moth flights and two larval generations were observed. The week when the first moth peak occurred was similar across locations while the week when the second peak occurred was more variable. Analysis of covariance showed that larval numbers were related to moth numbers caught in the traps two weeks earlier, but this relationship varied between fields. The synchrony of moth detections each spring and when the first moth flight occurred, and the reduced number of moths caught during the second flight seem to suggest that armyworm migrate into the rice production area of California.

Billbug Management in Mississippi Rice

Lipsey, H.L., Cook, D.R., Towles, T.B., Lytle, M.J., Crow, W.D., Floyd, C.A., Bateman, N.R., and Gore, J.

The rice billbug, *Sphenophorus pertinax,* Chittenden, is a common pest of furrow-irrigated rice in the Mid-South. Damage to rice can be caused by both adults and immatures; however, the main cause of damage is from the larval feeding on inner stem tissues. This feeding inside the stem disrupts nutrient flow to the panicle and can result in aborted heads or dead tillers. Infestations occur when overwintering females emerge and move into the young rice fields, chewing a hole at the base of a rice plant and inserting a single egg. Larvae will emerge from the egg inside the stem and feed until pupation is complete, at which point they emerge from the stem as adults in late summer. Although these larvae can impart significant yield loss on furrow-irrigated rice, they cannot tolerate flooded conditions and are therefore not a significant pest of traditional flooded rice. Because the larvae spend such a long period of time inside the rice stems, control options are limited. As foliar insecticide applications will not provide adequate control, the main form of chemical control includes combinations of diamide and neonicotinoid insecticide seed treatments.

Reduced Efficacy of Insecticidal Seed Treatments in Louisiana Rice

Wilson, B.E.

Insecticidal seed treatments, including diamides (chlorantraniliprole and cyantraniliprole) and neonicotinoids (thiamethoxam and clothianidin), have been the cornerstone of rice pest management in the US Mid-South for the past 15 years. These insecticides are primarily used to control the rice water weevil (*Lissorhoptrus oryzophilus*), the most economically damaging rice pest in the region, but they also effectively manage a broader spectrum of pests.

Chlorantraniliprole has become the most widely used insecticide in south Louisiana rice production due to its exceptional efficacy against a complex of Lepidopteran stem borers. For approximately 10 years, chlorantraniliprole has been applied to over 80% of rice acres in south Louisiana, often as the sole insecticide. While chlorantraniliprole consistently provided greater than 80% control of both *L. oryzophilus* and stem borers for most of this period, inconsistent efficacy began to emerge in 2022.

Research trials conducted in 2024 at the H. Rouse Caffey Rice Research Station in Crowley, Louisiana, confirmed this decline in efficacy. None of the currently registered seed treatments demonstrated greater than 60% control of *L. oryzophilus* or provided any appreciable control of stem borers. Surveys conducted on commercial farms corroborated these findings, revealing damaging *L. oryzophilus* infestations in fields treated with chlorantraniliprole across south Louisiana.

Furthermore, heavy infestations from three stem borer species were observed in chlorantraniliprole-treated fields in 2024. In some cases, these infestations resulted in total yield loss. The estimated yield loss across the south Louisiana rice production region attributed to *L. oryzophilus* infestations in 2024 ranged from 10% to 15%. While more difficult to quantify, stem borer control failures also led to significant yield losses.

Consequently, none of the registered insecticidal seed treatments currently provide adequate control of either *L. oryzophilus* or stem borers in Louisiana. To mitigate future losses from these pests, additional control tactics will be necessary. Foliar-applied insecticides and cultural control methods employed before the widespread adoption of seed treatments offer the most practical and immediate solutions.

Chemical Control of Rice Diseases in Louisiana: Challenges and Opportunities

Dalla Lana, F. and Cerutti, A.

Fungicides are an important component of integrated pest management in the Louisiana rice industry. However, the active ingredients are limited to a few, older molecules, predominantly from the SDHI, QoI, and DMI groups. Recent epidemics of Cercospora net blotch (CNB) and Cercospora panicle blight (CPB), both caused by *Cercospora janseana*, challenge the effectiveness of chemical control for these diseases. The same fungus also causes narrow brown leaf spot (NBLS). Flutolanil, a fungicide from the SDHI group, is not effective against ascomycete fungi, such as *C. janseana*. A high frequency of strains with the G143A mutation, potentially as high as 75%, suggests that strobilurins (QoIs) are also not expected to be effective in controlling these diseases. DMIs, especially propiconazole, have been used to control NBLS for over four decades. However, the efficacy of this fungicide in controlling CNB was not explored previously. The aim of this study was to evaluate the efficacy of propiconazole in controlling CNB. Two studies were conducted to evaluate the efficacy of propiconazole in controlling CNB. In the first study, weekly applications of propiconazole (Tilt, Syngenta) were sprayed at 10 fl oz/A weekly, from panicle differentiation plus seven days to heading. The fungicide application did not affect yield or the incidence of CNB. Another study, involving eight varieties and applications of propiconazole at early boot or late boot, also did not show a significant yield increase or a reduction in disease incidence. Future studies will explore other active ingredients, as well as biological agents, to control CNB, and applications after heading.

Plant Pathology Challenges in Arkansas: Blast and Cercospora

Nicolli, C., Pedrozo, R., Hardke, J.T., and Dalla Lana, F.

Rice production in Arkansas faced significant challenges in 2024 due to notable increases in both incidence and severity of diseases, particularly leaf, neck blast, and Cercospora. In response, our research program has adopted a comprehensive disease management approach, focusing on testing disease-resistant rice varieties, optimizing fungicide application strategies, and advancing our understanding of pathogen biology and ecology. For blast, a key aspect is identifying and characterizing prevalent *Magnaporthe. oryzae* races to guide resistant variety development. Additionally, we are assessing the economic impact of Cercospora by analyzing its contribution to yield losses under various management strategies and determining optimal fungicide timing.

During the 2024 season, blast samples were collected from 22 fields across 12 counties, representing rice varieties such as CLM04, DG353M, RT7521FP, Taurus, and Titan. A total of 150 single-spore isolates were obtained for *AVR* gene detection, with 83 analyzed so far, most carrying the *AVR-Pita1*, *AVR-Pib*, *AVR-Pizt* genes, and *AVR-Pi9*. For Cercospora, three trials were conducted with cultivars PVL03 (Provisia), CLL19 (Clearfield), and RT7521FP (Hybrid FullPage) under two treatments: untreated control and fungicide (propiconazole, Tilt at 730.20 mL/ha) applied at early, mid-, and late-boot stages. Results showed low Cercospora incidence, with symptoms confined to the sheaths, and no significant yield impact, as treated and untreated plots had similar yield averages.

In conclusion, the 2024 findings underscore the need for integrating genetic and management strategies to mitigate rice disease impacts in Arkansas. *AVR* genes in regional blast populations provides insights for breeding programs, helping to pinpoint effective sources of resistance genes for utilization in developing resistance rice varieties. The low impact of Cercospora on yield highlights the importance of continued monitoring and targeted fungicide applications. These efforts will strengthen sustainable rice production and support growers in managing evolving disease challenges.

Updating the Rice Blast Races (*Magnaporthe oryzae*) Present in Arkansas

de Paula, S., Belmar, S., Pedrozo, R., Jia, Y., Sha, X., and Nicolli, C.

Rice is a staple food for more than half the world's population. Blast, caused by the fungus *Magnaporthe oryzae* (syn. *Pyricularia oryzae)*, is one of the most destructive diseases affecting rice production. Breeding programs have successfully deployed rice varieties carrying resistance genes (*R* genes) in recent years, contributing to the management of rice blast in a gene-for-gene manner. Currently, commercial varieties grown in Arkansas carry at least one of the following *R* genes, *Pi-ta/Ptr, Piz*, *Pib*, and *Pi*k recognizing the corresponding avirulence genes, *AVR-Pita1*; *AVR-Pizt*, *AVR-Pib*, and *AVR-Pik* respectively in triggering robust disease resistance responses. However, disease outbreaks have been reported, leading to the primary objective of obtaining *M. oryzae* isolates from symptomatic rice fields in the 2024 season and assessing their *AVR* genes to understand if the outbreaks on the current rice cultivar in Arkansas are due to shifts in pathogen populations.

M. oryzae race assignment can be performed through the inoculation of differential rice varieties and/or *AVR* genes detection. The first method is based on host reaction (levels of susceptibility or resistance) and involves plant growth, fungal inoculation, and symptom assessments. The *AVR* gene detection method is based on pathogen DNA and represents a complementary approach to characterize new *P. oryzae* isolates and potentially predict virulence to a specific rice variety (*R* gene). Rice blast sampling was carried out across Arkansas. Samples were processed using isolation techniques followed by single spore protocol and stored at -20 ºC for further characterization. Isolates were recovered from filter paper and placed onto rice bran medium for 10 days at 25 ºC under a 12-hour light cycle. DNA isolation was carried out following the manufacturer's recommendation (MP Bio, FastDNA SPIN Kit). All PCR reactions were performed using *Taq* 2X Master Mix (New England BioLabs). Specific primers for *AVR-Pita1, AVR-Pib, AVR-Pi9,* and *AVR-Pizt,* were tested in this study. The PCR products were separated by 2.0% agarose gel electrophoresis and stained with GelGreen (Biotium).

A total of 22 fields were sampled from 12 counties (Arkansas, Clay, Cross, Drew, Independence, Jackson, Jefferson, Poinsett, Prairie, Randolph, White, and Woodruff). The six diseased rice varieties sampled were RT7521 FP (resistant), Taurus (moderately susceptible), Titan (moderately susceptible), CLM04 (susceptible), Vialone Nano (highly susceptible), and DG353M (unknown). A total of 83 single-spore isolates were obtained and submitted for *AVR* gene detection. All tested *M. oryzae* isolates contained multiple *AVR* genes. *AVR-Pita1*, *AVR-Pib,* and *AVR-Pizt* were detected in all 83 tested isolates, while *AVR-*

Pi9 was found in 82 isolates. These results demonstrate a high frequency of all the *AVR* genes tested so far within the *M. oryzae* isolates collected across Arkansas in the 2024 rice season. The continued sampling of rice fields, investigation of other *AVR* genes, and isolates race assignment utilizing the differential rice varieties over the next years will contribute to a more robust dataset and provide crucial information for breeding and extension programs.

Screening Arkansas Rice Cultivars for Resistance to Leaf Blast

Ferreira, A.C.B., Harris, J., Pedrozo, R., Hardke, J.T., and Nicolli, C.

Blast, caused by the fungus *Magnaporthe oryzae* (*Pyricularia oryzae*), is a major disease affecting rice cultivation leading to substantial yield losses under favorable environmental conditions. In Arkansas, the disease remains a persistent concern, particularly on susceptible rice hybrids and varieties, as severe outbreaks can reduce crop yields and profitabily. This study aimed to evaluate the resistance and susceptibility of rice hybrids and varieties to leaf blast disease under controlled conditions at the University of Arkansas's Rice Research & Station Center in Stuttgart.

124 rice entries from the Uniform Regional Rice Nursery (URRN) and Arkansas Variety Advancement Trial (ARVAT) were tested for leaf blast under controlled conditions. These entries were evaluated against five *P. oryzae* races (IB-1, IB-49, IB-17, IC-17 and IE-1K) with three replications, utilizing the susceptible cultivar M206 and the resistant cultivar Rondo as controls. Plants were inoculated with 20 mL of a spore suspension containing 60,000 spores/mL and placed in a dew chamber for 16 hours. The evaluation process considered two key factors: (1) the total number of infected plants (incidence, %); and (2) the Blast rating, which measures the severity of the disease in the plants. The rating scale ranges from 0 to 9, where 0 indicates highly resistant, 1 resistant, 2-3 moderately resistant, 4-5 moderately susceptible, 6-7 susceptible, and 8-9 highly susceptible. Ratings from 0 to 3 were classified as resistant and from 4 to 9 as susceptible.

Across all five races and 620 plants evaluated, 64.51% (400 plants) demonstrated resistance, while 35.48% (220 plants) were susceptible, highlighting the overall effectiveness of some cultivars in resisting blast disease. Race IB-1 had the highest percentage of resistant plants, with 100% showing resistance. Conversely, race IC-17 exhibited the most susceptible plants, with 33.87% (42 plants) resistant and 66.12% (82 plants) susceptible. Taurus cultivar exhibited high resistance to all the five races tested, while Titan cultivar was susceptible to only race IB-17, underscoring the importance of understanding race-specific interactions and integrating this knowledge into breeding programs. These findings underscore the importance of understanding race-specific interactions and integrating this knowledge into breeding programs. Continued screening and development of rice varieties with broad-spectrum resistance remain critical to managing the evolving threat of blast disease.

Understanding and Managing the Emerging Rice Kernel Smut Disease

Zhou, X.G. and Khanal, S.

Kernel smut (*Tilletia horrida*), once considered a minor disease, has emerged as one of the most economically important rice diseases in the U.S. This disease causes severe losses in both yield and milling quality in various rice varieties, including hybrids, especially during wet cropping seasons. The limited understanding of the pathogen's biology and epidemiology, along with the lack of effective management practices, frequently results in substantial economic losses for farmers. Since 2015, we have initiated a research program focused on rice kernel smut to enhance knowledge of the disease and develop sustainable management methods. This presentation highlights recent findings on the pathogen's genome and genetic diversity, resistance to propiconazole, the impact of fertility practice on disease severity, and the identification of effective fungicides and resistant rice varieties for managing kernel smut.

Draft genome sequences were developed for seven *T. horrida* isolates, representing the first addition of U.S. isolates to the only previously available draft genome sequence from China. A multi-locus sequence analysis of 63 isolates from across the U.S. revealed the presence of four distinct clades, with populations from Mississippi and Louisiana showing the highest genetic diversity. In contrast, Arkansas and California populations exhibited the least diversity, while Missouri and Texas populations were intermediate.

For the first time, resistance to propiconazole was detected in 83% of the sampled isolates from across the U.S., which was confirmed to result from mutations in the CYP51 gene. Fungicide trials indicated that an application of Amistar Top (azoxystrobin plus difenoconazole) was more effective in reducing kernel smut than Tilt (propiconazole). The mid-boot stage was confirmed as the optimal timing for fungicide application, followed by the PD + 7 days stage, while applications at the heading stage were ineffective.

A 2-year field study showed that increasing N application from 179 kg/ha (160 lbs/acre) to 247 kg/ha (220 lbs/acre) significantly elevated kernel smut severity. Field evaluations of 39 rice varieties over two years identified several resistant varieties, including AddiJo and DGL274, while most varieties like CLGemini214, Presidio and PVL03 were susceptible or highly susceptible.

These findings enhance our understanding of *T. horrida* biology and offer practical guidance for managing this emerging disease in rice.

Monitoring Fungicide Resistance in Sheath Blight Across Arkansas Rice Fields

Ronning, B., Harris, J., Pedrozo, R., Rojas, A.R., Hardke, J.T., and Nicolli, C.

Sheath blight, caused by the fungus *Rhizoctonia solani,* is a significant disease affecting rice fields in Arkansas. This pathogen produces sclerotia that can persist in the soil for several years, ensuring its survival and recurrence. Disease is favored by high temperatures and elevated nitrogen fertilizer use, as these factors increase plant susceptibility during rainy season. Due to the lack of effective host plant resistance to the pathogen, disease management primarily relies on chemical fungicides. This study aimed to evaluate the efficacy of the most used fungicide active ingredients azoxystrobin (Quadris®) against *Rhizoctonia solani* isolates collected in Arkansas rice fields during 2023 and 2024 growing seasons. The research was conducted in response to producers' concerns about reduced fungicide efficacy in controlling sheath blight.

Isolates were collected from 12 different counties in 2023: Arkansas, Clay, Desha, Drew, Greene, Jefferson, Lafayette, Lawrence, Lincoln, Miller, Pulaski, and White. In 2024, additional isolates were collected from 7 counties: Conway, Cross, Dauphin, Jackson, Monroe, Poinsett, and Randolph. Symptomatic tissues were used for isolation, and molecular analyses were performed in collaboration with Michigan State University (MSU) to identify the anastomosis group (AG) of each isolate. Fungicide assays were performed using azoxystrobin (Quadris®) to determine the effective concentration required to inhibit pathogen growth by 50% (EC50). The following concentrations were tested: 22,900 µg/mL, 10,000 µg/mL, 1000 µg/mL, 100 µg/mL, 10 µg/mL, 1µg/mL, 0.1 µg/mL, 0.01 µg/mL, and 0.001 µg/mL. Mycelial growth assays were incubated at 25°C in the dark, and EC50 was calculated after four days. Salicylic hydroxamic acid (SHAM) and Propyl gallate (PG) were used to inhibit secondary respiration, ensuring the response specifically to azoxystrobin.

From the 2023 samples, all the 17 isolates were identified as *Rhizoctonia solani* belonging to the AG1-IA group indicating low variability in the presence of anastomoses from other groups in Arkansas rice fields.

In 2024, 15 isolates were obtained, with their anastomosis group currently under identification at MSU. Fungicide assays revealed that isolates from Jefferson, Miller, and Arkansas counties exhibit reduced sensitivity, with mycelial growth observed even at elevated fungicide concentration (22,900 µg/mL). Conversely, isolates from Clay and Lafayette showed high sensitivity, with substantial mycelial growth inhibition observed at concentrations below the minimum tested (0.001 µg/mL). To complete the resistance mapping of *R. solani*, additional samples from symptomatic rice plants will be collected in 2025 from other rice-producing counties. This on-going monitoring is crucial for early detection of changes in resistance dynamics, enabling the development of more effective county-specific management strategies.

Dissecting Genetic Resistance to Narrow Brown Leaf Spot and Cercospora Net Blotch of Rice

Richards, J.K., Gaire, S., Budot, B., Searight, J., Angira, B., and Famoso, A.N.

Cercospora janseana is a fungal pathogen of rice that causes narrow brown leaf spot (NBLS) and Cercospora net blotch (CNB). Typical symptoms of NBLS occur on rice leaves as long, narrow necrotic lesions. CNB symptoms appear on rice sheaths or stems as a net-blotch pattern. Yield losses due to both diseases typically range from 10-40%, but under conducive weather conditions and if a susceptible cultivar is planted, actual losses may be even higher. Both NBLS and CNB are considered late season diseases, therefore, early planting may help avoid disease incidence. These diseases may also be managed through chemical applications, however, fungicide resistance in pathogen populations exists. Host genetic resistance is a viable strategy to control NBLS and CNB, however, relatively little is known about specific resistance loci effective against either disease. The *CRSP2.1* NBLS resistance gene was recently mapped, but the functional resistance gene has not been identified and validated. Additionally, no information on host resistance to CNB currently exists. To address these knowledge gaps, we took a fine mapping and comparative genomics approach to identify *CRSP2.1* candidate genes, as well as developed phenotyping methodology to initiate genetic resistance studies for CNB.

Five recombinant inbred lines derived from a LaGrue (resistant) x Cypress (susceptible) cross were found to be heterozygous across the *CRSP2.1* region. These lines were selfed to produce heterozygous inbred families (HIFs). Over 10,000 $F_{2:3}$ HIF individuals were genotyped with eight single nucleotide polymorphism (SNP) markers which identified 26 recombinants. The critical recombinants were phenotyped under controlled conditions and *CRSP2.1* was delimited to ~230 kb on rice chromosome 2. Comparative genomics analysis using a highly contiguous LaGrue genome assembly and annotation identified six receptor-like kinase genes which are our current top *CRSP2.1* candidates. A genetic transformation protocol has been optimized for LaGrue and CRISPR/Cas9 gene disruption is underway to functionally validate *CRSP2.1*. We also discovered that although *CRSP2.1* provides strong leaf resistance, plants that harbor this gene remain susceptible to CNB. This indicated that *CRSP2.1*-mediated genetic resistance is tissue-specific, and therefore, we hypothesized that CNB resistance is under separate genetic control. To investigate this further, we first developed and optimized sheath inoculation assays. We tested sheath inoculations with conidia and mycelial plugs, as well as with or without wounding. Inoculated plants were incubated in a humid chamber for 21 days and plants were evaluated by measuring lesion length. Our results demonstrated that inoculating wounded plants with mycelial plugs consistently reproduced CNB symptoms. Next, we used this method to screen varieties for CNB resistance and identified rice variety DG263L as highly resistant. LaGrue and PVL03, both having different *CRSP2.1* resistant haplotypes were moderately susceptible and popular varieties Cheniere and Mermentau were highly susceptible. Genetic studies to investigate DG263L resistance are currently underway and will be critical for managing this destructive disease. Taken together, our studies on NBLS and CNB have made progress in identifying functional resistance genes or diagnostic molecular markers and laid the foundation for improving host resistance to both diseases.

Broad-Spectrum Disease Resistance Obtained from Seed-Priming with the Biological Agent A257

Bruno, J.S., Ontoy, J.C., Barphagha, I., and Ham, J.H.

Biological control agent A257 is a naturally avirulent strain of the rice bacterial pathogen *Burkholderia glumae*, which causes bacterial panicle blight (BPB) in rice. Previously, we reported this avirulent strain as 'strain 257sh-1' and elucidated that a single nucleotide polymorphism resulting in an amino acid substitution in the master regulatory gene *qsmR* is the cause of its lost virulence and observed that this avirulent strain inhibited the growth of rice fungal pathogen *Rhizoctonia solani*, the causal agent of sheath blight (ShB). The non-pathogenic and antifungal traits of A257 make it recognized as a potential biological control agent for major rice diseases.

In this study, two years of field trials demonstrated that A257 effectively suppressed BPB when applied as a foliar spray. Further greenhouse and field trials showed that seed treatment with A257 significantly increased rice resistance to ShB as well as BPB. Additionally, rice plants grown from A257-treated seeds exhibited significantly fewer symptoms of narrow brown leaf spot (NBLS), a serious disease problem in Louisiana caused by the fungal pathogen *Cercosposra janseana*. This result strongly suggests that the effect of A257 seed treatment on rice disease resistance extends beyond the early growth stages, given the common occurrence of NBLS later in the growing season. These findings suggest that A257 can be utilized as a versatile biological agent to suppress a wide range of rice diseases through seed treatment. Moreover, we developed a mutant derivative of A257, named A257ΔqsmR, to eliminate the risk of regaining pathogenicity through single nucleotide substitution. Greenhouse tests indicated that this mutant derivative maintains comparable disease suppression efficacy against ShB, offering a safe alternative for disease management.

Seed Endophytic Bacteria: A New Tool for Protecting Rice from Seedling Blight Pathogens

Khanal, S., Antony-Babu, S., and Zhou, X.G.

Seedling blight is an important disease in rice, particularly affecting dry-seeded rice, the predominant rice production method in the southern US. This disease can lead to substantial stand losses. Seedling blight is caused by several fungal pathogens, with *Rhizoctonia solani* as the primary pathogen. While conventional growers often manage the disease with fungicide seed treatment, organic farmers face challenges due to the unavailability of effective seed treatment options. Biocontrol agents offer a promising and sustainable approach to managing seedling blight in rice, particularly organic rice. Integrating biocontrol agents with synthetic fungicides can enhance efficacy and minimize environmental impact. Microbial communities within seeds play an essential role in promoting germination and increasing resilience to both biotic and abiotic stresses. These seed-associated microbes also serve as a natural defense against various soil and seed-borne pathogens. Endophytic bacteria within seeds, particularly those with antifungal properties, offer a stable biocontrol option for safeguarding seedlings. This study aimed at identifying potential biocontrol agents against seedling blight pathogens, with a focus on naturally occurring endophytic bacteria within rice seeds.

Seed endophytic bacteria were isolated from rice seeds cultivated through organic or conventional farming systems. The isolates were identified by16S rRNA gene sequence characters at a >97% similarity as the same "species". Representative isolates from each species group were selected for screening for their antagonistic activities. *In vitro* assays were conducted to assess the *in vitro* biocontrol effects of selected bacterial isolates against three seedling blight pathogens: *R. solani* AG11, *R. solani* AG4, and *Marimus* *graminum*. Bacterial isolates demonstrating *in vitro* activity were subsequently evaluated under greenhouse and field conditions against *R. solani* AG11 and *R. solani* AG4, the two most prevalent pathogens causing seedling blight. Cruiser Maxx Rice, a standard commercial fungicide seed treatment, served as the positive control.

A total of 85 endophytic bacteria were isolated from rice seeds, and subsequent 16S rRNA sequence analysis classified them into 10 genera and 31 unique "species". Among these, *Bacillus* sp. ST24, *Burkholderia* sp. OR5, and *Pantoea* sp. ST25 exhibited antagonistic activities against all three seedling blight pathogens. However, *Burkholderia* sp. OR5 was found to hinder seed germination. In greenhouse trials, seeds treated with *Bacillus* sp. ST24 or *Pantoea* sp. ST25 significantly reduced the diseases caused by *R. solani* AG4 and *R. solani* AG11, achieving control efficacy levels comparable to the Cruiser Maxx treatment. In field trials, seed treatment with *Bacillus* sp. ST24 or *Pantoea* sp. ST25 also mitigated stand loss from *R. solani* AG11 and *R. solani* AG4, although efficacy did not reach the levels observed with the Cruiser Maxx treatment in preventing stand loss. These results highlight the potential of utilizing naturally occurring seed endophytic bacteria as biocontrol agents for managing seedling blight pathogens in rice.

Elucidating the Role of Seeds as Primary Inoculum Source of *Pantoea ananatis* in Rice Production

Pedrozo, R., Huang, Y., Nicolli, C., and Jia, Y.

The seedborne nature of *Pantoea ananatis* might pose a significant challenge to global rice production, with implications for crop yield and disease management. This study investigated naturally contaminated rice seeds as a primary inoculum source for *P. ananatis*, focusing on three rice varieties: JiBoYa, Pratao, and Branco de Brejo. Laboratory and greenhouse experiments were conducted to assess the incidence of seedborne contamination, its impact on seedling vigor, the development of leaf blight symptoms in adult plants, and its effect on seed production.

The incidence of seedborne *P. ananatis* was determined using Pantoea-Genus Species Agar (PGSA). Seeds were surface sterilized with 70% ethanol (v/v) for 1 minute, followed by a 1-minute treatment in 10% hypochlorite (v/v), and double rinsed with sterile water. Twenty seeds from each variety were incubated at 28°C for seven days. Suspicious bacterial colonies surrounding the seeds were analyzed via colony PCR to confirm the bacterial identity. JiBoYa exhibited the highest incidence of contamination, followed by Pratao and Branco de Brejo. In greenhouse trials, seed emergence rates were high across all varieties (100% for JiBoYa and Pratao, and 93% for Branco de Brejo). Leaf blight symptoms became apparent around 60 days post-planting (d.p.p.) and intensified over time. JiBoYa was the most affected, with all plants showing bacterial leaf streak symptoms by 120 d.p.p. In contrast, nearly all Pratao and Branco de Brejo plants also exhibited symptoms by this stage, though symptom severity was slightly lower. Second-generation seeds were harvested from infected plants, revealing significant differences ($p < 0.005$) in seed yield across varieties. JiBoYa produced the lowest seed yield, averaging just 0.14 grams per 10 plants, while Pratao and Branco de Brejo averaged 1.8 grams and 2.8 grams, respectively.

Future efforts in 2025 will build on these findings by leveraging advanced molecular techniques to characterize the genetic factors underlying strain virulence and host specificity. Whole-genome sequencing of the isolated strains will identify pathogenicity determinants and establish genetic markers for early detection. Additional rice varieties will be screened to expand the understanding of *P. ananatis* distribution and to enhance the rice-related strain collection at USDA-ARS Dale Bumpers. This research aims to develop practical strategies for managing *P. ananatis* in rice, ensuring crop resilience and sustainability among growing global demand. By addressing the complex interactions between seedborne pathogens and their hosts, these efforts will contribute to food security and sustainable agricultural practices.

Factors Associated with Development of Sheath Blight on Field Experimental Settings

Borges, B.R.C., Borges, K.L.R., Angira, B. Famoso, A.N., and Dalla Lana, F.

Despite the best effort, host resistance to sheath blight (SB) is still limited, with no major resistance gene identified yet. To improve the breeding for SB resistance, it is fundamental to optimize our capacity to accurately phenotype the disease. However, field studies for SB are often challenged by spatial and temporal variability. The aim of this study is to explore the use of temporal and spatial variation correction to improve the experimental results in small plots studies for SB resistance.

During the 2024 season, a subset of 241 long grain lines from Breeding Germplasm Panel was planted on two environments, defined by different planting dates (March 15 and April 26). The study was conducted in a randomized complete block design with two replications, on plots of 1.80 m x 0.6 m (3 rows) plus a common border. Each field was equally divided into twelve zones for soil analyses of pH, P, K, Ca, Mg, S, Cu, Na, Zinc, and Organic Matter. Weather data were collected using weather stations measuring wind speed/direction, precipitation, PAR light, temperature, humidity, dew point, and leaf wetness. In addition, fields received wireless sensors to record temperature, humidity, and dew point. Fields received between five and six wireless sensors, where each sensor covered an area of around 67 m^2. Plots were inoculated with *Rhizoctonia solani* at green ring stage to promote disease development.

Disease severity was scored visually four to five times on each trial from 15 to 70 days after inoculation. Severity was estimated based on the average high of SB lesion, ranging from 0 (no symptoms) to 9 (whole plant diseased). The Area Under the Disease Progress Curve (AUDPC) was calculated to summarize disease intensity over time. The preliminary results from 2024 showed that P and Na varied ($P < 0.05$) among zones within all fields. Significant micro-climate variability in temperature and humidity was observed between and within fields ($P < 0.001$). The weather stations beside the fields always presented statistically lower levels of humidity and temperature when compared to sensors within the field. The highest disease variability between genotypes was observed 50 to 58 days after inoculation. The first trial's AUDPC values ranged from 26.5 to 269, while the second trial ranged from 59.1 to 320. Notably, L202 is the least susceptible overall, with AUDPC of 26.5 in first planting and 67.1 in the second planting. CLL17 was, overall, the most susceptible, with an AUDPC of 269 in the first planting and 301 in the second planting. Future studies will expand analysis of the small-scale environmental variability to include multispectral and thermal images captured by drones and genetic markers.

Cover Crops Reduce Yields but Not Pest Populations in the First Year of Rice Production

Gambino, C., Wilson, B.E., and Stout, M.J.

Winter cover crops are recognized for their agroecological and economic benefits, but their impact on rice systems remains underexplored. While traditional U.S. rice production relies heavily on pesticides and fertilizers, cover crops offer an alternative that may improve soil health and reduce input reliance. To investigate the role of cover crops in rice rotations, we designed an experiment using a cover crop mixture of Austrian winter pea, *Pisum sativum*, (54.92 kg/ha), sodbuster radish, *Raphanus sativus*, (3.36 kg/ha), and cosaque black oats, *Avena strigosa,* (16.81 kg/ha), planted in October 2023. Control plots were left fallow for comparison. The cover crops were chemically terminated in February 2024, and PVL03 was no-till drill-seeded in March 2024, at the H. Rouse Caffey Rice Research Station. Nitrogen (N) was applied at rates of 0, 112, 280, and 448 kg N/ha at the 3-leaf stage. The experimental design followed a split-split-plot factorial structure, with cover crop presence, nitrogen rate, and insecticide seed treatment (IST) as the main factors. This study was replicated three times. Arthropod diversity and pest pressure were assessed by soil core samples for rice water weevil (L. oryzophilus) and whitehead collection from stem borer infestations.

This study is part of a three-year project to assess the long-term effects of winter cover crops on rice production systems. Preliminary results from the first year indicated that while pest pressure, including infestations from *Lissorhoptrus oryzophilus* and Lepidoptera: Crambidae, was insignificant, the use of cover crops led to a decrease in rice yield compared to the fallow control plots. Further analyses across the remaining two years will provide more comprehensive insights into the effects of cover crop integration on yield and other agroecological outcomes.

Evaluation of Pyrethroid Susceptibility in Mid-South Rice Stink Bug Populations

Lytle, M.J., Cook, D.R., Crow, W.D., Towles, T.B., Bond, J.A., Gore, J., Catchot, A.L., Bateman, N.R., Floyd, C.A., Chlapecka, J.L., and Bernaola, L.

Rice stink bug, *Oebalus pugnax* (F.), is an injurious late season insect pest of rice (*Oryza sativa* L.) Rice stink bug has the potential to cause direct yield loss due to kernel development being restricted, as well as profit loss resulting from damaged and discolored kernels receiving a lower grade when the rice is sold. From 2021-2024, laboratory bioassay experiments evaluating the efficacy of pyrethroids on Mississippi rice stink bug populations were conducted at the Delta Research and Extension Center in Stoneville, MS. The study consisted of liquid scintillation vials each treated with technical grade lambda-cyhalothrin at various concentrations and a nontreated control. Technical grade lambda-cyhalothrin was diluted in acetone and 0.5 milliliters was pipetted into each vial. The vials were placed onto a commercial hot dog roller with the heating element disabled and allowed to roll until the acetone had evaporated, leaving only the appropriate lambda-cyhalothrin dose in each vial. Lambda-cyhalothrin was chosen as a representative of the pyrethroid class due to its popularity with Mississippi rice producers. Rice stink bug populations were collected throughout southern U.S. rice growing states and one rice stink bug was placed in each vial. 24 hours following vial infestation, mortality ratings were taken. Percent mortality data suggests that populations of rice stink bug exhibit increased tolerance to pyrethroids at previously lethal doses. Profit losses resulting from rice stink bug feeding emphasize the need for effective control options in order for rice producers to remain economically sustainable.

A Meta-Analytic Study of Five Decades of Sheath Blight Chemical Control in Louisiana

Mohottige, D. and Dalla Lana, F.

Sheath Blight (SB), a rice disease caused by the fungus *Rhizoctonia solani* AG1, can lead to severe yield and grain quality losses. Host resistance to the disease is limited and often ineffective to provide adequate control. Therefore, growers rely on fungicide applications to maintain control of the disease on fields heavily infested. Fungicide efficacy trials for sheath blight control are being conducted at the LSU Rice Research Station for over 50 years. These studies, although independent and with different goals, share common methodology and often same fungicide treatment. Meta-analysis is a statistic procedure used to combine independent studies giving different weight for each based on its variability. In this study, we applied a meta-analytic approach to explore a subset of the data to explore the yield return of the fungicide azoxystrobin (azox) applied at panicle differentiation plus seven days (PD7), boot (B), and heading (H), using rates of 0.1, 0.15, and 0.2 lb ai/A on the control of SB. We use a multivariate mixed model meta-analysis and mean difference as effect size, using the untreated check as baseline control. From 1977 to 2020, 233 trials studied fungicide control of SB, but only 109 contain the treatment on interesse for this preliminary analysis. The results show yield increases ranging from 851 to 1292 lb/A with a fungicide application, with 0.15 lb ai/A of azox at H stage generating the lowest yield return and 0.2 lb ai/A of azox at PD7 stage having the highest return. Contrast estimations indicate that applications at H stage generate a yield increase 581 lb/A and 277 lb/A higher than applications at B and PD7 stage respectively, although P-values were not significant. Further analysis will expand the active ingredients and include moderator variables, such as variety disease reaction classifications and weather conducive for disease development. Results of this study can be used in the decision-making process to select the fungicide active ingredient, the rate, and the application timing based on all available scientific evidence.

Investigating the Molecular Mechanisms via Which the Plant Growth-Promoting Bacterium, *Azospirillum brasilense*, Improves Growth in Salt-Stressed Rice

Neuhaus, D., Calhoun, M., Hoggard, S., Fritz, H.G., Gilkey, A., Long, S., Bommes, A., and Mukherjee, A.

Major food crops, such as rice and maize, display severe yield losses (30-50%) under salt stress. Furthermore, problems associated with soil salinity are anticipated to worsen due to climate change. Therefore, it is necessary to implement sustainable agricultural strategies, such as exploiting beneficial plant-microbe associations, for increased crop yields. Plants can develop associations with beneficial microbes [e.g., mycorrhiza, plant growth-promoting bacteria (PGPB)]. PGPB improve plant growth via multiple mechanisms, including protection against biotic and abiotic stresses. *Azospirillum brasilense*, one of the most studied PGPB, can mitigate salt stress in different crops. However, little is known about the molecular mechanisms by which *A. brasilense* mitigates salt stress. Previously, we established an experimental system in which *A. brasilense* inoculation improved plant mass in rice grown under high salt concentrations (100 mM and 200 mM NaCl), seven days post-inoculation (dpi). We hypothesized that *A. brasilense* inoculation would regulate the expression of rice genes involved in salt-stress response, nutrient and ion transport, and abscisic acid and jasmonic acid signaling, among others. Using RNA sequencing, we identified the transcriptomic changes in rice plants during *A. brasilense*-mediated salt stress tolerance at seven dpi. Our results identified key gene expression patterns in rice via which *A. brasilense* help improve growth in rice. To identify the early plant transcriptomic changes in salt-stressed rice upon *A. brasilense* inoculation, recently we completed an RNA-seq experiment and are currently analyzing the results. In this study, we expect to identify differentially expressed genes in salt-stressed rice involved in the initial perception and response to *A. brasilense*. Our findings will provide essential insights into salt stress mitigation in rice by *A. brasilense*.

Integration of Host Genetic Resistance and Fungicides to Control Cercospora in Rice

Pereira, J. S., Pedrozo, R., Hardke, J.T., and Nicolli, C.

Rice (*Oryza sativa* L.) is an important crop in the United States, especially in the southern region, where the leading rice-producing states are located. However, the productivity and performance of rice plants are often challenged by various biotic factors, including fungal diseases. Among these, the fungus *Cercospora janseana* pose a significant threat, causing symptoms on different plant structures: Narrow Brown Leaf Spot (NBLS) on leaves, Cercospora Net Blotch (CNB) on sheaths, and Cercospora Panicle Blight (CNP) on panicles. Recently, Cercopora has re-emerged as a problem in Arkansas, with increasing reports of its symptoms. This resurgence highlights critical gaps in our understanding of the pathogen's behavior and effective management strategies. Given its sporadic occurrence in the past, there is limited guidance available on mitigating its impact. Therefore, the present study aimed to analyze the integration of genetic resistance and fungicide application to controlling Cercospora in rice.

The experiment was conducted in a factorial design using the cultivars PVL03, CLL19, and RT7521FP, with two treatment conditions: control and propiconazole fungicide (Tilt®) applied at early boot, mid boot, and late boot stages. Two Arkansas locations were used in this study. The experimental layout followed a randomized block design with four replications. Fungicide applications were conducted at the above predetermined stages at rate of 730.20 mL/ha (10 fl oz/acre). Natural pathogen infection occurred, and symptoms were assessed by sampling 50 plants per plot, recording the number of infected plants to estimate incidence (%), as well as the number of lesions per plant and lesion size. Grain yield was determined after harvest and reported bushels/acre and converted to kg/ha. Statistical analysis, including analysis of variance, Tukey's test for mean comparison, and Pearson correlation between variables were performed using R software.

CNB was the only symptom observed at both trial locations. Significant differences were noted among cultivars, with RT7521FP exhibiting the highest CNB incidence (11.62%). Fungicide application timing also influenced disease management outcomes. For the CLL19 cultivar, propiconazole was most effective when applied at early boot, whereas PVL03 showed greater efficacy with mid-boot applications, though early boot applications also yielded satisfactory results. In RT7521FP, mid-boot applications provided the best CNB control. The grain yield was higher in the treatments with fungicide. Pearson's correlation analysis revealed a strong positive correlation ($r = 0.90$) between disease incidence and lesion number for CNB, indicating that increased pathogen incidence leads to more lesions. This damage has the potential to impact yield under severe conditions. Additional trials are planned for the 2025 season to further evaluate the impact of Cercospora on rice production.

Elucidating the Key Volatiles Involved in Rice-Rice Stink Bug Interactions

Santos, L., Stout, M.J., Glassmire, A.

Understanding the interactions between plants and insects is important to better manage pests in the field. The rice stink bug *(Oebalus pugnax)* (RSB) affects rice plants by reducing yield and quality of the grain. In rice-growing areas in the US, sweep sampling is the main tool used to establish population levels and implement treatment thresholds. Strategies such as weed control, biological control and use of pesticides are ways to reduce source populations of RSB. Knowledge of the volatiles emitted by developing rice grains can help in detecting infestation. The goal of this study is to improve knowledge of the key volatiles emitted by different stages on rice plants differ, that feeding by stink bugs changes the volatiles emitted by rice panicles, and the volatiles emitted by rice attract RSB. Three rice varieties (medium-grain: Jupiter, long-grain: Cheniere, aromatic: CLJ01) were studied across three panicle stages: early flowering, milk (10–14 days post-flowering), and dough (7–10 days post-milk). A total of 54 samples were analyzed, with six replicates for each stage and variety. Volatiles were collected using a system pull method with a 4-hour collection duration. Samples were analyzed using GC-MS (Thermo Fisher TRACE 1310 and ISQ 7000) with a temperature program of 40°C (4 min), ramped at 8°C/min to 280°C, and held for 3 minutes. Nonanal (30 µl, 0.88 µg/ml final concentration) was used as an internal standard. Volatile amounts were calculated relative to the IS area. As results we found that volatile emission by rice panicles differed at different stages of panicle maturation.

Investigating the Effect of Silicon on the Occurrence of Rice Insect Pests Using *OsLsi1* Rice Mutants Under Field Conditions

Sharma, J., Tai, H.T., and Stout, M.

Silicon (Si) has been associated with enhanced plant defenses against various insect pests. We carried out field trials to examine the effect of Si on the occurrence of insect pests and diseases using *OsLsi1* rice mutants. To examine this, we utilized two silicon transporter (*OsLsi1*) mutants with varying levels of Si uptake (one ~55% deficient in the uptake of Si, and the second with uptake similar to the wild type) and compared to the wild-type rice cultivar Nipponbare. The mutant 55% deficient in the uptake of Si accumulates a lower amount of Si at each growth stage as compared to the wild type. Our experimental design was a randomized complete block design that included the rice mutant genotypes, silicon fertilizer, and seed treatment. During the field trials, we measured the densities of rice water weevils, populations of rice stink bugs, and the presence of stem borers to evaluate the effects of Si on insect pests, as well as on rice growth and production. The preliminary result showed the positive effect of Si on plant growth but few effects on insect pests. This study helps to examine the implications of Si in developing integrated pest management strategies.

ABSTRACTS OF PANEL POSTERS:
PLANT PROTECTION
Moderator: Blake Wilson

Disease Loss Estimates from the Rice Producing States in the United States: 2023 and 2024

Allen, T.W., Dalla Lana, F., Nicolli, C., Espino, L., Chlapecka, J.L., Floyd, C.A., and Zhou, X.G.

Compiling disease loss estimates for the major rice diseases is an important effort to determine the potential yield losses that occur as a result of important plant diseases. Even though rice hectares in the southern U.S. and California are rather limited compared to some of the other row crops, plant diseases continue to be an economic concern. In 2023 and 2024, plant pathologists with rice Extension and research responsibilities continued to add to their effort to compile loss estimates for their respective states. Prior to 2018, disease loss estimates were not compiled for rice, making it the only major row crop not conducting this annual effort. Not only do disease loss estimates help farmers understand the potential of plant diseases, but they help researchers plan for future research needs. In addition, collating the loss estimates helps track the importance of major plant diseases should large reductions or increases occur over time. Annually, a spreadsheet is circulated to scientists with rice pathology responsibilities with a list of 16 of the most important rice diseases (autumn decline, bacterial panicle blight, bakanae, blast (leaf and neck), brown spot, Cercospora stem disease(s), crown sheath rot, false smut, kernel smut, narrow brown leaf spot, seedling diseases, sheath blight, stem rot, straighthead, and a category marked as "other" to include diseases of importance that may have occurred within a specific state that were not included in the list). Estimates were made by rice pathologists, or the state specialist with rice responsibilities in the absence of a pathology contact. Multiple techniques were employed to arrive at estimates but were based on field-level experience with each of the diseases that were based on observation of cultivar trials, fungicide efficacy trials, or answering rice farmer troubleshooting calls in commercial rice fields related to each of the diseases. The additional category of Cercospora stem disease(s) was added for the 2023 season following increased observation of the disease in the southern U.S.

In 2023, rice diseases accounted for an estimated total of 4.2% rice production losses. Similar to previous years, the greatest losses were observed as a result of sheath blight, caused by *Rhizoctonia solani*. Two diseases, Autumn decline and bakanae were both reported to have no losses associated with them during the 2023 season. The top five yield-reducing diseases based on percent yield suppression across the entire rice producing area during the 2023 season were: Sheath blight, neck blast, Cercospora steam disease(s), seedling diseases, and bacterial panicle blight. Considering total disease losses by state, sheath blight was the most important disease with estimated losses of between 1.0 and 2% from Louisiana and Texas, respectively. The greatest total estimated losses were observed to occur in Texas (6.3%), followed by Arkansas (5.7%), and California (5.0%), with the lowest estimates of loss in Missouri (1.5%).

In 2024, rice diseases accounted for an estimated total of 5.8% loss of the total U.S. rice production. Similar to 2023, as well as several additional previous years, the greatest losses were observed as a result of sheath blight, and the disease with the least impact on the rice production area included four diseases with no losses observed (Autumn decline, bakanae, false smut, and straighthead). The top five yield-reducing diseases based on percent yield suppression across the entire rice producing area during the 2021 season were: Sheath blight, Cercospora stem disease(s), narrow brown leaf spot, neck blast, and leaf blast. On a state basis, sheath blight was the most important disease with estimated losses of between 0.5% and 4.5% from Missouri and Texas, respectively. The greatest estimated losses were observed to occur in Texas

(11.1%), followed by Louisiana (10.6%), and Arkansas (6.0%), with the lowest estimates of loss in California (2.0%).

In 2023, the total number of hectares devoted to rice accounted for 1.15 million hectares versus only 984,600 hectares in 2021. Between the two years, a slight increase of 1.5% in the total number of hectares occurred with an increase between 2023 and 2024. Total rice production, averaged across the six rice producing states, accounted for 11,403 kg/ha in 2023 as compared to 11,198 kg/ha in 2024. Between 2023 and 2024, a 1.8% reduction in average rice production across the entire rice producing area was observed.

Host Resistance and Fungicide Strategies for Cercospora Diseases in Rice

Cerutti, A. and Dalla Lana, F.

Narrow Brown Leaf Spot (NBLS), Cercospora Net-Blotch (CNB), and Cercospora Panicle Blight (CPB). NBLS manifests as narrow, linear, dark brown lesions on leaves, which impair the plant's ability to photosynthesize. CNB appears on the sheaths, displaying a net-like pattern of brown and yellow discoloration that weakens the plant's structure. CPB, the most severe symptom, affects the panicles, leading to premature grain maturity, reduced grain quality, and, in extreme cases, plant lodging due to weakened stems. A breakthrough in rice breeding was the identification of the CRPS2.1 gene, which provides resistance to NBLS, the most widespread and studied symptom caused by C. janseana. However, this genetic resistance does not protect against CNB or CPB, leaving rice plants susceptible to these other forms of infection. To assess these vulnerabilities, eight rice varieties were evaluated. Four varieties carried the CRPS2.1 gene (DG263L, Jupiter, PVL03, and Titan), while the other four lacked it. Among the non-CRPS2.1 varieties, three (Cheniere, Mermentau, and CLL19) were moderately susceptible to NBLS, and one (CLJ01) showed moderate resistance. All varieties, except Mermentau and Titan, were treated with two fungicide programs: one applied early in the boot stage (EB) and the other later (LB), both using propiconazole (20 g ai/ha). These treatments, along with the genetic background of the varieties, were tested across three environments. Key outcomes such as the incidence of CNB, the severity of NBLS and CPB, lesion size, grain yield, and milling quality were measured. The findings revealed that genotype and environment were the most influential factors, both showing highly significant effects ($p < 0.001$). The timing of fungicide application had a marginally significant impact ($p = 0.09884$), indicating a slight effect. Importantly, the interaction between genotype and environment was also highly significant ($p < 0.001$), highlighting that genotypes respond differently depending on environmental conditions. However, interactions between fungicide timing and genotype or environment were not significant, nor was the three-way interaction among fungicide timing, genotype, and environment ($p = 0.77392$). This suggests that fungicide timing operates largely independently of the genetic and environmental factors influencing the plants.

Effect of Tadpole Shrimp on the Establishment of Rice and Weeds

Brim-DeForest, W., Espino, L., Clark, T., Grettenberger, I., Baez Vega, C., and Guan, T.

Tadpole shrimp (*Triops longicaudatus*) (TPS) is a common arthropod pest in California rice fields. Tadpole shrimp can affect rice seedlings as they germinate. Consumption and uprooting of seedlings are the primary factors leading to reduced rice stands and ultimately lower yields. Injury can occur until seedlings reach the first or second true leaf stage. The most common control method is the application of pyrethroid insecticides.

Studies at the Rice Experiment Station in Biggs, CA have shown that rice seedlings can escape TPS injury when fields are seeded soon after flooding (1-3 days). This timing allows for the rice to establish a stand before the TPS are large enough to cause injury to the seedlings. Field observations have shown that TPS also consume germinating weeds. This study aims to determine if TPS weed consumption can be utilized as part of an IPM strategy to reduce weed pressure in California rice fields.

Trials were conducted in 2023 and 2024 in a basin with a history of high TPS pressure at the Rice Experiment Station. Four treatments in a randomized complete block design with four replicates were used to study the effect of TPS on establishment of weeds and rice: TPS present and herbicides applied, TPS present without herbicides applied, TPS absent and herbicides applied, and TPS absent and no herbicides applied. Data collected were TPS size and density, rice stand counts, percent rice and weed canopy cover, fresh and dry weight biomass, and grain yield.

Plots with no TPS and no herbicides had the highest weed canopy coverage, reducing rice canopy cover by 44 and 48% 30 days after seeding (DAS) and by 93% and 56% 69 DAS in 2023 and 2024, respectively. Plots which had TPS and no herbicides had a reduction in percent rice canopy cover of 33% and 18% 35 DAS and 62 and 4% 69 DAS in 2023 and 2024, respectively. Stand counts in plots which had TPS with herbicides were 35 and 33 plants/0.09 m^2 in 2023 and 2024, respectively, while plots that had no TPS with herbicides had 43 and 41 plants/0.09 m^2 in 2023 and 2024, respectively. In 2023 and 2024, plots that received herbicides and had no TPS had the highest yields (8,453 Kg/Ha. & 9,815 Kg/ Ha), while plots with TPS present and treated with herbicides had the second-best yields (7,074 Kg/ Ha & 9,789 Kg/Ha).

Parasitism of True Armyworm in Rice Fields

Espino, L. and Varela, V.

The armyworm, *Mythimna unpuncta*, can be a significant pest of rice in California when larval populations reach high levels. In the past few years, armyworm populations have varied widely, with densities ranging from very low to high. Pheromone traps show that moth populations can vary as well, but there is no correlation between moth and larval densities. Many factors affect the relationship between moth and larval densities. One of them is larval parasitism. Two armyworm parasitoids documented in rice fields are the wasps *Apanteles militaris* and *Hyposoter exiguae*. However, their parasitism rates and temporal variation have not been determined.

During 2024, armyworm larvae were collected weekly between June 11th and August 22nd from rice fields in Butte and Glenn counties. A total of 1,000 larvae were placed on artificial diet and reared on an incubator at 25 ºC until a parasitoid or moth emerged. Armyworm mortality rate was 20%. Five parasitoid species were recovered, *A. militaris* (7.8%), *H. exiguae* (0.5%), small (11.4%) and large (1.9%) tachinid flies, and an ichneumonid wasp recovered only once (0.1%), The small tachinid fly and *H. exiguae* were recovered from the first larval armyworm generation, while *A. militaries* and the large tachinid fly were recovered from the first and second larval generations. Parasitism rates were similar across collection locations, ranging from 17.6 to 27.5%.

Yield Reduction in Rice Due to Stem Rot in California

Espino, L. and Brim-DeForest, W.

Stem rot, caused by the fungus *Sclerotium oryzae*, is a common disease of rice in California. When severe, the disease can produce panicle blanking and lodging, reducing yields and interfering with harvest. Stem rot lesions appear on tillers at the water level mid-season and are most noticeable when fields are drained for harvest. Lesions may not be detected because they remain under the canopy.

Eleven fungicide trials conducted between 2017 and 2022 were used to estimate the effect of stem rot severity on yield. When trials were drained for harvest, tiller samples from fungicide treated and untreated plots were cut at the water level and 30 to 50 tillers per plot rated using a severity scale that ranged from 0 to 4. Zero corresponded to no stem rot lesions present on the tiller, 1 was when lesions were only present on the outer leaf sheath, 2 when lesions had penetrated into inner leaf sheaths, 3 when lesions were present in the culm, and 4 when the culm was rotted through. Regression of rice yield against stem rot severity per plot showed that rice yield decreased an average of 328 kg/ha for every unit increase in the stem rot severity scale, or 3.2% of the predicted maximum yield. Monitoring and management of stem rot to avoid negative effects on yield will be discussed.

Management of Rice Seed Midge in California Rice

Grettenberger, I., Goding, K., and Espino, L.

Rice seed midge are sporadic pests whose larvae feed primarily on rice seeds and seedlings, resulting in seed death and seedling damage. Midges have especially high damage potential in late-planted fields and cool seasons as the abundant midges have more time to feed on the slow-germinating seeds. They have become problematic in California in some fields under certain conditions and can lead to early season stand loss. Through this work, we evaluated the effectiveness of various insecticides against midges in field trials. We tested materials typically used early in the season, including pyrethroid and growth regulator modes of action, as well as a *Bt israelensis*-based material. The trials started approximately 10-12 days after the last rice in the area was planted. We used a combination of small plots with one meter in diameter metal rings and larger bermed plots. We conducted substrate sampling in each ring to evaluate midge populations. We have found that lambda-cyhalothrin, a pyrethroid typically used for other early-season pests in rice, does not provide sufficient control. A number of other materials did provide good control, although we did find variability in efficacy. *Bt israelensis*, at multiple rates, was very effective. Results from this study will help inform the management of midges as an early-season rice pest.

ABSTRACTS OF PAPERS FROM PANEL ORAL PRESENTATIONS: WEED CONTROL AND GROWTH REGULATION

Panel Chair: Connor Webster

Moderator: Connor Webster

Commercialization of a Fenclorim Seed Treatment: What are the Benefits for Midsouth Rice Growers?

Norsworthy, J.K., Avent, T.H., and Baxley, R.C.

The profitable production of rice in the mid-southern U.S. is threatened by the ongoing evolution of herbicide resistance in economically problematic weed species. Weeds such as barnyardgrass (*Echinochloa crus-galli*) have become resistant to several of the primary conventional rice herbicides that were once effective. Consequently, Arkansas growers spend approximately 81% of their average yearly herbicide expenses on most likely ineffective applications. Weedy rice (*Oryza sativa*) is challenging to control because it is closely related to rice grown for commercial production. Therefore, the lack of control by conventional rice herbicides requires planting herbicide-resistant technologies. However, outcrossing between the rice of these technologies and weedy rice can allow for the accumulation of resistance to herbicides used in these systems.

Methods of crop protection for rice are currently being evaluated regarding the ability to allow the application of herbicides registered for use in other crops. Herbicides of particular interest include inhibitors of the 4-hydroxyphenyl pyruvate dioxygenase (HPPD) and very-long-chain fatty acid elongase enzymes. However, because of the unacceptable injury that would follow the application of these herbicides to rice, measures must be implemented to prevent or mitigate phytotoxicity. Herbicide safeners, such as fenclorim, can protect the crop. For more than five years, weed scientists with the University of Arkansas System Division of Agriculture have evaluated fenclorim as a seed treatment for reducing or preventing phytotoxicity in rice caused by herbicides in more than 50 small-plot field and greenhouse trials. Through this research, it has been documented that commercial safety to microencapsulated acetochlor (Warrant®) applied delayed preemergence can be obtained on silt loam and clay soils when the crop seed is treated with fenclorim at 2.5 g/kg seed. Microencapsulated acetochlor applied delayed preemergence in rice, regardless of the presence or absence of a herbicide-tolerance trait, has been shown to aid the control of weedy rice and barnyardgrass populations resistant to other herbicides. The fenclorim seed treatment does not provide commercial safety to similar herbicides such as *S*-metolachlor (Dual Magnum®) or pyroxasulfone (Zidua®). Additional benefits include some safening to selected HPPD-inhibiting herbicides, reduced injury caused by preemergence-applied clomazone (Command® 3ME), and enhanced root and shoot growth. UPL has announced its intent to commercialize fenclorim in rice, which should aid weed management, particularly barnyardgrass control. The registration of Warrant or other microencapsulated formulations of acetochlor, such as Arrest CS or Enversa™, in rice, is not expected currently. Additional seed treatments and herbicide chemistries will continue to be evaluated, and protecting the intellectual properties identified is critical to commercializing safeners in rice and other crops.

Watergrass (*Echinochloa* spp.) in California: Management and Identification

Brim-DeForest, W., Guan, T., Clark, T., and Baez Vega, C.

For the past several years, late watergrass, barnyardgrass, and now Walter's barnyardgrass (*Echinochloa* spp.) have been increasingly challenging to control late in the season, and our options for follow-up foliar applications in California rice are limited, resulting in widespread usage and reliance on propanil. Propanil is one of the most widely used herbicides in California rice due to its effective wide-spectrum control of various weeds present in our systems. Several weed species, including watergrasses, smallflower umbrella sedge, and ricefield bulrush have been found to have propanil resistance, likely due to over-reliance on propanil as a final clean-up spray. Furthermore, overapplication, both over the allowable label rate and the use of multiple applications in close succession over one season, have now made it likely that the herbicide resistance will continue to spread. There is also concern that this usage pattern may result in changes to the registration and allowed use patterns of propanil in rice in California, as the label has already been pulled once, and re-registration a second time seems unlikely if the label is pulled again.

A three-year field trial has been conducted from 2022-2024, consisting of one trial in 2022, five trials in 2023, and five trials in 2024, in grower fields throughout the Sacramento Valley, as well as one trial (in both 2023 and 2024) at the California Rice Experiment Station in Biggs, CA. The treatments varied slightly over the three years, but consisted of an untreated control and 7-15 herbicide treatments of varying rates and combinations with the herbicides: propanil, thiobencarb, carfentrazone, florpyrauxifen-benzyl, cyhalofop-butyl, bispyribac-sodium, halosulforon, and benzobicyclon in varying tank mix combinations as well as applied in close succession. The purpose of the tank-mixes or herbicides applied in close succession is to overwhelm the metabolic resistance present in these species. In 2022, treatments consisted of propanil tank mixes with other herbicides. In 2023-2024, half of the treatments contained propanil, and the others contained bispyribac-sodium as the base tank mix partner herbicide. In 2024, two additional treatments were added to Applications were made at the 5-leaf stage to tillering, with a 10-ft handheld boom. All herbicides were applied with label-recommended surfactants and at highest labeled rates. Each treatment was replicatd four times at each trial location, in a Randomized Complete Block Design. Evaluations consisted of percent phytotoxicity (stunting, stand reduction, tip burn, chlorosis, or lodging) and watergrass percent control (in comparison to the untreated) collected at 7, 14, and 21 days after application. Final yield data of each plot was also collected and standardized to 14% moisture.

There were differences in control between sites and between years. However, overall, based on the eleven trials, alternative cleanup sprays to multiple propanil applications that demonstrated comparable watergrass control to the double propanil application are: tank mixes of thiobencarb + bispyribac-sodium, propanil + florpyrauxifen-benzyl, propanil + carfentrazone, thiobencarb + propanil, bispyribac-sodium + cyhalofop, and propanil + cyhalofop-butyl. The best overall program is bispyribac-sodium followed by propanil (7 days apart).

Season-Long Weed Management Program Utilizes Florpyrauxifen-Benzyl in California Rice

Inci, D. and Al-Khatib, K.

Florpyrauxifen-benzyl (Loyant CA) is an auxin-mimic herbicide newly registered for California rice systems. This research was conducted in 2023 and 2024 at California Rice Experiment Station, Biggs, CA, and aimed to utilize florpyrauxifen-benzyl in a season-wide effective herbicide program; therefore, characterize the effects on crop safety and weed control when applied alone or combined with partner herbicides. Florpyrauxifen-benzyl applied alone at 40 g ai ha^{-1} and twice within 14-d intervals, or after a base application of benzobicyclon/halosulfuron-methyl, clomazone, or thiobencarb. Foliar treatments were applied on 4–5 leaf stage rice with MSO at 584 ml ha^{-1}. Rice injury from all florpyrauxifen-benzyl applications was minimal and insignificant. Florpyrauxifen-benzyl alone and as a sequential application provided greater than 95% control of watergrasses, sedges, and broadleaf weeds. Control of smallflower umbrella sedge, ricefield bulrush, ducksalad, and redstem increased to 100% as a post-emergence alone and in mixtures with bispyribac-sodium, penoxsulam/cyhalofop-butyl, or propanil. The highest yield—7,683 kg ha^{-1} in 2023 and 11,249 kg ha^{-1} in 2024—was observed with florpyrauxifen-benzyl sequential treatment without a base application. The research indicates florpyrauxifen-benzyl weed control can be improved when applied in a season-wide program or with an appropriate mixture partner.

ABSTRACTS OF STUDENT PANEL POSTERS:
WEED CONTROL AND GROWTH REGULATION
Panel Chair: Felipe Dalla Lana

Weed Control Programs in Rice for Hemp Sesbania and Yellow Nutsedge Control

Avent, T.H., Norsworthy, J.K., Ketchum, C.C., Sandoski, C.A., Carvalho-Moore, P., and Scott, R.C.

Hemp sesbania [*Sesbania herbacea* (Mill.) McVaugh] and yellow nutsedge (*Cyperus esculentus* L.) remain two of the most problematic weeds in flooded and furrow-irrigated rice in mid-southern United States rice production. Research was conducted at the Pine Tree Research Station near Colt, AR, to compare herbicide programs with combinations of glyphosate and clomazone with saflufenacil, quinclorac, halosulfuron, and prosulfuron at preplant burndown. At 2- to 3-leaf rice, clomazone and fenoxaprop were applied to all treatments. At preflood, treatments received either halosulfuron + thifensulfuron, or halosulfuron + prosulfuron. Evaluations included hemp sesbania and yellow nutsedge control and rice injury at 2- to 3-leaf rice, at preflood, and 30 days after flooding (DAF). Early season evaluations indicated that combinations required halosulfuron preplant burndown to provide higher control levels of both species. By 30 DAF, rice injury was greatest for combinations of halosulfuron + prosulfuron applied preflood, ranging from 14 to 24% on average. Hemp sesbania and yellow nutsedge control ≥ 99% required herbicide combinations of halosufluron + prosulfuron preplant burndown and halosulfuron preflood. Treatments excluding halosulfuron or prosulfuron preflood resulted in unacceptable hemp sesbania control (< 70%). Overall, this research demonstrates the need for halosulfuron preflood to achieve adequate yellow nutsedge and hemp sesbania control. Furthermore, there appears to be minimal risk for visible crop injury, but this experiment failed to capture yield and prove that these programs do not result in yield reductions. The cost of the herbicide programs, according to UADA enterprise budgets, will also be featured on the poster.

Evaluation of Warrant in Roxy Rice with and without Seed Safeners

Baxley, R.C., Norsworthy, J.K., Avent, T.H., Dodde, M.R., Souza, M.C.C.R., Barber, L.T., and Scott, R.C.

The profile of herbicide resistance present in key economic weed species such as barnyardgrass [*Echinochloa crus-galli* (L.) P. Beauv.] and weedy rice (*Oryza sativa* L.) serves as a dilemma to commercial producers of rice. As many conventional rice herbicides are becoming ineffective, there is a need to explore potentially new options for chemical control. The Roxy Rice Production System is a herbicide-resistant technology being developed for use in Midsouth rice production. The system enables the use of oxyfluorfen, a protoporphyrinogen oxidase inhibitor, to control a broad assortment of grass and broadleaf weeds. A field study established in the summer of 2024 at the Rice Research and Extension Center in Stuttgart, AR, evaluated herbicide programs containing sequential applications of oxyfluorfen with and without microencapsulated acetochlor (Warrant) applied delayed preemergence. A nontreated check was included, and a standard treatment was added that contained clomazone preemergence followed by quinclorac early postemergence followed by propanil pre-flood. Clomazone and quinclorac alone preemergence were applied as part of herbicide programs evaluated in combination with oxyfluorfen. Additionally, the seeded rice was treated with fenclorim at 2.5 g/kg of seed to protect from injury the Warrant would otherwise cause. At 1 week after rice emergence, oxyfluorfen applied preemergence in combination with clomazone or quinclorac provided superior barnyardgrass and weedy rice control compared to the standard program that received clomazone alone. However, late-season barnyardgrass control did not differ among the treatments evaluated, ranging from 93 to 99%, meaning that the standard was just as effective as the treatments containing sequential oxyfluorfen applications with or without acetochlor. Conversely, the oxyfluorfen-containing treatments with and without acetochlor effectively controlled weedy rice, providing 93 to 98% control, compared to only 52% control in the standard treatment. There were no differences in rough rice yield among the evaluated herbicide treatments, which may have resulted from the low weedy rice population at the test site.

Crop Response in Louisiana Rice Varieties Following Fluridone Applications

Carr, W.B., Webster, L.C., Hains, M.P., Stoker, S.B., Sparks, G.B., and Williams, E.M.

An herbicide containing fluridone has been labeled in rice (*Oryza sativa L.*) for Palmer amaranth *(Amaranthus palmeri)* control due to a new farming practice that uses furrow irrigation with the absence of a permanent flood. Traditional preemergence herbicides used in rice have little control of Palmer amaranth. Over the past growing seasons, Palmer amaranth has become an issue in furrow irrigated rice.

In 2023, at the H. Rouse Caffey Rice Research Station in Crowley, Louisiana, four studies were conducted to evaluate crop response to fluridone on Louisiana rice varieties. Rice varieties PVL03, Avant, and Jupiter were seeded at 78.5 kg ah-1, and RT7321 was seeded at 33.63 kg ha^{-1}. All varieties were seeded on Crowley silt loam. For each study the experimental design consisted of a two-factor factorial arrangement of treatments within a randomized complete block design replicated four times. Factor A consisted of rates of fluridone at 0, 84, 126, or 168 g ha^{-1}. Factor B consisted of five application timings targeting pre-emergence, delayed pre-emergence, 1-2 leaf rice, 3-4 leaf rice, and preflood. Plot sizes were 1.5 by 5.2 m^2. Trials were kept weed-free for the duration of the study. Applications were made with a backpack sprayer calibrated to deliver 140 L ha^{-1}. Injury was evaluated visually at 14 and 28 days after treatment (DAT) on each timing as a percentage. Percent heading and plant heights were collected at harvest. Yield was obtained and adjusted to 12% moisture.

At 14 DAT, crop injury of 13% was observed when 84 g ha^{-1} of fluridone was applied at the preflood timing and 42% at the delayed pre-emergence timing in Avant. In Jupiter, crop injury of 8% was observed when 126 g ha^{-1} of fluridone was applied at the pre-flood timing and 20% at the 1-2 leaf rice timing. In PVL03, crop injury of 15% was observed when 168 g ha^{-1} of fluridone was applied at the pre-flood timing and 32% at the 1-2 leaf rice timing. Rice response to fluridone varies by variety as well as application timing and rate.

Tetflupyrolimet-Based Weed Control Programs on Silt Loam and Clay Soils

Carvalho-Moore, P., Castner, M.C., Norsworthy, J.K., and Barber, L.T.

The novel active ingredient tetflupyrolimet will soon be an option for residual weed control in rice fields. Efficacy and rice response can vary depending on the herbicide program and under different soil conditions. Therefore, field experiments were conducted near Stuttgart, AR, in silt loam soil and near Keiser, AR, in clay soil to evaluate tetflupyrolimet-based weed control programs in comparison to commercial standards available for conventional rice. The experiment was designed as a randomized complete block with four replications and two-site years for each soil texture. Treatments consisted of six herbicide programs, including preemergence (PRE) and 3-4 leaf rice (POST) applications. The herbicides tetflupyrolimet, clomazone, or quinclorac were used in PRE. The POST application included tetflupyrolimet, clomazone, penoxsulam, cyhalofop, propanil, fenoxaprop, or pendimethalin. Herbicide rates were adjusted according to soil type. Nontreated was included for comparison. Barnyardgrass [*Echinochloa crus-galli* (L.) P. Beauv.] control was evaluated at 7 and 56 days after POST treatment (DAT). Additionally, rice injury was assessed at 7 DAT. No differences were observed in different soil textures; thus, injury and barnyardgrass control data were averaged across locations and site-years. At 7 and 56 DAT, all herbicide programs provided barnyardgrass control above 96%. Rice injury significantly differed among the programs tested. The highest rice injury (10%) was observed in the herbicide program that mixed tetflupyrolimet, clomazone, and fenoxaprop in the POST application. Based on these results, tetflupyrolimet is an effective herbicide that can be safely mixed with other herbicides, providing robust weed control throughout the season.

Effective Palmer Amaranth Management in Furrow-irrigated Rice with Brake®

Dodde M.R., Norsworthy J.K., King T.A., Carvalho-Moore P., Souza M.C.C.R., and Barber L.T.

Palmer amaranth [*Amaranthus palmeri* (S.) Wats.] is normally suppressed by flood conditions in paddy rice. However, there has been an increasing number of furrow-irrigated rice acres grown in Arkansas, and Palmer amaranth has proven to be a troublesome weed that farmers face. Field experiments were conducted in 2022 and 2023 at the Milo J. Schult Agricultural Research and Extension Center in Fayetteville, AR and the Pine Tree Research Station near Colt, AR to evaluate various herbicide programs incorporating fluridone (Brake) to control Palmer amaranth. An experiment in a randomized complete block design was conducted with four replications. Treatments included a preemergence (PRE) application of clomazone at 336 g ai hectare^{-1} with or without fluridone at 168 g ai hectare^{-1}, early postemergence (EPOST) applications of florpyrauxifen-benzyl at 15 g ae hectare^{-1} with or without fluridone at 168 g ai hectare^{-1}, and a mid-postemergence (MPOST) application of florpyrauxifen-benzyl at 15 g ae hectare^{-1} or 30 g ae hectare^{-1} with or without fluridone at 168 g ai hectare^{-1}. A nontreated control was also included for comparison. Visible injury and Palmer amaranth control were assessed weekly, and rough rice grain yield determined at harvest. Palmer amaranth control 14 days after MPOST (DAMPOST) was comparable with every treatment that included either an EPOST or MPOST, having 90% or greater control. When clomazone and fluridone were applied PRE with no following herbicide application, Palmer amaranth control was only 69% at the 14 DAMPOST evaluation. Clomazone at 336 g ai hectare^{-1} applied PRE followed by fluridone at 168 g ai hectare^{1} plus florpyrauxifen-benzyl at 15 g ae hectare^{-1} applied EPOST followed by florpyrauxifen-benzyl at 15 g ae hectare^{-1} applied MPOST provided the highest level of Palmer amaranth control numerically at both the 14 and 28 DAMPOST evaluations, with 92% and 98% control, respectively. Rice injury never exceeded 17% with any treatment and no differences in yield were observed. Based on these findings, fluridone should be considered an effective option for providing residual control of Palmer amaranth in furrow-irrigated rice production systems.

Rice Response to Selected Soil-Applied HPPD Herbicides with and without Potential Safeners

Ketchum, C.C., Norsworthy, J.K., Carvalho-Moore, P., Souza, M.C.C.R., Avent, T.H., and Baxley, R.C.

Weedy rice is the second most difficult weed to manage in mid-southern U.S. rice production. Although herbicide-resistant rice varieties are available on the market, there is the inherent risk of outcrossing with weedy rice. Furthermore, rice producers lack effective options for weedy rice when utilizing conventional rice varieties. A field experiment was conducted at the Pine Tree Research Station near Colt, AR, to determine how effective fluxofenim and fenclorim seed safeners were at protecting conventional rice from bleaching symptoms of several 4-hydroxyphenylpyruvate dioxygenase- (HPPD) inhibiting herbicides. The experiment was a two-factor randomized complete block split-plot design. A nine-row drill was used for planting, and each drill pass was split into three sub-plots with three drill lines per sub-plot; each plot had sub-plots of non-treated seed, fluxofenim at 2.5 g/kg seed, and fenclorim at 2.5 g/kg seed, with herbicide applications serving as the whole-plot factor. Nine herbicide treatments were applied preemergence, equaling 27 treatments and four replications. Injury ratings were taken 1 and 4 weeks after rice emergence (WAE), with shoot counts taken at 1 WAE. Comparisons were made between safener-treated and untreated seed within each herbicide treatment. At 1 WAE, fluxofenim and fenclorim showed significant protection against injury in the form of bleaching with applications of topramezone at 98 g ha^{-1} and mesotrione at 420 g ha^{-1}. Still, at the third WAE evaluation, fluxofenim and fenclorim enhanced rice protection from injury caused by topramezone and mesotrione. Shoot counts were made relative to the nontreated seed that did not receive a herbicide application. For mesotrione at 420 g ha^{-1}, the fluxofenim and fenclorim seed treatments provided a 27% increase in rice shoot numbers compared to the absence of a seed treatment that received each respective herbicide. Additionally, fenclorim treated seed saw a 25% increase in shoot numbers in plots treated with the topramezone at 98 g ha^{-1}. Overall, fluxofenim and fenclorim seed treatments provided protection from rice from injury caused by select HPPD herbicides.

Season-Long Weed Management with Cliffhanger SC in CA Water-Seeded Rice

Lynch, M., Bernal, A., Estrada, S., and Al-Khatib, K.

California rice production has faced major weed management challenges due to a limited list of herbicides and an increase in herbicide resistant weed populations. Cliffhanger SC is a suspension concentrate formulation of benzobicyclon developed by Gowan Company that was recently released for California rice growers. Benzobicyclon is a Group 27 herbicide that inhibits 4-hydroxyphenyl-pyruvate-dioxygenase (4-HPPD) which can result in bleaching. Weeds are controlled by both foliar and root uptake in the water. Benzobicyclon is a pro herbicide that needs sufficient water to convert into the herbicidal active ingredient. The objective of this study was to determine how Cliffhanger SC season-long weed management programs performed in CA water seeded rice. A randomized complete block design with four replications was utilized during the 2024 rice season in Biggs, CA. In this study, the application rate of Cliffhanger SC was 267 g ai/ha (10.3 fl oz/ac) applied at one-leaf stage rice (1 LSR) alone and in combination with various rice herbicides such as Zembu (pyraclonil), Cerano 5 MEG (clomazone), Dodhylex (tetflupyrolimet), Loyant CA (florpyrauxifen-benzyl), Granite SC (penoxsulam), Regiment CA (bispyribac-sodium) and SuperWham! CA (propanil). All treatments of Cliffhanger SC included MSO at 1 % v/v and were sprayed onto the water surface. Base herbicides and follow-up herbicides were applied at their respected rates and timings according to the label. Weed control and crop response were evaluated at 7, 14, 28 and 42 days after treatment (DAT). Yield and moisture data were collected by a small-plot research combine. Cliffhanger SC alone provided complete control of bearded sprangletop, ricefield bulrush and smallflower umbrella sedge. All treatments provided excellent control of watergrasses and sedges at 42 DAT, however, Cliffhanger SC alone and Cliffhanger SC plus propanil had the lowest watergrass control. Cliffhanger SC alone and treatments that lacked a broadleaf herbicide resulted in high populations of redstem. Rice injury was minimal in all treatments and insignificant after 14 DAT except in combination with Zembu. Cliffhanger SC in combination with Dodhylex and Loyant CA provided the highest weed control and yield.

Evaluating Rindé™ for Improved Barnyardgrass Control in Rice

Malone, J.C., Norsworthy, J.K., Barber, L.T., Cundiff, G.T.

Arkansas has historically been the leading rice-producing state, accounting for almost 50% of total rice production in the United States. Weed control in Arkansas rice has been difficult for producers due to the lack of effective herbicides, with the most difficult-to-control weed being barnyardgrass (*Echinochloa crus-galli*). Herbicide resistance has contributed heavily to the difficulty in controlling barnyardgrass, resulting in the need for new herbicide products. Rinde is a mixture of quinclorac and bispyribac-sodium, two herbicides commonly used in rice to control barnyardgrass. The objective of this experiment was to determine the effectiveness of Rinde in an herbicide program for drill-seeded rice production. The research was conducted in 2023 in Keiser, AR, on Sharkey clay soil. Rice injury and barnyardgrass control ratings were taken at 7, 14, 21, 28, and 40 days after post-flood application (DAA). At 7 DAA, treatments containing fenoxaprop-p-ethyl (Ricestar HT) were the only applications resulting in significant injury; however, the injury never exceeded 13% throughout the experiment. All other Rinde-containing treatments never caused more than 4% injury. At 14 DAA, programs containing a delayed preemergence application of pendimethalin (Prowl H2O) or imazethapyr (Newpath) resulted in significantly greater barnyardgrass control, exceeding 90%. Barnyardgrass control in treatments that did not contain a delayed preemergence application ranged from 65-75%. At the final evaluation, all Rinde-containing treatments provided at least 98% control. These findings illustrate the effectiveness of rice weed control programs containing a quinclorac plus bispyribac-sodium premixture.

Postemergence Mixtures with Tetflupyrolimet and Clomazone for Improved Weed Control

Pierce, L.D., Norsworthy, J.K., Avent, T.H., Baxley, R.C., Ketchum, C.C., and Herman, W.

Tetflupyroliment (TVE29) is a novel site of action from FMC Corporation that provides residual weed control in rice. Postemergence control can also occur when applied to some small grass weeds. In 2023, a randomized complete block design experiment with eleven treatments and three replications was conducted in Stuttgart, AR. This research aimed to determine if TVE29 in mixture with clomazone (Command) and other herbicides added crop injury and/or improved weed control in broadleaves and sedges. Each treatment was sprayed labeled rates of postemergence (POST) herbicides, halosulfuron-methyl (Permit Plus), bispyribac-sodium (Regiment), bentazon + acifluorfen (Storm), propanil + bensulfuron-methyl (Duet), and propanil and thiobencarb (Ricebeaux), and a mixture of the herbicides with TVE29 + Command. The mixture of TVE29 + clomazone was also evaluated alone. Injury was evaluated at 1, 2, and 4 weeks after applying the POST (WAPOST) applications. Weed control ratings were collected for rice flatsedge (*Cyperus iria* L.) and hemp sesbania [*Sesbania herbacea* (R.) McVaugh] 2 and 4 WAPOST application. At 1 WAPOST, the highest injury was 25% when TVE29 + Command was applied with Storm. At 4 WAPOST, injury was ≤ 13% across all herbicides. Treatments that included a mixture of TVE29 + Command generally had greater injury than the herbicide alone, which was in the form of bleaching likely caused by Command. Overall, TVE29 + Command mixed with Permit Plus, Regiment, and Storm provided ≥ 88% control for rice flatsedge and hemp sesbania 2 WAPOST. In no instance did the addition of TVE29 + Command appear to reduce weed control over each herbicide alone. These results show that TVE29 + Command can be mixed with a wide assortment of postemergence rice herbicides without fear of unacceptable injury or a negative effect on postemergence weed control.

Response of Rice Cultivars to Postemergence Fluridone

Ross, A.D., Norsworthy, J.K., Souza, M.C.C.R., Godar, A.S., Carvalho-Moore, P., and Linn, S.L.

Furrow-irrigated rice (*Oryza sativa* L.) is an increasingly common practice in Arkansas. A major fallback of furrow-irrigated rice, as opposed to the typical flooded culture, is the increased weed occurrence associated with the lack of a flood. Given its reputation as a particularly noxious weed and a lack of dependable control options in rice, Palmer amaranth (*Amaranthus palmeri* S. Watson) presents itself as a unique threat to furrow-irrigated rice production systems. Because populations of Palmer amaranth have evolved resistance to many herbicide sites of action—including those in WSSA Groups 2, 4, 9, 10, 14, 15, and 27—new control options for this weed are needed for non-flooded rice. Fluridone, a phytoene desaturase-inhibiting (Group 12) herbicide historically used in cotton, has successfully controlled Palmer amaranth. Insufficient research regarding the tolerance of rice to fluridone prompts investigation into the matter; and varietal differences in tolerance have been speculated, not unlike the varietal tolerance to metribuzin seen in soybean [*Glycine max* (L.) Merr.]. To further understand the potential for use of fluridone in rice, twelve rice cultivars were assessed for tolerance to fluridone applied at the 3-leaf stage, an application timing that currently matches the labeled recommendation. Both pureline and hybrid cultivars were evaluated including CLL15, CLL16, RT7321 FP, RT7521 FP, PVL03, RTv7231 MA, DG263L, Diamond, Titan, Jupiter, Lynx, and XP753. The experiment was repeated across two years – 2022 and 2023 – and varieties were subjected to 0X, 1X, and 2X rates of fluridone (0, 168, and 336 g ai/ha, respectively). In 2022, injury never exceeded 5% at any rate, and no yield penalty occurred. In 2023, the only cultivars showing injury greater than 25% at the 2X rate were DG263L, PVL02, RTv7231 MA, and XP753; and at the 1X rate, only DG263L showed injury above 15%. There was a yield penalty to DG263L and RT7521FP at both fluridone rates, and the 2X fluridone rate decreased yield of CLL15, Jupiter, PVL02, RT7321FP, RTv7231 MA, and Titan compared to the nontreated.

Mixtures of Tetflupyrolimet and Clomazone for Preemergence Grass Control in Rice (*Oryza sativa* L.)

Sparks, G.R., Webster, L.C., Fritsche-Neto, R., Hains, M.P., Stoker, S.B., Carr, W.B., and Williams, E.M.

Tetflupyrolimet will be classified as a group 28 herbicide and will belong to the first new mode of action released in decades. Tetflupyrolimet is a selective herbicide applied preemergence for grass control in rice. Over many years barnyardgrass (*Echinochloa crus-galli* (L.) Beauv.) has developed resistance to multiple herbicides making it important to preserve the options still available today. Therefore, in 2023 and 2024 experiments were conducted in Crowley, Louisiana on a Crowley silt loam soil to compare different rates of tetflupyrolimet and clomazone for control of barnyardgrass, broadleaf signalgrass (*Urochloa platyphylla* (Munro ex C. Wright) R.D. Webster), and Amazon sprangletop (*Leptochloa panicoides* (J. Presl) Hitchc.) when applied alone and as mixtures.

The experiment was organized as a randomized complete block including 16 treatments with three replications. Plot size was 3 by 9.14m. Treatments were applied at 4.8 kmh prior to weed and crop emergence using a CO_2-pressurized backpack sprayer calibrated to deliver 93.6 L ha^{-1}. Visual ratings for barnyardgrass and broadleaf signalgrass control were observed at 21, 28, 35, and 56 DAT, along with one rating of Amazon sprangletop control 63 DAT. Tetflupyrolimet alone was applied at 50, 75, 100, 125, and 150 g ai ha^{-1}, clomazone alone was applied at 125, 188, 250, 313, 375 g ai ha^{-1}, and mixtures of tetflupyrolimet and clomazone were applied with increasing rates, respectively.

At 56 DAT, tetflupyrolimet applied at 125 g ha^{-1} controlled barnyardgrass 88% and clomazone applied at 313 g ha^{-1} controlled barnyardgrass 75%. At the same rating date, tetflupyrolimet mixed with clomazone at the previously mentioned rates controlled barnyardgrass 94%. Similar results were observed for broadleaf signalgrass control at 56 DAT. Amazon sprangletop control at 63 DAT ranged from 68 to 95% across all rates of tetflupyrolimet applied alone, compared to 25 to 62% across all rates of clomazone applied alone. Tetflupyrolimet mixed with clomazone controlled Amazon sprangletop at 63 DAT 78 to 95% across all rates evaluated. Tetflupyrolimet mixed with clomazone has the potential to provide extended residual control of barnyaradgrass and broadleaf signalgrass compared to each herbicide applied alone.

Imazethapyr Soil Persistence in Louisiana Rice Rotation Systems

Stoker, S.B., Webster, L.C., Hains, M.P., Sparks, G.R., Carr, W.B., and Williams, E.M.

Imazethapyr is labeled for use in the imidazolinone resistant (Clearfield®) rice production system. Imazethapyr inhibits acetolactate synthase in susceptible plant species, and expresses selective action against various grass, broadleaf, and sedge species commonly found in Louisiana. Extended soil persistence of imazethapyr has been reported under anerobic soil conditions. Current rice/crawfish rotations practices cause anerobic soil conditions that inhibit degradation of imazethapyr. The residual soil persistence of imazethapyr impacts rice growth and development in non-imidazolinone resistant rice varieties. Rice yield losses have been observed when conventional rice varieties are planted subsequently to Clearfield® rice and crawfish rotation.

Three studies were conducted in 2024 at the H. Rouse Caffey Rice Research Station near Crowley, Louisiana. This research was implemented to evaluate the varietal response of non-Clearfield® medium and long grain rice cultivars to residual imazethapyr in the soil profile. Plot size was 1.5 by 5.2m^{-2} and seeded with 'PVL03', 'Avant', or 'Jupiter' at 79 kg ha^{-1}. The experimental design for each study was structured as a randomized complete block design with four replications. Pre-plant imazethapyr treatments were applied at 5, 9, 13, 18, 22, 26, 30, 35 g ai ha^{-1}. All applications were made with a CO_2-pressurized backpack sprayer calibrated to deliver 140 L ha^{-1}. Timely rainfall allowed for sufficient incorporation of imazethapyr treatments, subsequently rice was planted after the soil dried. Data collection consisted of visual crop injury, stand count collections, plant heights, and percent rice heading at maturity. Rice yield was obtained and adjusted to 12 % moisture content.

At 70 DAE, imazethapyr treatments caused differences of 34 and 12% in panicle development in Avant and PVL03, respectively, when compared to the nontreated. Panicle development was delayed among PVL03, Jupiter, and Avant by 25, 22, and 27% when compared to the nontreated at 77 DAE, respectively. Results suggest delayed maturity in both medium and long grain rice varieties when imazethapyr was applied compared to nontreated rice.

Zero Day Plant-Back Burndown Programs Using ALS-Inhibiting Herbicides

Williams, E.M., Webster, L.C., Stoker, S.B., Hains, M.P., Carr, W.B., and Sparks, G.R.

In Louisiana, the ideal burndown program prior to planting rice (*Oryza sativa* L.) is an application of glyphosate mixed with 2,4-D. A burndown application of glyphosate plus 2,4-D is not only cost effective but also provides broad spectrum control of grasses and broadleaf weeds. However, there are limitations regarding 2,4-D in relation to planting rice following an application. The plant-back interval for rice following 2,4-D is 30 days or 21 days following an inch of rainfall, which can be problematic if burndown applications cannot be made in a timely manner. This research evaluates herbicide mixture options with glyphosate outside of 2,4-D that would allow for a shorter plant-back window.

A field study was conducted in 2024 at the H. Rouse Caffey Rice Research Staton in Crowley, Louisiana to evaluate alternative burndown programs in rice. Plot size was 3 by 9.14 m^2. The experimental design consisted of a randomized complete block design with nine herbicide treatments and a nontreated added for comparison. The herbicide treatments evaluated in this study consisted of several ALS-inhibiting herbicides applied in mixture with glyphosate and/or saflufenacil. All herbicide applications were applied with a CO_2-pressurized backpack sprayer calibrated to deliver 93.5 L ha^{-1}. Visual evaluations of percent control were observed for alligatorweed [*Alternanthera philoxeroides* (Mart.) Griseb.], Indian jointvetch (*Aeschynomene* *indica* L.), little barley (*Hordeum pusillum* Nutt.), hairy buttercup (*Ranunculus sardous* Crantz), and hedgeparsley [*Torilis arvensis* (Huds.) Link] at 21, 35 and 49 days after treatment (DAT). Rice flatsedge (*Cyperus iria* L.), eclipta [*Eclipta prostrata* (L.) L.], and eastern black nightshade (*Solanum* ptychanthum) were also evaluated at 35 and 49 DAT.

Glyphosate alone and all glyphosate containing mixture controlled little barley 99% across all evaluation dates. At 35 DAT, glyphosate alone controlled Indian jointvetch 73% compared to all other glyphosate mixtures, where control was observed from 85 to 96%. At 49 DAT, glyphosate alone controlled hedgeparsley 23% and a mixture of glyphosate plus saflufenacil controlled hedgeparsley 63%. At the same rating date, glyphosate mixtures containing an ALS-inhibiting herbicide controlled hedgeparsley 96-98%. This research indicates that incorporating an ALS-inhibiting herbicide into a burndown program can enhance both the spectrum and levels of control while maintaining a short plant-back window.

Evaluating Control of Volunteer Rice with Postemergence Herbicides

Herrman, W., Norsworthy, J.K., Barber, L.T., Scott, B., Carvalho-Moore, P., and Avent, T.H.

Volunteer rice (*Oryza sativa* L.), also known as weedy rice or red rice, is one of the most troublesome weeds in cultivated rice (*Oryza sativa* L.) production. With the advent of herbicide-resistant rice almost two decades ago, volunteer herbicide-resistant rice is proving to be yet another rice weed control challenge. In the summer of 2024, a trial was conducted near Colt, AR, to test postemergence (POST) herbicide control options on both volunteer rice and barnyardgrass [*Echinochloa crus-galli* (L.) P. Beauv.], another troublesome rice weed. The field where this research was conducted has a history of employing rice traits with resistance to acetolactate synthase- and acetyl CoA carboxylase-inhibiting herbicides. A randomized complete block design with four replications and eleven treatments was created. Plot sizes were 2.4 x 6.1 m. The trial was non-cropped and had a natural infestation of volunteer rice and barnyardgrass. Treatments included a nontreated check alongside six postemergence herbicides (cyhalofop at 624 g ai/ha, imazamox at 88 g ai/ha, quizalofop at 120 g ai/ha, clethodim at 140 g ai/ha, glufosinate at 655 g ai/ha, and glyphosate 1,120 g ae/ha) applied alone and four of these (quizalofop, clethodim, glufosinate, glufosinate, and glyphosate) were applied sequentially with 2 weeks between applications. The single application treatments also included *S*-metolachlor for residual control. The test site was flooded immediately following the second application. Adjuvants were added as recommended by the product labels. Weekly weed control ratings by species occurred beginning the day of the sequential application and continued for four weeks. Cyhalofop completely failed to control volunteer rice, as expected, and imazamox never provided more than 45% volunteer rice control. Cyhalofop, quizalofop, clethodim, and imazamox provided <50% barnyardgrass control 2 weeks after treatment. Conversely, glyphosate and glufosinate provided >85% barnyardgrass control at the same time. By 4 weeks after the sequential application, barnyardgrass control exceeded 90% for all treatments that contained clethodim, quizalofop, glyphosate, or glufosinate. Volunteer rice control with the same treatments ranged from 79 to 95%. Unfortunately, no single treatment provided complete control of barnyardgrass or volunteer rice; albeit some were much more effective than others.

Weed Populations in Reduced Tillage Rice in California: A Preliminary Evaluation

Brim-DeForest, W., Espino, L., Stogsdill, R., and Linquist, B.

The practice of reduced till or no-till rice production in California is a recent area of research in the production system. With increasing water shortages due to droughts, as well as herbicide resistance posing an ever-increasing issue, changing stand establishment systems and shifting irrigation regimes are becoming a larger need for the industry. This study aims to determine the effects of no-till and reduced tillage drill-seeded rice on weed populations in California rice. This study is part of a larger study that is evaluating fertility requirements, rice yields, disease and arthropod management, as well as water usage.

The trial was carried out for two years, 2023-2024, at the California Rice Experiment Station in Biggs, CA. The experimental design was a split plot with the main plot treatments in larger 0.4 ha (1-acre) basins consisting of four treatments replicated three times in 2023: straw chopped in the fall, straw baled and removed from the basin, straw burned, and no straw in the previously fallow fields (left untilled from the previous season). Each basin was drill-seeded with a no-till drill when soil moisture was adequate to drive equipment into the field. Fields were not flushed, but a permanent flood was established when rice reached the tillering stage. To better understand the weed control in each basin one untreated control and one herbicide treatment were applied in small plots (3 m x 6 m) (replicated twice per basin). In 2023, treatments were: an untreated control (no herbicides), and a post-emergent, pre-flood spray of pendimethalin. The large basins were treated with a preflood (3-4 leaf stage rice) spray of propanil + cyhalofop + pendimethalin and a postflood spray of bispyribac-sodium + adjuvants. In 2024, the three main plot treatments were: straw chopped in the fall, straw baled and removed from the basin, and no straw in the previously fallow fields (left untilled from the previous season). In 2024, one untreated control and two herbicide treatments were used in a small plot (3 m x 6 m) (replicated twice per basin). Treatments were a post-emergent, pre-flood spray of pendimethalin, and a pre-emergent, pre-flood spray of pendimethalin. The large basins were treated with a preflood (3-4 leaf stage rice) spray of propanil + florpyrauxifen-benzyl + pendimethalin and a postflood spray of cyhalofop + adjuvant. Percent cover ratings were taken at 1-month intervals from the small plots as well as from the larger basins. Yields were harvested from both the larger basins as well as the small plots.

In 2023, results showed the straw chopped treatment had the least amount of weed pressure, both with and without herbicide treatments. No significant yield differences were found between the treatments, with the fallow-treated fields having the highest yields. In 2024, the previously fallowed basins had the least amount of weed pressure, both with and without herbicide treatments. No significant yield differences were found between the treatments, with the fallow-treated fields having the highest yields again. Some key findings are that winter weeds proved to be problematic when changing from a continuously flooded and tilled system to a no-till system.

Assessing Herbicide Application Programs for Weed Control and Yield Improvement in New Rice Varieties

Zhou, X.G., Sanford, J., and Bagavathiannan, M.

Various herbicides are used to control a range of weeds, including grasses, broadleaves, and sedges. However, their effectiveness can vary with rice variety. The recent introduction of FullPage® Rice varieties, such as RT7321 FP, and Max-Ace® Rice varieties, such as RTv7231 MA, provides farmers with new options for enhanced weed management. Additionally, Trinity and RT7301 are newly released inbred and hybrid rice varieties, respectively. The objective of this study was to evaluate the performance of herbicide application programs on crop safety, weed control, and yield improvement in these new rice varieties under Texas environmental conditions.

A field trial was conducted at Eagle Lake, Texas, using four rice varieties, Trinity, RTv7231 MA, RT7321 FP, and RT7301, with 17 herbicide application programs. Weed seeds of morningglory, American jointvech, waterhemp, hemp sesbania, yellow nutsedge, barnyardgrass, and broadleaf signalgrass were planted into the plots at seeding. Herbicide-caused plant injury and overall w eed control were visually rated multiple times per season, and rice grain yield and milling quality were determined.

None of the 17 herbicide programs caused significant crop injury to any of the four varieties, though Vopak caused minor initial injury (5%) to Trinity and RT7301. All the 17 herbicide treatments achieved excellent weed control, especially for waterhemp, hemp sesbania, yellow nutsedge, barnyardgrass, and broadleaf signalgrass, across all four new varieties. The herbicides ZuraxL, High Gard, Postscript, and Gambit proved safe and effective for rice weed control.

The herbicide treatments significantly ($P < 0.05$) affected rice grain yield and milling quality. Across treatments, RT7321 FP and RT7301 showed the highest average yields, with 12,525 kg/ha (11,174 lb/ac) and 11,726 kg/ha (10,461 lb/ac), respectively, while Trinity had the lowest yield at 6,232 kg/ha (5,560 lb/ac). RTv7231 MA yielded 8,381 kg/ha (7,477 lb/ac), placing it between the others. The herbicide programs significantly improved whole rice and total rice on each variety.

In summary, the combined use of new herbicides ZuraxL, High Gard, Postscript, and Gambit in the herbicide programs provided excellent control of weeds, including morningglory, American jointvetch, waterhemp, hemp sesbania, yellow nutsedge, barnyardgrass, and broadleaf signalgrass, on each of the four rice varieties evaluated. RT7321 FP and RT7301 performed very well on yield and milling quality. The long grain inbred Max-Ace variety RTv7231 MA performed well under the Texas environment conditions. Trinity showed comparable milling quality to RT7321 FP and RT7301 but had a significantly lower yield in this study.

ABSTRACTS OF PAPERS FOR PANEL ORAL PRESENTATIONS: POSTHARVEST QUALITY, UTILIZATION, AND NUTRITION
Panel Chair: Griffiths Atungulu
Moderators: Evans Ameyaw, Faith Ouma, and Samuel Olaoni

Replacing Rice Tempering with Microwave Technology in Crossflow Column Dryers: A Laboratory Feasibility Study

Atungulu, G., Regonda, B., and Luthra, K.

The market value of rice heavily relies on its milling yield, particularly the head rice yield, which is greatly influenced by the drying process. In the United States, rice is typically dried post-harvest using high-temperature air drying in one or more passes. Following each pass, the rice is tempered overnight or longer to reduce moisture and temperature gradients developed during drying, hence minimizing breakage during processing. However, multiple drying and tempering passes involving transferring rice between dryer and bins pose risks of breakage and incur costs and time for processors. Microwave heating, due to its volumetric heating capacity, has shown promise in reducing moisture and temperature gradients in rice. This study hypothesized that microwave heating could decrease tempering duration or potentially eliminate the need for tempering altogether. Additionally, this study also explored the microwave potential as the source for drying rice, including the traditional tempering procedure. Experimenting with a long grain cultivar at 22.5% initial moisture content (wet basis), the rice was subjected to two distinct drying methods. In the first method, rice was dried using a 915 MHz industrial microwave at 5 kW for 1 minute, followed by tempering in a convection oven at 60°C for various durations (0, 30, 60, 90, 120, 150, 180, 210, and 240 minutes). In the second method, rice underwent two-pass hot air drying (45°C and 20% relative humidity (RH) for 20 minutes per pass), with microwave tempering at various power levels (1, 2, 3, 4, and 5 kW for one minute) after each pass, along with control group using traditional tempering (60°C for 4 hours) was maintained for comparison.

Results showed that microwave drying followed by 210 minutes of tempering yielded the highest head rice yield (HRY) at 57.2%, surpassing the control (53.1%). In the hot air drying with microwave tempering method, 2 kW for 1 minute achieved comparable results to the control with HRY of 50.2% versus 51.3% for control. Moisture removal was most efficient at 5 kW microwave tempering, removing 8.8% moisture, but this led to increased fissuring and reduced HRY. The 2 kW microwave tempering for 1 minute balances efficiency and quality, matching the control moisture removal while significantly reducing tempering from 4 hours to 1 minute. Despite not achieving complete drying after two passes to the storage moisture level of 12.5%, the advantages of microwave tempering were evident and expected to persist beyond two passes. Through comparative analysis, this study aims to evaluate the efficiency and effectiveness of microwave heating in rice processing, considering both time savings and quality outcomes.

Analyzing Milling Behavior and Industrial Appraisal Standards for Conventional and Hybrid Long- and Medium-Grain Rice Cultivars

Olaoni, S., Luthra, K., and Atungulu, G.

Concerns have emerged regarding the milling characteristics of some rice cultivars, primarily due to a decrease in head rice yield (HRY). The laboratory method which required that each sample be milled to 0.4% surface lipid content (SLC), corresponding to USDA's well-milled rice grading, has frequently been

reported as over-milled. Therefore, it was necessary to investigate the milling behavior of cultivars, particularly hybrids, due to their distinct morphological compositions. This study utilized rough rice samples comprising conventional long-grain (CLL 16 and PVL 03), hybrid long-grain (RT 7321 FP and RT 7521 FP), and a conventional medium-grain cultivar (Titan). The samples were dried to 12.5% moisture content and milled with McGill #2 mill for durations of 10, 15, 20, 30, and 40 s. The SLC values of the samples were obtained at the specified milling durations. Subsequently, the samples were submitted to the Federal Grain Inspection Service for industrial appraisal according to USDA standards and were graded as hard-milled, well-milled, and reasonably well-milled. The SLC was compared with the USDA grading to evaluate the milling behaviors of the cultivars. The whiteness index of the samples was measured and recorded using a colorimeter for further validation. The results revealed that milling behavior varies among cultivars, with long grain cultivars exhibiting different rates of bran removal, while medium grain cultivars demonstrated the least degree of milling. At 0.4% SLC, all cultivars were classified as hard-milled according to USDA grading, with samples considered as well-milled and reasonably well-milled found to range from 0.5-0.7% SLC for long grain and up to 0.9% SLC for medium grain. These findings indicate the necessity to establish an SLC bound that aligns with USDA's well-milled rice standards. This will address the discrepancies resulting from over-milling, increase the HRY, and influence the economic value of rice for growers.

Optimizing Parboiling Parameters and Quality Characteristics of Modern Rice Cultivars

Ameyaw, E.O. and Atungulu, G.

The head rice yield (HRY) is a critical parameter for rice processors handling parboiled rice. Previous research indicates that maximum HRY during parboiling can be achieved without extensive starch gelatinization, with approximately 40% gelatinization being sufficient in earlier studies. However, the introduction of modern rice cultivars with unique starch compositions necessitates a reassessment of the optimal gelatinization levels and parboiling conditions to maximize HRY and overall quality. This study aimed to (1) identify the degree of starch gelatinization associated with maximum HRY in modern rice cultivars and (2) determine the optimal parboiling processing parameters to enhance the quality attributes (color, texture, and HRY) of these cultivars.

25 rice cultivars harvested in 2023 from various Arkansas regions were processed using an automated parboiling unit at the University of Arkansas Rice Processing Program (UARPP). Soaking was performed at temperatures slightly below each cultivar's onset gelatinization temperature until full hydration was achieved. Steaming treatments were applied at 100°C and 110°C for 4, 10, and 20 minutes. Gelatinization temperatures (GT) were measured via differential scanning calorimetry. Across 7 cultivars, the degree of gelatinization varied from 58.8% to 100% depending on treatment. The optimal gelatinization level for maximum HRY was determined to be 87%, yielding a maximum HRY of 75%. Steaming at 100°C for 10 minutes produced the best quality (combination of texture, color, and HRY), establishing this condition as optimal.

These findings provide valuable insights for rice processors, enabling the identification of energy-efficient parboiling parameters to achieve superior HRY and quality in modern rice cultivars.

Classification of Rice by Bran Color: A Non-Destructive and Rapid Approach Using NIR Spectroscopy

Mendoza, P.T., Armstrong, P., McClung, A., Scully, E., and Siliveru, K.

Pigmented rice seeds, such as red rice and purple rice, have different bran colors but can have a similar hull color to brown rice. This makes it challenging for farmers and processors to ensure consistent quality and prevent non-intended mixing. Traditional methods for identifying rice bran color involve hull removal and visual inspection, which can be time-consuming, destructive, and subjective, particularly for large-scale applications.

In this study, we evaluated the single-kernel near-infrared (SKNIR) spectroscopy in combination with multivariate analysis and machine learning techniques in classifying rough rice according to bran color (brown, purple, or red). The single-seed spectra of whole-grain rice samples with diverse hull colors from different growing locations were analyzed using classification methods and variable selection. Samples were split into 70% calibration and 30% validation sets. The classification was performed in three groups: samples with (a) similar straw hull color, (b) different hull colors, and (c) similar straw hull color and different growing locations.

The canonical plots in all three groups show separation among brown, purple, and red bran rice samples regardless of hull color and growing location. From the prediction scatter plots, some brown bran seeds were misclassified as red bran or purple bran, while some red bran seeds were misclassified as brown bran. Based on the results of this study, SKNIR spectroscopy can be a potential screening tool to assist breeders, farmers, and processors in sorting rough rice. This approach offers an objective, non-destructive alternative to traditional methods, facilitating quality control and breeding processes.

A New Way to Meet Consumer Appetite and Convenience for Rice Through Instantization: Optimizing Cultivar Selection

Ouma, F.A., Luthra, K., Regonda, B., and Atungulu, G.

Instant rice has become increasingly popular due to its convenience yet producing high-quality products with desirable physical and textural properties remains a challenge. This study evaluated the instantization potential of 26 rice cultivars harvested in 2023 from various regions in Arkansas to identify those most suitable for industrial processing. Key quality attributes assessed included optimal cooking duration (OCD), rehydration ratio, volume increase ratio, bulk density, color (whiteness index), and texture. Rice samples with 12.5% moisture content (w.b.) were milled to a 0.4% surface lipid content and cooked in an excess water ratio (1:20). The OCD was determined using the glass plate method. The cooked samples were dried using a stepwise hot air oven process at 230°C, 220°C, 210°C and 200°C for 1, 1, 1 and 3 minutes, respectively followed by controlled drying (25°C, 55% RH) to achieve a final moisture content of 12% (w.b.). Principal Component Analysis (PCA) was used to explore correlations between quality parameters and cultivar performance. Significant differences ($P < 0.05$) in quality attributes and moisture removal percentages were observed among cultivars. The hybrid cultivar RT7523 had the highest rehydration ratio (3.42), low adhesiveness (−107.36 gs), and optimal bulk density (0.33 g/mL), despite a longer OCD (29 minutes). In contrast, medium grain pureline cultivars such as CLM04 and Titan had shorter OCDs (19 minutes) but underperformed in key instantization traits. PCA revealed that textural attributes correlated with the first principal component (PC1, 38% variance), while physicochemical properties (bulk density, volume increase ratio, rehydration ratio) aligned with the second (PC2, 23.4% variance). Using the multi-attribute optimization tool JMP Prediction Profiler, RT7523 was identified as the best-performing cultivar based on the defined quality goals. These findings provide valuable insights for processors seeking to optimize rice cultivars for instant rice products with desirable physicochemical and textural attributes.

Blend Matters: Impact of Blending Rice Cultivars on Milling Yield, Physicochemical Attributes & End-Use Functionality

Atungulu, G.

Blending (commingling or mixing) of different rice cultivars before milling is a common practice aimed at saving time and effort in managing rough rice. Alternatively, blending is done to achieve the desired quality for the final product. It can lead to processing inefficiencies and inconsistent product functionality, ultimately impacting the economic value of rice. Despite its prevalence in farm or industrial settings, the extent to which this blending practice affects milling yield and the physical and chemical attributes of rice grown in Arkansas remains insufficiently studied. This study aimed to fill this gap by investigating the impact of blending different hybrid long grain cultivars (RT 7521 FP, RT 7321 FP, XP 753), pureline long grain cultivars (CLL 16, Ozark) and medium grain cultivars (Titan, RT 3202) on the rice milling yield and physicochemical attributes. Blending before and after postharvest drying were studied. Five types of blends were made among the long grain cultivars with varying percentages, and one blend was made among medium grain cultivars. Specifically, the study compared individual cultivars and the resulting blends length to width ratio, thickness, chalk distribution, milling yield, color, pasting, and cooking properties. The analysis revealed significant effects of rice blending on the composite lots length to width ratio and thickness. While some cultivars benefited from blending, others experienced a reduction of values in the composite lot.

For example, blending RT 7321 FP with other hybrids decreased the composite lots overall length to width ratio by 0.13, whereas blending RT 7521 FP increased it. Differences were also observed in chalk percentage, with RT 7521 FP and RT 7321 FP showing the highest percentages. However, blending these cultivars with others reduced the composite lot's overall chalk percentage. Regarding milling yield, pre-drying blending yielded better results compared to post-drying blending. Individual cultivars, such as RT 7321 FP and XP753, exhibited head rice yields of 47.27% and 58.60%, respectively, while blending hybrid cultivars resulted in an overall head rice yield of around 52%. Among the pasting properties, hybrid cultivars, when blended among themselves and with pureline cultivars, the viscosities decreased significantly when compared to its individual cultivars. Variations were also observed in the cooking duration, with RT 7521 FP having a duration of 26 minutes. However, when blended with other cultivars, the cooking duration ranged between 21- and 22-min. These findings offer valuable insights for rice farmers and processors, guiding optimizing blending practices to enhance the overall milling yield and quality of rice. It was found that blending can both positively and negatively impact various quality parameters. Cultivars with high L/W ratio and lower chalk% were compromised when mixed with less L/W ratio and higher chalk %. Pureline cultivars, when blended, performed better in terms of head rice yield, and pasting properties, and mixing hybrid and pureline cultivars reduced the hardness and gumminess among the textural properties.

Resistant Starch Content in High-Amylose, Basmati, and Jasmine Rice Types

Perdiguerra, K.N.C., Samonte, S.O.PB., Sanchez, D.L., Prodhan, Z.H., Bocco, R., Wilson, L.T., and Yan, Z.

Specialty rice is increasingly valued for its excellent eating quality and nutritional potential in response to the growing consumer demand for healthier food options. Resistant starch (RS), a starch fraction that cannot be digested by the small intestine, has been associated with various health benefits, including improved digestive health and enhanced glycemic control. This study evaluates the RS concentrations in 30 rice genotypes, including Basmati, Jasmine, high-amylose rice, long-grain, and U.S. cultivars.

The RS content was quantified using the Megazyme Digestible and Resistant Starch Assay Kit (K-DSTRS). We optimized the protocol for the analysis of cooked rice samples. Rice samples were cooked separately in beakers inside an automatic electric rice cooker. The samples were then subjected to enzymatic digestion using pancreatic α-amylase (PAA) and amyloglucosidase (AMG) under controlled conditions to quantify RS levels.

The high-amylose rice types, particularly TIL24052 (0.63%) and TIL24053 (0.45%), exhibited the highest RS concentrations, indicating their potential for significant health benefits, such as promoting digestive health and regulating blood glucose levels. In contrast, genotypes such as TIL24067 (0.00%) and ARoma 17 (0.01%), a check genotype for the Jasmine rice type in the U.S., showed minimal RS content, suggesting that although these varieties are more readily digestible, they may offer fewer health benefits in terms of glycemic control and gut health.

High-amylose rice genotypes exhibited higher RS content (ranging from 0.21% to 0.63%), while Jasmine rice types ranged from 0% to 0.14%. These findings highlight the substantial variation in RS content across different rice genotypes, emphasizing the potential for breeding programs to develop rice varieties with higher RS concentrations.

Unlocking the Full Potential of Rice: Enhancing Milled and Malted Rice Quality for Brewing Applications

Aitkens, M.A., Guimaraes, B.P., Schubert, C.S., and Lafontaine, S. R.

Rice is a versatile raw material with significant potential in beverage production, particularly in brewing. Its use, whether milled or malted, directly influences flavor profiles, extract yield, and sensory qualities. Milled rice, with its controlled starch content and purity, offers brewers a consistent and efficient starch source for fermentation, addressing growing consumer demand for gluten-free options. Malted rice, on the other hand, provides unique enzymatic activity and flavor characteristics, presenting opportunities to diversify product offerings.

Our research focuses on evaluating milled and malted rice quality to meet brewers' specific needs. By assessing extract yields, enzymatic activity, and flavor impacts, we aim to provide critical insights for defining need breeding directions, defining raw material specifications for beverage purposes, and improving brewing processes. Climate change is expected to have a greater impact on malting barley than rice, positioning rice as a more resilient and sustainable alternative for brewing applications.

This research also offers new directions for individuals in the rice industry such as breeders and raw material distributors. Developing rice varieties with high malting quality or high extract potential can open novel breeding pathways, aligning agricultural innovation with the evolving needs of beverage producers. By leveraging these findings, we aim to enhance the value of rice as a brewing raw material, supporting industry diversification, growth, and sustainability.

Assessment of a New Nondestructive Method to Measure Rice Chalk Content Based on Rough Rice Properties

Tachie, C.Y.E., Reddy, C., Luthra, K., Dongyi, W. and Atungulu, G.

Chalkiness is one rice quality defect that is of great concern to farmers. Chalky rice exhibits poor milling efficiencies, affecting head rice yield and physicochemical characteristics. Chalky rice samples are usually detected and eliminated after milling using destructive conventional methods, which are challenging in cost, accuracy, large sample size, and results subjected to human errors. Recently, hyperspectral imaging (HSI), a non-destructive technique capable of providing both spatial and spectral information via scanning, has been used in various research. Machine learning is a sub-science of artificial intelligence (AI) that can be applied to classify and discriminate rice seed quality. Machine learning modeling involves dataset collection, training, validation, and testing. About 162 fused hyperspectral and imaging data from rough and brown rice samples were used as input features to discriminate between high, moderate, and low chalky samples using a support vector machine (SVM), multi-layer Perceptron (MLP), and Stacking Cascade-deep neural network. The cross-validation concept was used and accuracies obtained for classifying both rough (87.8, 47.52, 37.03%) and brown (96.96, 51.80, 47.75%) rice for and stacking cascade-DNN, SVM, and MLP, respectively. HSI demonstrated robustness in evaluating rice chalkiness. This innovative sorting method improves quality control and benefits rice handlers and consumers.

Analyzing Milled Rice Breakage Patterns Under Diverse Environmental Conditions

Chukkapalli, D. and Atungulu, G.

This study investigates the impact of environmental conditions relative humidity (RH), temperature, and exposure duration on the quality of milled rice, using three rice cultivars: CLL16 (long grain pureline), XP753 (long grain hybrid), and Titan (medium grain pureline). A standardized post-harvest workflow was followed, including cleaning, drying to 12.5% MC, equilibration at 24 °C and 50 % RH, milling, and subsequent exposure to controlled environmental conditions. Post Milling Exposure (PME) and Post Storage Exposure (PSE) was conducted at 10 °C, and 40 °C under RH levels of 60 %, 75 %, and 90 % for durations of 0, 4, 8, 24, and 48 hours. PME and PSE followed similar environmental parameters to mimic transportation and storage conditions. Quality attributes such as moisture content (MC) changes on a wet basis (% w.b.), fissure formation (%), and mechanical strength (MS) bending force in Newtons (N) were evaluated at each stage.

The results revealed that higher RH and prolonged exposure durations significantly influenced milled rice quality, with more pronounced effects at 75 % and 90% RH. MC increased across all cultivars, with Titan and XP753 showing the highest sensitivity, while CLL16 demonstrated greater stability. Fissure formation progressed steadily over time, with XP753 experiencing the highest fissure percentages, followed by Titan and CLL16. MS decreased consistently across all cultivars under high humidity, with Titan exhibiting the steepest decline. Statistical analyses confirmed RH as the most significant factor affecting all parameters ($p < 0.0001$), followed by exposure duration and cultivar. PSE highlighted similar trends, emphasizing the cumulative effects of high humidity during storage and transport. CLL16 exhibited superior resilience to high-humidity conditions, suggesting its suitability for humid conditions, whereas XP753 and Titan were more prone to MC changes, Fissures formations, and MS decline. These findings underline the critical importance of controlling environmental conditions during storage and handling to minimize quality losses. Tailored strategies, such as cultivar-specific storage protocols and optimized humidity control, are essential to preserving rice grain integrity. This study provides practical insights for enhancing post-harvest management and transportation practices to maintain the quality of milled rice under varying environmental conditions.

Using Insecticide Netting as a Novel IPM Tactic to Protect Postharvest Rice and Other Stored Products from Insects

Morrison III, W.R., Ranabhat, S., Starkus, L., McKay, T., and Zhu, K.Y.

Long-lasting insecticide-incorporated netting (LLIN) has successfully been used to impair mobility and prevent infestation of stored grain by stored product beetles after harvest. Understanding how to integrate LLIN with existing integrated pest management (IPM) tactics, such as phosphine fumigation, and at real-world food facilities, can improve IPM. In this study, we used three 110 metric tons (MT) grain bins, and in each, 60 perforated buckets (e.g., miniature silos) were filled with 500 g of uninfested wheat. Silos were protected by LLIN (0.3% α-cypermethrin, Carifend®, BASF), a positive control (without insecticide), or negative control (no netting). Half of each treatment was randomly assigned to phosphine fumigation treatment, while the remainder were not fumigated. Monthly samples of 100 g of grain from four silos in each of four blocks from three grain bins were taken between Jun–Oct in 2022 and 2023. Dispersing insect life stages and grain quality measures were recorded. Based on the Federal Grain Inspection Service defect guidelines, if the threshold (e.g., two live insects or 16 IDK per 100 g) was met in any bucket during the month, fumigation was triggered. We determined whether phosphine fumigation could be reduced with the use of LLIN over the season. In addition, we also deployed LLIN (both Carifend, and D-Terrence/ZeroFly with 0.4% deltamethrin) at a commercial rice processing facility on the intake manifolds for six months in Arkansas and cleaned half of the LLIN while leaving the other half untouched. We evaluated mortality on a monthly basis during that period against *T. castaneum* and *R. dominica*.

Overall, we found that silos protected with LLIN showed insect dispersal and progeny production that was reduced by 83–99% and 89–99%, respectively, compared to insecticide-free netting and no-netting controls. Additionally, damage in silos was reduced by 50–99% compared to controls. Importantly, the total number of fumigations could be reduced by 68–91% by using LLIN compared to controls. Finally, we found no decrease in efficacy of either LLIN over six months at a commercial rice processing facility. In addition, cleaning had no effect on efficacy, suggesting deposition of food dust will not impair efficacy of netting. Our study demonstrates that LLIN is consistently effective for existing pest management tactics such as phosphine fumigation in bulk storage structures as well as at rice processing facilities in the field.

Management of Insect Pests in Stored Rice

Cook, D.R., Threet, M., Huff, K., Towles, T.B., Lytle, M.J., and Lipsey, H.L.

Numerous insects can infest stored rice, *Oryza sativ*a L., in Mississippi. Many of these are beetle and weevil species, but several caterpillars can also infest stored grain. The risk of insect infestations when storing grain on-farm can vary depending on the level of site and grain bin sanitation, the length of grain storage, and the use of preventative treatments including insecticide application to the empty grain bin and/or insecticide grain protectants (applied directly to the grain). Typically, the risk of infestation/damage is relatively low with short term grain storage (till late winter/early spring). However, if winter conditions are mild, insects that infest stored grain could remain active. Also, some producers are holding grain for longer periods of time for marketing purposes. The longer grain is stored, the greater the risk of insect infestations. Currently, little research is being conducted on stored grain insect pests in Mississippi or the Mid-South. The label for Storicide II, which has been considered a premier stored grain treatment for rice, has recently been revoked. This leaves producers with very limited options for insect management in stored rice.

These trials were conducted using 113.6 L (30 gal) plastic drums as a means of storing grain. A total of 68 kg (150 lbs) of rough rice was placed in each drum. Plots (drums) were arranged in a randomized complete block design with four replications. Treatments included Diacon IGR Plus (deltamethrin plus (s)-methoprene 212.9 ml / 20,412 kg), Diacon IGR Plus plus PBO-8 (deltamethrin plus (s)-methoprene 212.9 ml + piperonyl butoxide 399 ml / 20,412 kg), fumigation with aluminum phosphide (monthly May through Oct), and an untreated control. Tempo (β-cyfluthrin 399.2 ml/94.6 L) applied as an empty bin treatment. The empty bins (drums) were sprayed until wet. Drums were allowed to dry before being filled with grain. These were applied using a seed treater large enough to treat the entire sample. The tops of drums were covered with hardware cloth to prevent intrusion and disturbance by birds and rodents. However, the mesh size was large enough for insects to access the grain. Drums of grain for the experiment were stored under an open air equipment shed for rain protection and to allow natural infestations of insect pests. Samples from each container were collected ca. monthly and grain temperature, moisture content, and the density of insect pests were determined. Grain temperature was determined using a 30.5 cm (12 in) digital thermometer. The thermometer was inserted ca. 28 cm (11 in) into the grain mass. Grain samples were collected using a standard 101.6 cm (40 in) slotted grain probe. The probe was inserted into each plot (drum) at random locations to yield a sample volume of 800 cm^3 (1.7 pints) of grain. Insects were separated from grain using a 0.212 cm (0.0833 in) mesh size sieve. Grain moisture was determined using a Dickey-John 500XT grain analysis computer. Data for each sample date were subjected to analysis of variance and means separated according to Fisher's Protected LSD.

No differences in grain temperature were observed among treatments during Mar through Oct 2024. The untreated barrels had higher grain temperature during Nov 2024 compared to all other treatments. No differences in grain moisture were observed among treatments during Apr and Aug 2024. During Feb, Mar, May, Jun, Jul, Sep Oct, and Nov all of the insecticides resulted in lower grain moisture compared to the untreated control. No differences in maize/rice weevil, *Sitophilus zeamais* Motschulsky, *Sitophilus oryzea* (L.), densities were observed during Feb, Mar, Apr, May, Sep, Oct, or Nov. All of the insecticides reduced weevil densities compared to the untreated control during Jun. During Jul all of the insecticides, except Tempo applied as an empty bin treatment, reduced weevil densities compared to the untreated control. While all of the insecticides, except Diacon IGR Plus, reduced weevil densities compared to the untreated control during Aug. Weevil densities began declining in Aug, while densities of lesser grain borers began increasing. No lesser grain borers were detected before the Jul sample. During Sep, Oct, and Nov all of the insecticides, except Tempo during Sep and Oct, reduced densities of lesser grain borer compared to the untreated control. Maize/rice weevil and lessor grain borer were the primary insect pests observed. Data for total insect pests followed similar trends as that for weevils plus lessor grain borer.

ABSTRACTS OF STUDENT PANEL POSTERS: POSTHARVEST QUALITY, UTILIZATION, AND NUTRITION

Panel Chair: Felipe Dalla Lana

Characteristics of Arabinoxylan in Long-Grain and Medium-Grain Rice Cultivars

Ameyaw, E.O., and Atungulu, G.

Rice parboiling is a widely employed process that involves soaking, steaming, and drying to partially gelatinize rice starch, improving rice nutrition and milling yields. This process generates by-products, including rice bran, which is often treated as waste or used for animal feed. Arabinoxylan (AX), the primary fiber in rice bran, has diverse applications, but its presence and characteristics in parboiled rice remain underexplored.

This study examines the presence and characteristics of AX in long-grain (RT 7401) and medium-grain (CLM04) rice cultivars, comparing non-parboiled and parboiled forms. The bran samples were obtained by milling rough rice into white rice for both parboiled and non-parboiled rice. Approximately 350 g of rice bran from each cultivar was subjected to alkaline-hydrogen peroxide treatment for AX extraction. The extracted AX was analyzed for yield, molecular weight (MW), total starch, and protein content to assess the impact of parboiling.

The results showed a reduction in AX yield for parboiled samples, with long-grain un-parboiled bran yielding 12.59% AX compared to 8.61% for parboiled bran. Medium-grain un-parboiled and parboiled bran yielded 11.42% and 9.24% AX, respectively. MW chromatograms revealed minor differences, with more quantifiable peaks in un-parboiled samples. Total starch content in AX samples slightly varied, ranging from 0.31% (long-grain un-parboiled) to 0.28% (parboiled) and from 0.41% (medium-grain un-parboiled) to 0.43% (parboiled). Protein content showed significant differences, increasing from 11.31% (long-grain un-parboiled) to 19.9% (parboiled) but decreasing from 16.4% (medium-grain un-parboiled) to 14.0% (parboiled).

These findings provide new insights into AX content and its functional properties, highlighting its potential for food and industrial applications while elucidating the effects of parboiling on rice bran's compositional characteristics.

ABSTRACTS FOR PANEL POSTERS: POSTHARVEST QUALITY, UTILIZATION, AND NUTRITION
Panel Chair: Griffiths Atungulu

Potential for Pigmented and Aromatic Rice Varieties in Ricemilk

Chaffee, O., Ardoin, R., Lea, J., Sookraj, A., Boue, S.M., Smith., B, Dupre, R., Olson, D., Broussard, W., and Priddy, D.

Pigmented rice varieties (e.g., “red,” “purple,” or “black”) owe their coloration to polyphenolic compounds such as anthocyanins and proanthocyanidins. These pigments can also provide health benefits due to their antioxidant capabilities. Varieties containing the compound 2-acetyl-1-pyrroline (2-AP) are considered aromatic rices and have a characteristic popcorn-like flavor. While these niche rice varieties are less consumed than milled white rice, an expansion of the plant-based “milk” market may provide a new avenue for their utilization. Therefore, the current research explored the sensory and chemical properties of ricemilks made from whole grain, pigmented, and/or aromatic rice varieties.

Five ricemilk beverages were formulated from the following rice types: aromatic red, aromatic purple, aromatic brown, aromatic white, and non-aromatic white. Greatest in vitro antioxidant capacity (based on oxygen radical absorbance capacity) was found for purple ricemilk (753 µM Trolox equivalents). However, consumers were not as readily receptive to the unusual pigmented ricemilk colors. Based on trained sensory panel analysis, a “blueberry” flavor was unique to samples made from pigmented rice, and the “popcorn” flavor distinguished aromatic from non-aromatic ricemilks. Gas chromatography was used to confirm relative differences in 2-AP concentrations in aromatic rice kernels as the starting material. In terms of flavor, overall acceptability and purchase intent, all aromatic ricemilks scored significantly higher than non-aromatic ricemilk, with aromatic brown ricemilk performing best. With soy, oat, and almond-milks currently dominating the US plant-based milk market, this research demonstrated that capitalizing on the unique properties of niche rice varieties improved health benefits and consumer acceptance, and thus may provide an opportunity for increased market share for rice in this product category.

Effect of Pre-Milling Sample Preparation on Rice Milling Quality of Different Hybrid Rice Varieties

Larazo, W., Larazo, N., and Adviento-Borbe, M.A.A.

Rice milling quality is a critical determinant of yield, processing efficiency, and rice market value. However, variability in pre-milling sample preparation, such as harvest timing, moisture content, and drying methods, can significantly affect milling outcomes. Understanding these effects is essential for developing best practices to ensure consistent and high-quality results. This study investigated the influence of pre-milling sample preparation on the milling quality of hybrid rice varieties. Grain samples were collected from an experimental field under two irrigation practices as main treatments (continuously flooded, CF and furrow, FR), and two fertilizer types as sub-treatments (urea, and sulfate enriched urea, urea_S). Three hybrid rice varieties (RT7321, RT7421, RT7521) and one inbred rice variety (CLL16) were tested. The grain samples were harvested at 80–85% maturity with a moisture content of 23–25%, manually threshed immediately post-harvest, stored in cooler containers, and air-dried for 7–10 days. Cleaning was done once the grain moisture content reached 15–18%. The total weight milling recovery (TWMR) and the percentage of whole

milled grains (PWMG) were measured using two 100 g replicates per sample after milling and grain separation.

Results show that although TWMR varied slightly among treatments, ranging from 71% to 75% under CF irrigation and 73% to 74% under FR irrigation, statistical analysis revealed no significant effects of irrigation type ($P = 0.244$) or rice cultivar ($P = 0.627$). Similarly, PWMG showed minor differences, with CF irrigation producing recovery rates of 95% to 96% and FR irrigation ranging from 94% to 96%, yet neither irrigation method ($P = 0.540$) nor rice variety ($P = 0.946$) significantly influenced whole-grain recovery. Under CF irrigation, varieties RT7421 (urea and urea_S) consistently achieved the highest TWMR (75%) and PWMG (96%), while under FR irrigation, RT7521 performed the best in PWMG (96%). However, other cultivars, including RT7321, RT7421, and CLL16, demonstrated competitive recovery rates across both irrigation systems, indicating that all tested varieties performed well under standardized pre-milling conditions. The more uniform TWMR observed under FR irrigation suggests that this method may reduce variability among cultivars, although it did not statistically outperform CF irrigation. These findings suggest that while irrigation type and rice variety may introduce slight variability in milling outcomes, their effects are minimal when pre-milling sample preparation is conducted at moisture content between 23% to 25%. Our results corroborated previous studies reporting that milling quality is critically linked to grain moisture content at harvest. Careful consideration of grain moisture content at harvest provides rice growers with higher milling quality regardless of environmental or varietal differences.

Deciphering the Phenolic Constituents of Rice Hull Extracts using UPLC-qTOF-MS/MS and Their Antioxidant and Cytotoxic Effects Against Estrogen-Dependent Human Breast Cancer Cells.

Rana, S., Broussard, W., Elliot, S., Burow, M.E., and Boue, S.M.

The growing interest in antioxidants and their health benefits has led to the exploration of rice hulls that are a by-product of rice milling. These hulls typically are a waste product but could be a source of bioactive phenolic compounds. Breast cancer remains the most diagnosed cancer among women worldwide, and antioxidant-rich diets have been directly correlated with a decreased risk of breast cancer. This study examined free and bound phenolic compounds extracted from the hulls of five different rice varieties: Rondo, Cypress, Tiara, Scarlet and Cahokia. Free phenolics were recovered using 80% methanol while bound phenolics were obtained from the residue through alkaline hydrolysis. UPLC-qTOF-MS/MS analysis identified phenolic acids and flavonoids in both free and bound rice hull fractions. *In vitro* antioxidant activity of the extracts was assessed using the ORAC and DPPH radical scavenging assays. The phenolic acid and flavonoid contents of the free and bound fractions from the rice hulls were identified using UPLC-qTOF-MS/MS. Breast cancer cells (MCF-7N and mutant MCF-7-Y537S) were dosed with rice hull extracts for 24 and 48 hours before evaluating cytotoxicity using crystal violet.

Results showed that rice hull extracts significantly inhibited human breast cancer MCF-7N and mutant MCF-7-Y537s cells at different concentrations. Bound phenolic extracts had significantly higher phenolic content compared to their correspondent free phenolic extracts. These bound extracts also exhibited superior antioxidant activity, as indicated by both ORAC and DPPH assays. Key phenolic acids identified included 4-hydroxybenzoic, p-coumaric, ferulic, vanillic, protocatechuic, and caffeic acids. Notably, rice hull extracts demonstrated significant cytotoxic effects on the estrogen-dependent human breast cancer cells (MCF-7N and mutant MCF-7-Y537S) at varying concentrations. These findings suggest that rice hulls are a valuable source of bioactive phenolic compounds with potent antioxidant and anticancer properties against breast cancer. Our study highlights the potential of rice hulls as a cost effective and sustainable resource for developing nutraceuticals.

ABSTRACTS OF PAPERS FOR PANEL ORAL PRESENTATIONS: ECONOMICS AND MARKETING

Panel Chair: Michael Deliberto

Moderator: Michael Deliberto

The Impact of CAFTA-DR on Rice Trade Dynamics: A Spatial Partial Equilibrium Modeling Approach

Durand-Morat, A. and Han, J.

The Dominican Republic-Central America Free Trade Agreement (CAFTA-DR) is a trade pact between the U.S. and six Central American countries: Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and the Dominican Republic. The agreement aimed to create fair trade conditions between members and phasing out most other tariffs within 15 years, with all tariffs eliminated in 20 years. Based on the tariff-reduction schedules, imports of U.S. rice have been duty-free in El Salvador, Honduras, Guatemala, and Nicaragua since 2023, and will achieve that status in the Dominican Republic by 2026 and Costa Rica by 2028.

Despite these trade preferences granted to the U.S., Central America has shifted rice imports from the U.S. to Mercosur. This trend poses a significant challenge for the U.S. rice industry, which exports over 40% of the rice produced every year and for which Central America is among the top 3 exporting regions. This phenomenon suggests that the benefits of CAFTA-DR for rice stakeholders in Central American countries may not outweigh the welfare gains achieve by trading with Mercosur countries, suggesting that CAFTA-DR may need to be renegotiated to better align with its members' needs. Therefore, understanding the nuanced trade dynamics between CAFTA-DR countries and their major rice partners, as well as the role of the agreement in these interactions, is crucial. However, despite its significance, the impact of CAFTA-DR on global rice trade has rarely been explored in the literature, leaving the role of the agreement in shaping rice trade dynamics unclear.

This study aims to assess the impact of the DR-CAFTA agreement on rice trade, production, and distribution, focusing on Western hemisphere countries, including the U.S. It also examines the effects of extending preferential treatment to other rice-exporting countries, which could weaken U.S. competitiveness in the region.

We use a Spatial Partial Equilibrium Model (SPEM) to capture bilateral trade dynamics. The model incorporates supply and demand functions calibrated to exogenous elasticities and 2023 trade data, focusing on long-grain rice, the primary type traded under DR-CAFTA. Data sources include COMTRADE, USDA, FAOSTAT, and target countries' government agencies, while policy information comes from USDA GAIN reports, OAS databases, and WITS.

Our preliminary findings show that DR-CAFTA has benefited the U.S. rice sector by increasing producer welfare and exports but at the cost of higher domestic rice prices, reducing U.S. consumer surplus. However, these benefits may decline if DR-CAFTA extends preferences to other competitive exporters, particularly from Mercosur. Our analysis will explore the agreement's effects on production, trade, demand, and welfare across the global rice market.

Testing the Hedging Pressure Hypothesis in U.S. Rice Futures Prices

Yang, Y. and McKenzie, A.M.

Transferring risks from hedgers to speculators is one of the major roles of futures markets. Keynes (1930) posits that hedgers in futures markets should compensate speculators for bearing the risk. The Hedging Pressure Hypothesis suggests that futures prices are affected by the demand for hedging. Futures prices decrease as producers and commercials hedge by taking short futures positions, while they increase as speculators take long futures positions to balance the market. Although this hypothesis has been examined extensively for major agricultural commodities, such as corn and soybeans, there is no extant research on this topic for U.S. rice futures markets.

We collect weekly data on the positions (i.e. open interest, long position, and short position) held by different categories of traders (e.g. hedgers or commercials versus non-commercials or speculators) from the Commodity Futures Trading Commission (CFTC) from June 13, 2006, to November 19, 2024. We compare weekly changes in the net trading positions of each trading category with respect to weekly changes in rice futures prices (returns) over the same sample period. We define net trading as the difference between the number of short futures contracts and the number of long futures contracts held by each trading category. Commercial hedgers are typically net short futures contracts while speculators or typically net long futures contracts. We model the weekly changes in futures prices and the net trading positions of each trader category using a vector autoregressive regression (VAR) model and use Granger causality tests to determine if the changes in category positions drive futures price changes and vice versa.

Our preliminary results reveal that rice returns are more highly correlated with the net trading activity of commercial traders (hedgers) compared with speculators or non-commercial traders. We find that greater hedging activity, reflected by higher levels of short-futures trading, is associated with positive changes in futures returns. This would be consistent with greater producer selling and hedging of rice in cash markets when prices increase. Analogously, we find that higher levels of buying (or going net long) by speculators is associated with positive futures returns. This is consistent with the notion that as hedging demand increases and net short positions by hedgers increase during periods of price increases, the larger the net long positions taken by speculators to meet the higher hedging demand. We find additional support for this argument in that we also identify a unidirectional influence with respect to changes in trading category positions, where commercial traders' positions significantly impact non-commercial traders' behavior, but not vice versa.

Expected Rice Returns in Different Planting Windows: Stochastic Efficiency with Risk Function (SERF).

Badarch, B., Watkins, K.B., and Hardke, J.T.

Rice *Oryza sativa L.* farmers face weather challenges almost every planting season. Extreme spring weather events, e.g., excessive rainfall or cooler than average temperatures during the spring planting, significantly shorten the planting season. One of the most common challenges farmers face today is figuring out the optimum planting date that could minimize the economic losses caused by weather-related production risk. Because there are different levels of weather risk associated with each planting time (early, middle, or later), for instance, early planting in the season can cause poor seed maturity and growth performance due to frost and flooding during the season, versus later planting can also cause poor yield performance due to drought and disease outbreak during the growing season.

Therefore, the objective of this study is to evaluate six different Planting Windows (PDs), e.g., PD1 ends by March 22nd, PD2 ends by April 5th, PD3 ends by April 20th, PD4 ends by May 5th, PD5 ends by May 20th, and PD6 ends by June 4th, based on their expected rice net returns. The method is based on the Stochastic Efficiency with respect to a function (SERF) framework that incorporates risk aversion bounds. It is applied in this study to determine which planting window is preferred (highest rice net return) at the given level of risk aversion preference. In addition, we estimate potential risk premiums associated with switching early planning windows to middle and later planting windows to investigate how changes in planting dates influence economic returns. The data used in this study is from the Degree-Day 50 (DD50) rice cultivar thermal unit threshold studies conducted annually by the University of Arkansas System Division of Agriculture (UADA).

Based on the preliminary results, the analysis revealed that the chances of having less than zero rice net returns in PD1, PD2, PD3, PD4, PD5, and PD6 are 3%, 6%, 5%, 15%, 10%, 23%, respectively. Based on the SERF with risk aversion bounds, PD1 is the most preferred until its absolute risk aversion reaches 0.008, and then PD2 is more preferred. Lastly, the risk premiums of switching from the middle (PD3 and PD4) or the later planting dates (PD5 and PD6) to early planting dates (PD1 and PD2) across risk aversion bounds are \$48.16 ha-1, or \$104.41 ha-1, respectively, on average. Based on the current findings, we concluded that early planting windows (PD1 and PD2) tend to have the highest rice net returns with the lowest risk aversion relative to rice net returns at later planting windows (PD3, PD4, PD5, and PD6).

Precise Nitrogen Recommendations Improve Economic and Environmental Outcomes in Rice Production

Nalley, L., Durand-Morat, A., Shew, A., Parajuli, R. and Roberts, T.L.

Using data from seven rice growing seasons and 1,129 rice producers who submitted soil samples for N testing we use a stepwise Life Cycle Analysis (LCA) to monetize the environmental improvements from historical N-STaR adoption. N-STaR is a N test specifically targeted to the unique growing conditions of paddy rice. Quantification of environmental impacts (like those estimated in this study), which are non-market goods/services in terms of a monetary unit (that is, a single score), facilitates comparison amongst alternate management technologies, in our case, N-STaR adoption. Average benefits per year were estimated at 15.51 million (2018 USD), of which 70% are ecosystem benefits, 25% N application cost savings, and 5% aerial N application savings. Our findings suggest that by overlooking the environmental benefits of N-STaR adoption and only focusing on the cost savings from reduced N application, the benefit-cost ratio would be underestimated by 286%. As environmental concerns grow in production agriculture, commodity yield ceilings are approached with more and private monies flow into input-reducing research, making accounting for environmental benefits and potential foregone environmental damage more important. Often at the state/province/federal level soil tests are subsidized to some extent and studies like this provide more evidence to funding bodies that they need to not only look at the benefits to producers from soil testing but society as well.

An Economic Risk Analysis of Alternative Rice Irrigation Systems in Eastern Arkansas Under Varying Pump Lifts

Watkins, K.B., Henry, C.G., and Badarch, B.

Groundwater is the largest source of irrigation water used in Eastern Arkansas, and approximately 94% of all groundwater for irrigation comes from the Mississippi River Valley alluvial aquifer (MRVAA). Large groundwater withdrawals are placing significant downward pressure on this economically important source of irrigation water. Less groundwater translates into deeper pumping depths, making irrigation water more expensive in locations where water is more limiting. Rice accounts for a significant portion of the groundwater withdrawn from the MRVAA. Most rice farmers keep from 75 to 154 mm (3 to 6 in) of standing water on rice fields during the growing season, with average annual irrigation water use in rice production totaling 813 mm (32 in) during a typical growing season. Conservation of irrigation water in rice production is thus of paramount importance in Eastern Arkansas.

This study evaluates the profitability of different irrigation systems currently used by rice producers in Eastern Arkansas with the objective of identifying the monetary funds necessary to encourage a rice producer to switch from a water intensive irrigation system to a more water conserving alternative when also accounting for varying pump lifts. Six different irrigation systems are evaluated in the analysis: 1) contour levees; 2) contour levees with Multiple Inlet Rice Irrigation (MIRI); 3) straight levees; 4) straight levees with MIRI; 5) zero-grade; and 6) furrow (row rice) irrigation. Annual irrigation system returns are calculated on a per hectare basis for all 26 counties in Eastern Arkansas for the period 2000 – 2023 and are defined as gross returns (rice price * county yield) less variable and fixed expenses. Irrigation system profitability is evaluated for both diesel and electric irrigation motors based on fuel consumption values from the literature. Annual irrigation labor is also calculated for each irrigation system based on irrigation labor data obtained from the literature. Annual irrigation system returns thus vary by mode of power (diesel or electric), county yield, county average pump lift, rice price, diesel price, electric price, and labor wage rate.

The relative profitability for each irrigation system is evaluated using stochastic efficiency with respect to a function (SERF). The SERF method calculates a certainty equivalent (CE) for a risky outcome (in this case an irrigation system) given a specified level of risk aversion exhibited by a decision maker (a rice producer). A CE value assumes the decision maker exhibits some level of risk aversion, whereas an expected (or mean) monetary value assumes the decision maker is risk neutral and is therefore unconcerned with return variability. Empirical investigations of risk in agriculture indicate farmers express varying degrees of risk aversion and that their risk attitudes may strongly affect their economic behavior. The difference between the CE of a dominant outcome and the CE of an inferior outcome for a given level of risk aversion represents the risk premium (RP) of the dominant outcome. The RP reflects the risk weighted premium the decision maker would receive for choosing the dominant outcome over the inferior outcome. This study evaluates RPs for rice irrigation systems that are more water conserving relative to contour levee rice irrigation under low, moderate, and high levels of risk-aversion.

The results highlight the impact pump lifts have on risk premiums for water conserving irrigation systems. Six counties in Eastern Arkansas (Arkansas, Cross, Lonoke, Poinsett, Prairie, and St. Francis Counties) exhibit deep pump lifts (27 to 35 m or 88 to 116 ft), whereas the remaining 20 counties in Eastern Arkansas exhibit relatively shallow pump lifts (12 to 21 m or 39 to 70 ft). Counties with deep pump lifts have larger RPs for water conservation practices than counties with shallow pump lifts. For example, assuming diesel irrigation power, RPs for contour levees with MIRI relative to contour levees without MIRI ranged from \$115 ha^{-1} (\$47 ac^{-1}) under low risk aversion to \$78 ha^{-1} (\$31 ac^{-1}) under high risk aversion for deep pump lifts, and ranged from \$74 ha^{-1} (\$30 ac^{-1}) under low risk aversion to \$53 ha^{-1} (\$21 ha^{-1}) under high risk aversion for shallow pump lifts. In addition, risk premiums are higher for diesel irrigation power than for electric irrigation power. For example, assuming the rice producer is moderately risk averse and operates in a county with deep pump lifts, the RPs for contour levees with MIRI relative to contour levees without MIRI is \$88 ha^{-1} (\$36 ac^{-1}) for diesel power versus \$71 ha^{-1} (\$29 ac-1) for electric power. Results from this analysis should be useful for determination of accurate, more targeted incentive payments for water conservation in rice production, particularly when risk aversion rather than risk neutrality is considered.

Economic Analysis of Fertilizer Use for Furrow Irrigated Rice (FIR) and Flooded Rice Production Systems in Arkansas

Mohite, D.B., Mane, R., and Henry, C.G.

Arkansas has the highest area of rice harvested and highest average rice production, with an average area of 0.53 million hectares, and an average production of 4.9 million tons respectively, over a period of 4 years, from 2016 to 2020. Flooded Rice Production System is the most common rice cultivation system practiced for rice cultivation in Arkansas. However, in recent years Furrow Irrigated Rice (FIR) production practice has increased significantly in Arkansas. The FIR production practice has increased from 4,156 acres in 2012 to 118,000 acres in 2019, an increase of 113,844 acres over an 8-year period. There is a remarkable challenge in the FIR cultivation system, there is still a knowledge gap in inputs cost, irrigation methods, and crop management that influence net returns. The objective of this research is to study the cost of fertilizers for both FIR and flooded rice cultivation systems.

The fields considered in this study are in the northern and eastern regions of Arkansas and are in Arkansas, Clay, Craighead, Jackson, Jefferson, and Lawrence Counties respectively. The field data is divided into two samples for data analysis, namely, sample A and sample B. Sample A consists of 26 paired fields (13 flooded rice fields and 13 FIR fields) from selected rice-growing counties in Arkansas, from 2016 to 2020. Whereas sample B consists of 16 paired fields from the Arkansas state from 2016 to 2020 (8 flooded rice fields and 8 FIR fields). Sample B is a subset of sample A. The paired fields are the fields that are adjacent to each other, having similar characteristics such as the same soil type. The reason to create sample B from sample A is that the rice producers in sample B have experience in growing FIR rice prior to 2016 as compared to rice producers in sample A. The data analysis was conducted using SAS 9.4 statistical software. The Wilcoxon rank-sum test, a non-parametric method, was performed to compare the fertilizer costs of FIR and flooded rice in samples A and B respectively. Based on producer level data from 2016 to 2020, this research concludes that (at $\alpha = 0.05$) there was no significant difference in fertilizer costs between the flooded and FIR rice cultivation system for both samples A and B respectively. Sample A has an average fertilizer cost of 138.40 and 122.40 dollars per acre for FIR and flooded rice, respectively. Whereas for sample B, these costs are 131.00 and 116.00 dollars per acre for FIR and flooded rice respectively. It was observed that most of the rice producers used the same quantity of pre flood fertilizers, especially pre-emergence fertilizers such as phosphorus (P) and potassium (K) for both systems. Furthermore, for both systems, most rice producers applied the same amount of nitrogen (N).

Evaluating Insurance Changes in the Farmer Act of 2024 on U.S. Rice Farms

Lambert, E., Outlaw, J., Fischer, B., Bryant, H., and Knapek, G.

Crop insurance has been a critical risk management tool for farmers since its inception in 1889, with the Federal Crop Insurance Corporation (FCIC) established in 1938 to assist farmers during the Great Depression and Dust Bowl. The passage of the Federal Crop Insurance Act of 1980 introduced a public-private partnership, offering premium support to encourage farmer participation. However, the effectiveness of this program has been limited by competing disaster relief payments. Historically, farmers have relied on individual coverage options such as Revenue Protection (RP) and Yield Protection (YP), while participation in supplemental area programs like Supplemental Coverage Option (SCO), Stacked Income Protection (STAX), and Enhanced Coverage Option (ECO) has been low.

The Federal Agricultural Risk Management Enhancement and Resilience Act of 2024 (FARMER Act of 2024) proposes significant changes to address these issues, including lowering the minimum coverage level and increasing premium support for Supplemental Coverage Option (SCO). This study investigates the potential impact of these proposed changes on rice, specifically evaluating whether the proposed changes will increase participation in SCO insurance plans. Additionally, it will examine the cost-effectiveness of various insurance combinations for rice farms, using representative farms from the Agriculture and Food Policy Center (AFPC) at Texas A&M University. Finally, the analysis aims to determine if proposed adjustments will effectively reduce reliance on ad hoc disaster assistance without leading to unintended consequences, such as excessive buy-down of underlying policies.

ABSTRACTS FOR PANEL POSTERS: ECONOMICS AND MARKETING
Panel Chair: Michael Deliberto

Climate Smart Agriculture Practices in Rice Production Systems

Deliberto, M.A., Dimas-Rodriguez, A.M., and Hilbun, B.M.

Rice production in the mid-south region of the United States represents a significant majority of rice produced in the U.S. on an annual basis. New federal policies place emphasis on the relationship between agriculture and environmental resilience that has resulted in additional research funding to evaluate alternative production practices deemed 'climate smart'. Climate Smart Agriculture (CSA) defines a set of production practices that can address climate change under an integrated approach with respect to economic and environmental efficiencies. The main goal of CSA is to increase crop productivity, enhance resilience to environmental changes and reduce greenhouse gas (GHG) emissions.

Alternative rice production systems are grouped under the appropriate water management strategy (e.g., traditional flood, furrow irrigation, and alternative wetting and drying). This grouping can serve as the initial step in measuring the economic and environmental effectiveness of each system based on farm profitability and GHG emissions. Farm input usage is measured against yield and price received per rice cultivar to determine the net return per hectare of rice. By comparing the economic cost for each alternative production system, farm profitability can be determined subject to anticipated yield and price volatility. Furthermore, the estimated risk premium among each alternative as it compares to a traditional flood management strategy can be obtained. This can be beneficial in determining the financial incentive offered to producers to adopt alternative water management delivery systems in the presence of uncertainty. Additional research is aimed at quantifying the GHG emissions relative to the degree of the farm input used in the rice production process.

Rice Price Prediction: Economic and Marketing Insights in the U.S. and Louisiana

Goyal, R. and Ayettey, G.

Accurate rice price predictions are critical for enhancing the economic stability of rice producers and stakeholders in the US and Louisiana. Traditional forecasting models often fail to capture the complexities of market dynamics, such as weather-induced supply disruptions, fluctuating input costs, and global trade patterns. These gaps in predictive accuracy lead to suboptimal decision-making for farmers and marketers, potentially resulting in financial losses or missed opportunities. Leveraging machine learning (ML) and artificial intelligence (AI) offers a novel approach to integrating diverse data sources—such as historical price trends, real-time market signals, and regional production conditions—to enhance prediction accuracy. This study aims to address these challenges by providing actionable insights that support risk management, marketing strategies, and improved resilience in the face of economic and environmental uncertainty.

The study employs advanced ML and AI techniques, such as gradient boosting, neural networks, and ensemble learning, to model and predict rice price changes. Key inputs include historical price data, weather patterns, production estimates, and local demand factors. Data were sourced from USDA and state-level agricultural reports, and real-time commodity market platforms. These datasets were preprocessed to address missing values, outliers, and seasonality before being input into predictive models. A multi-phase

validation approach was used, combining cross-validation and out-of-sample testing to ensure robustness and reliability. In addition to quantitative predictions, sensitivity analyses were conducted to determine the relative importance of various factors, such as weather, input prices, and global trade dynamics.

Preliminary findings indicate that AI/ML models significantly outperform traditional econometric approaches in predicting rice price fluctuations, particularly under conditions of market volatility. The models identified weather-induced production variability and export demand as the most critical drivers of price changes. These insights have been disseminated through quarterly reports targeting farmers, agricultural consultants, and industry stakeholders. The reports highlight not only price predictions but also recommended marketing and risk management strategies, enabling stakeholders to make informed decisions regarding planting, storage, and sales. The project has already demonstrated value in helping farmers optimize their operations, manage input costs, and negotiate favorable market terms. Looking ahead, this research lays the foundation for broader adoption of AI/ML tools in agricultural markets. By improving price prediction accuracy, these methods offer the potential to enhance profitability and market stability for rice producers and other agricultural sectors, fostering a more data-driven approach to economic and marketing decision-making.

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INDEX OF ABSTRACT AUTHORS (continued)

INSTRUCTIONS FOR PREPARATION OF ABSTRACTS FOR THE 2027 MEETING

Beginning with the Proceedings for the 24th Rice Technical Working Group meetings, Desktop Publishing software was chosen as a means for expediting the post-meeting publication process. To accomplish this move, Microsoft Word (Windows) has been identified as the preferred word processing software to be used. If individuals do not have access to MS Word, submission of materials in ASCII format (DOS compatibility is essential) is acceptable. **Each electronic file should include: 1) title of materials, 2) corresponding RTWG panel, 3) corresponding author's name, daytime telephone number, e-mail address, and 4) computer format** (i.e., MS Word and version number). These criteria apply uniformly to 1) presented paper abstracts, 2) poster abstracts, 3) symposia abstracts, 4) panel recommendations, and 5) list of panel participants. More details with respect to each of these items follow below.

Presented Paper, Poster, and Symposia Abstracts

To be published in the printed proceedings, presented paper, poster, and symposia abstracts for the 41st RTWG meeting must be prepared as follows. Please follow these instructions -- doing so will expedite the publishing of the proceedings.

1. An electronic file is required and should be submitted to the respective panel chairs 2½ months prior to the 41st RTWG meeting in 2027, or earlier as stated in the Call for Papers issued by the 41st RTWG meeting chair and/or panel chairs.

   The respective panel chairs for the 2027 RTWG meeting and their email and mailing addresses are presented following this section. In case of other questions or in the absence of being able to access the Call for Papers, contact:

   Dr. Kurt Guidry
   H. Rouse Caffey Rice Research Station
   LSU AgCenter
   1373 Caffey Road
   Rayne, LA 70578
   Phone: (337) 788-7531
   Email: kmguidry@agcenter.lsu.edu

2. Margins: Set 1-inch for side margins; 1-inch top margin; and 1-inch bottom margin. Use a ragged right margin (do not full justify) and do not use hard carriage returns except at the end of paragraphs.

3. Type: Do not use any word processing format codes to indicate boldface, etc. **Use 11 point Times New Roman font**.

4. Heading:
   a. Title: Center and type in caps and lower case.
   b. Authors: Center name(s) and type in caps and lower case with last name first, then first and middle initals, with no space between the intials (e.g., Groth, D.E.).
   c. Affiliation and location: DO NOT GIVE AFFILIATION OR LOCATION. Attendance list will provide each author’s affiliation and address.

5. Body: Single space, using a ragged right margin. Do not indent paragraphs. Leave a single blank line between paragraphs.

6. Content is limited to one page.
    a. Include a statement of rationale for the study
    b. Briefly outline methods used
    c. Summarize results

7. **Tables and figures are not allowed**.
8. **Literature citations are not allowed**.
9. **Use the metric system of units**. English units may be shown in parentheses.
10. **When scientific names are used, *italicize* them -- do not underline.**

Special Instructions to Panel Chairs

Each panel chair is responsible for collecting all of his/her panel abstracts prior to the 41st RTWG meeting. The appropriate due date will be identified in the Call for Papers for the 41st RTWG meeting. **Each panel chair is responsible for assembling his/her panel abstracts into one common MS Word file that is consistent with the above guidelines, with the abstracts appearing in the order presented. Paper abstracts will be presented first and poster abstracts second. A Table of Contents should be included with each panel section. Panel chairs are responsible for editing all abstracts for their panel.** A common file should be developed prior to the beginning of the 41st RTWG meeting and submitted to the RTWG Publication Coordinator to accommodate preliminary preparation of the proceedings prior to the meeting. These materials will be merged in the final proceedings in the format submitted. Final editing will be done by the Publication Coordinator, Rice Research Station secretarial staff, and the incoming Chair.

In addition, panel chairs are to prepare and submit both a paper copy and MS Word computer file version of the (1) final Panel Recommendations and (2) a list of panel participants by the conclusion of the meeting. A copy of the previous recommendations and panel participants will be provided to each panel chair prior to the meetings.

ADDRESSES FOR 2027 PANEL CHAIRS

Student Contest Panel

Lina Bernaola
Texas A&M AgriLife Research and Extension Center
1509 Aggie Drive
Beaumont, Texas 77713
Phone: 409-245-8632
Email: lina.bernaola@ag.tamu.edu

Breeding, Genetics, and Genomics

Shyamal K. Talukder
Texas A&M AgriLife Research and Extension Center
1509 Aggie Drive
Beaumont, Texas 77713
Phone: 409-245-8623
Email: Shyamal.talukder@tamu.edu

Economics

To Be Determined

Plant Protection

Xin-Gen Zhou
Texas A&M AgriLife Research and Extension Center
1509 Aggie Drive
Beaumont, Texas 77713
Phone: 409-245-8627
Email: shane.zhou@aesrg.tamu.edu

Postharvest Quality, Utilization, and Nutrition

Yubin Yang
Texas A&M AgriLife Research and Extension Center
1509 Aggie Drive
Beaumont, Texas 77713
Phone: 409-245-8628
Email: yubin.yang@aesrg.tamu.edu

Rice Culture

Lee Tarpley
Texas A&M AgriLife Research and Extension Center
1509 Aggie Drive
Beaumont, Texas 77713
Phone: 409-245-8617
Email: ltarpley@tamu.edu

Weed Control and Growth Regulation

Sam Rustom
Texas A&M AgriLife Research and Extension
2963 FM 102
Eagle Lake, Texas 77434
Phone: 662-299-5434
Email: sam.rustom@ag.tamu.edu

IN MEMORY OF
Ned French

Ned French passed away on June 18, 2024. Ned completed his bachelor's degree in chemistry at Millsaps College, his M.S. in entomology at Mississippi State University, and his Ph.D. in Entomology at North Carolina State University.

Over his 30-year career, Ned served in numerous roles across the agriculture industry including positions as a Technical Service Representative and Product Development Manager, among others; and played a pivotal role in the labeling of Prowl herbicide for use in rice.

IN MEMORY OF
Carl Johnson

Carl Johnson passed away on April 17, 2023. Carl earned his bachelor's degree in agronomy from Kansas State University, his M.S. in agronomy from North Dakota State, and went on to receive his Ph.D. in agronomy and plant genetics from the University of Nebraska-Lincoln. He came to work at the Rice Experiment Station (RES) for the California Cooperative Rice Research Foundation (CCRRF) in 1974 and retired in 2008.

During his tenure RES released 38 rice varieties to California growers. Of the 14 Clarose type medium-grain varieties, his primary responsibility, several have been particularly successful. Industry standard M-202 was released in 1985, and M-205 and M-206, which combine high yield potential and improved milling, and M-208, with resistance to the race of rice blast disease found in California, mark additional accomplishments for Dr. Johnson.

Carl played a major role in the release of 10 premium-quality medium grains, short grains, and waxy varieties and was a contributor to 10 long-grain releases from RES, as well as several germplasm releases. He was instrumental in obtaining Plant Variety Protection for CCRRF varieties and lead inventor for multiple utility patents on rice cultivars. Some 14 Calrose medium grain varieties were released during Carl's leadership in the medium grain project at RES, in addition to his contribution to an additional 15 releases in 7 other market types.

IN MEMORY OF
Gene Reagan

Thomas Eugene “Gene” Reagan passed away on December 14, 2023. Gene earned his bachelor’s and M.S. degrees in entomology from Louisiana State University and his PhD from North Carolina State University. He was internationally recognized as an expert on the ecology and management of sugarcane insects and was the Austin C. Thompson Distinguished Professor of Entomology at LSU.

In addition to his work in sugarcane, Gene’s collaborative efforts with other researchers led to management of insect pests in rice, particularly the sugarcane borer and Mexican rice borer. A number of Gene’s students have gone on to serve in rice insect management roles.

IN MEMORY OF
J. Neil Rutger

J. Neil Rutger passed away on June 6, 2024, at the age of 90. He was a breeder with the United States Department of Agriculture and an emeritus adjunct professor in the UC Davis Department of Plant Sciences. He attended the University of Illinois, receiving his B.S. degree in agricultural science in 1960. He earned an M.S. in agronomy in 1962 and his Ph.D. in genetics in 1964, both at UC Davis. His research focused on malting barley genetics. He then joined the faculty at Cornell University as an Extension agronomist. Around 1969, he returned to Davis as a rice geneticist for the USDA, and an adjunct professor in the Department of Agronomy and Range Science. As a member of the graduate group in genetics, he trained 12 M.S. and 12 Ph.D. graduate students. His former students have occupied responsible rice genetics and breeding positions in Arkansas, California, Brazil, China, Egypt, Korea, the Philippines, and Taiwan. He also taught a plant breeding course when there was no department faculty available.

Rutger used induced mutation breeding to rapidly achieve new rice cultivars. His work on semidwarf cultivars, early maturity and grain characteristics had national international impact. In 1976, he developed the first semidwarf table-rice cultivar in the U.S., Calrose 76, which had a 20-percent yield advantage over tall cultivars. This was followed by another semidwarf, M-101, developed using Calrose 76 in a cross-breeding program. Clarose 76 became the ancestral source of semidwarfism for numerous additional varieties developed by rice breeders in California, Australia, and Egypt. These semidwarfs resulted in farm-yield increases of 20 percent and tens of millions of dollars of increased income for rice growers. This work was widely recognized by the International Atomic Energy Agency in Vienna as an example of successful use of induced mutation in plant breeding.

IN MEMORY OF
Bill Webb

Bill D. Webb passed away on July 17, 2023. Bill was born near Ralls, Texas and his family was in the farming business during his youth. Bill earned his bachelor's degree from Texas A&M – which was interrupted by his service in the Air Force during the Korean War. He completed his B.S. in biochemistry upon his return and ultimately his Ph.D.

Bill was employed as a research scientist by the USDA-ARS at the Texas A&M Rice Research Center in Beaumont, Texas. His career spanned 35 years in the US Rice Industry. He provided innovative and significant research to the development of U.S. rice varieties around the world. He was author of numerous scientific publications, book chapters, and reports on rice. He was also the recipient of many awards including a Fellow of the American Association of Cereal Chemists. He retired in 1996 as Research Leader of the USDA Rice Research Program at Beaumont, Texas.

IN MEMORY OF
Ida Wenefrida

Ida Wenefrida passed away on March 27, 2023. Ida was born in Yogyakarta, Indonesia. She received her bachelor's degree in Agronomy from both the Institut Pertanian Bogor (IPB) and the University of Tnjungpura, Indonesia, her M.S. in plant pathology from Mississippi State University, and her Ph.D. in plant health from Louisiana State University.

Ida was an Associate Professor at the LSU AgCenter and a recipient of the 2022 Kenneth W. Tipton Team Research Award for developing a low-glycemic, high-protein rice. This rice variety is named Frontiere and contains 53% more protein than conventional white rice. In 2020, she was awarded the Top 20 Global Woman of Excellence by the American Multi-Cultural Ethnic Coalition presented by U.S. Congressman Danny K. Davis.

GUIDELINES FOR RTWG AWARDS

1.0 The RTWG Chair shall solicit nominations, and when appropriate, award on a biennial basis the following types of awards, namely:

1.1 The Distinguished Rice Research and/or Education Award

1.1a Individual category – An award may be made to one individual at each RTWG meeting in recognition of recent achievement and distinction in one or more of the following: (1) significant and original basic and/or applied research, (2) creative reasoning and skill in obtaining significant advances in education programs, public relations, or administrative skills - which advance the science, motivate progress and promise technical advances in the rice industry.

1.1b Team category – Same as the individual category, except that one team may be recognized at each RTWG meeting. All members of the team will be listed on each certificate.

1.2 The Distinguished Service Award - Awards to be made to designated individuals who have given distinguished long-term service to the rice industry in areas of research, education, international agriculture, administration, and industrial rice technology. Although the award is intended to recognize contributions of a long duration, usually upon retirement from active service, significant contributions over a period of several years shall be considered as a basis of recognition.

2.0 The Awards Committee shall consist of the Executive Committee.

3.0 The duties of the Awards Committee are as follows:

3.1 To solicit nominations for the awards in advance of the biennial meeting of the RTWG. Awards Committee Members cannot nominate or write letters of support for an individual or team for the RTWG awards.

3.2 To review all nominations and select worthy recipients for the appropriate awards. Selection on awardees will be determined by a simple majority (highest number of votes) vote. The Awards Committee Chair (same as the Executive Committee Chair) can only vote in case of a tie. The names of recipients shall be kept confidential, but recipients shall be invited to be present to receive the award.

3.3 The Awards Committee shall arrange for a suitable presentation at the biennial RTWG meeting.

3.4 The Awards Committee shall select appropriate certificates for presentation to the recipients of the Awards.

4.0 Those making nominations for the awards shall be responsible for supplying evidence to support the nomination, including three (3) recommendation letters. Electronic submissions of the nominations are preferred; these should be submitted as a single pdf file, with the exception of a one-page summary of accomplishments that should be provided at the same time, but as a MS Word file. Hard copies can be submitted, in which case fifteen (15) complete copies of each nomination must be submitted, and a one-page summary of accomplishments included with each nomination. This summary will be published in the RTWG Proceedings for each award participant.

4.1 Nominees for awards should be staff personnel of Universities or State Agricultural Experiment Stations, State Cooperative Extension personnel, cooperating agencies of the United States Department of Agriculture, or participating rice industry groups.

4.2 A member of an organization, described in 4.1, may nominate or co-nominate two persons.

4.3 Nominations are to be sent to the Awards Committee for appropriate committee consideration.

4.4 The deadline for receipt of nominations shall be three months preceding the biennial meeting.

4.5 Awards need not be made if in the opinion of the Awards Committee no outstanding candidates have

PAST RTWG AWARD RECIPIENTS

Year Location	Distinguished Service Award Recipients		Distinguished Rice Research and/or Education Award Recipients
1972 Davis, CA	D.F. Houston R.D. Lewis N.E. Jodon E.M. Cralley	L.B. Ellis H.M. Beachell C.R. Adair W.C. Dachtler	None
1974 Fayetteville, AR	J.G. Atkins N.S. Evatt M.D. Miller T. Wassermand	R.A Beiber J.T. Hogan B.F. Hogan	None
1976 Lake Charles, LA	D. H. Bowman R.F. Chandler J.N. Efferson J.P. Gaines	T.H. Johnson M.C. Kik X. McNeal	None
1978 College Station, TX	J.W. Sorenson, Jr. R. Stelly	D.T. Mullins	R.K. Webster
1980 Davis, CA	M.L. Peterson L.E. Crane	W.R. Morrison F.T. Wratten	B.D. Webb
1982 Hot Springs, AR	C.C. Bowling J.P. Craigmiles	I. Drew	Arkansas "Get the Red Out" Team R.J. Smith, Jr. B.A. Huey F.L. Baldwin
1984 Lafayette, LA	M.D. Mors3 L.C. Hill	E.A. Sonnier D.L. Calderwood	California Rice Varietal Improvement Team H.L. Carnahn J.N. Rutger C.W. Johnson S.T. Tseng J.E. Hill J.F. Williams C.M. Wick S.C. Scardaci D.M. Brandon

Continued

PAST RTWG AWARD RECIPIENTS
(continued)

Year Location	Distinguished Service Award Recipients		Distinguished Rice Research and/or Education Award Recipients	
1986 Houston, TX	D.S. Mikkelson	J.B. Baker	Texas Rice Breeding and Production Team	
			C.N. Bollich	B.D. Webb
			M.A. Marchetti	G.N. McCauley
			J.E. Scott	J.W. Stansel
			F.T. Turner	A.D. Klosterboer
			E.F. Eastin	M.O. Way
			N.G. Whitney	M.E. Rister
1988 Davis, CA	M.D. Androus	H.L. Carnahan	Arkansas DD-50 Team	
	S.H. Holder	B.A. Huey	M.R. Boston	G.L. Davis
	M.D. Faulkner	W.R. Grant	F.N. Lee	N.P. Tugwell
	C.H. Hu	F. J. Williams	D.A. Downey	G.L. Greaser
			T. H. Johnson	G. Rench
			B.R. Wells	M.S. Flynn
			B.A. Huey	T.C. Keisling
			R.J. Smith	F.J. Williams
			D. Johnson	
1990 Biloxi, MS	H.R. Caffey O.R. Kunze	B.R. Jackson	None	
1992 Little Rock, AR	C.N. Bollich B.D. Webb	A.A. Grigarick C.M. Wick	J.W. Stansel	
1994 New Orleans, LA	S.H. Crawford J.V. Halick R. J. Smith	K. Grubenman R.N. Sharp	M.C. Rush	

Continued

PAST RTWG AWARD RECIPIENTS
(continued)

Year Location	Distinguished Service Award Recipients		Distinguished Rice Research and/or Education Award Recipients	
1996 San Antonio, TX	P. Seilhan	K. Tipton	D.M. Brandon	
1998 Reno, NV	G. Templeton S.-T. Tseng	B. Wells	S.D. Linscombe	
2000 Biloxi, MS	D.M. Brandon J.W. Stansel	R.K. Webster	<u>Advances in Rice Nutrition Team</u> P.K. Bollich R. J. Norman	 C.E. Wilson
2002 Little Rock, AR	F.L. Baldwin R.H. Dilday	M.A. Marchetti J.F. Robinson	<u>Bacterial Panicle Blight Discovery Team</u> M.C. Rush A.K.M Shahjahan	 D.E. Groth
2004 New Orleans, LA	P.K. Bollich A.D. Klosterboer F.N. Lee W.H. Brown	J.A. Musick J.E. Street J.F. Williams S.L. Wright	<u>Discovery Characterization and Utilization of Novel Blast Resistance Genes Team</u> F.N. Lee A.K. Moldenhauer <u>Individual</u> R.D. Cartwright	 M.A. Marchetti
2006 The Woodlands, TX	T.P. Croughan R. Talbert	J.N. Rutger F. Turner	<u>LSU Rice Variety Development Team</u> S. Linscombe P. Bollich L. White <u>Individual</u> R. Norman	 X. Sha R. Dunand D. Groth

Continued

PAST RTWG AWARD RECIPIENTS
(continued)

Year Location	Distinguished Service Award Recipients		Distinguished Rice Research and/or Education Award Recipients	
2008 San Diego, CA	M.C. Rush C. Johnson	R. Dunand	Bakanae Team J. Oster C. Greer Individual D. Groth	 R. Webster
2010 Biloxi, MS	T. Miller J. Kendall	J. Thompson	Individual E. Webster	
2012 Hot Springs, AR	E. Champagne J. Hill	G. McCauley	Advances in Nitrogen Use Efficiency Team D. Harrell G. McCauley R. Norman T. Roberts J. Ross Individual A. McClung	 N. Slaton B. Tubana T. Walker C. Wilson
2014 New Orleans, LA	R. Fjelistrom	J. Oster	Rice Entomology Team J. Bernhard G. Lorenz L. Espino L. Godfrey Individual J. Saichuk	 M. Stout J. Gore M. Way

Continued

PAST RTWG AWARD RECIPIENTS
(continued)

Year Location	Distinguished Service Award Recipients		Distinguished Rice Research and/or Education Award Recipients	
2016 Galveston, TX	Rolfe J. Bryant Farman Jodari	Lawrence M. White, III	Clearfield Rice Technology Research Team D. Groth D. Harrell Individual Terry Siebenmorgen	 S. Linscombe E. Webster
2018 Long Beach, CA	Merle Anders Randall "Cass" Mutters Steven D. Linscombe	Johnny Saichuk Terry Siebenmorgan Lloyd T. "Ted" Wilson	Rice Irrigation Management Team Merle Anders Michelle Reba Benjamin Runkle Chris Henry Joe Massey Individual Michael Orrin "Mo" Way	 Jarrod Hardke Arlene Adviento-Borbe Bruce Linquist Steve Linscombe Dustin Harrell
2020 Orange Beach, AL	Don Groth Kent McKenzie	Karen Moldenhauer Michael "Mo" Way	Genomics Team Christine Bergman Ming-Hsuan Chen Jeremy Edwards Robert Fjellstrom Individual N/A	 Melissa Jia Yulin Jia Anna McClung William D. Park

Continued

PAST RTWG AWARD RECIPIENTS
(continued)

Year Location	Distinguished Service Award Recipients		Distinguished Rice Research and/or Education Award Recipients	
2023 Hot Springs, AR	Ming-Hsuan Chen Gus Lorenz Zhongli Pan	Bob Scott Eric Webster	Arkansas Weed Science Rice Team Jason Norsworthy Tom Barber Individual Dustin Harrell	 Thomas R. Butts
2025 New Orleans, LA	Lee Tarpley		Organic Rice Research Team Fugen Dou Xing-Gen Zhou Lloyd "Ted" Wilson Yubin Yang Individual Jason Norsworthy	 Tanumoy Bera Anna McClung Michael "Mo" Way Bradley Watkins

RICE TECHNICAL WORKING GROUP HISTORY

Meeting	Year	Location	Chair	Secretary	Publication Coordinator(s)
1st	1950	New Orleans, Louisiana	A.M. Altschul		
2nd	1951	Stuttgart, Arkansas	A.M. Altschul		
3rd	1951	Crowley, Louisiana	A.M. Altschul		
4th	1953	Beaumont, Texas	W.C. Davis		
5th	No	Meeting Was Held			
6th	1954	New Orleans, Louisiana	W.V. Hukill		
7th	1956	Albany, California	H.T. Barr	W.C. Dachtler	
8th	1958	Stuttgart, Arkansas	W.C. Dachtler		
9th	1960	Lafayette, Louisiana	D.C. Finfrock	H.M. Beachell	
10th	1962	Houston, Texas	H.M. Beachell	F.J. Williams	
10th	1964	Davis, California	F.J. Williams	J.T. Hogan	
11th	1966	Little Rock, Arkansas	J.T. Hogan	D.S. Mikkelsen	
12th	1968	New Orleans, Louisiana	M.D. Miller	T.H. Johnston	
13th	1970	Beaumont, Texas	T.H. Johnson	C.C. Bowling	
14th	1972	Davis, California	C.C. Bowling	M.D. Miller	J.W. Sorenson*
15th	1974	Fayetteville, Arkansas	M.D. Miller	T. Mullins	J.W. Sorenson
16th	1976	Lake Charles, Louisiana	T. Mullins	M.D. Faulkner	J.W. Sorenson
17th	1978	College Station, Texas	M.D. Faulkner	C.N. Bollich	O.R. Kunze
18th	1980	Davis, California	C.N. Bollich	J.N. Rutger	O.R. Kunze
19th	1982	Hot Springs, Arkansas	J.N. Rutger	B.R. Wells	O.R. Kunze
20th	1984	Lafayette, Louisiana	B.R. Wells	D.M. Brandon	O.R. Kunze
21st	1986	Houston, Texas	D.M. Brandon	B.D. Webb	O.R. Kunze
22nd	1988	Davis, California	B.D. Webb	A.A. Grigarick	O.R. Kunze
23rd	1990	Biloxi, Mississippi	A.A. Grigarick	J.E. Street	O.R. Kunze
24th	1992	Little Rock, Arkansas	J.E. Street	J.F. Robinson	M.E. Rister
25th	1994	New Orleans, Louisiana	J.F. Robinson	P.K. Bollich	M.E. Rister
26th	1996	San Antonio, Texas	P.K. Bollich	M.O. Way	M.E. Rister M.L. Waller

RICE TECHNICAL WORKING GROUP HISTORY (Continued)

Meeting	Year	Location	Chair	Secretary	Publication Coordinator(s)
27th	1998	Reno, Nevada	M.O. Way	J.E. Hill	M.E. Rister M.L. Waller
28th	2000	Biloxi, Mississippi	J.E. Hill	M.E. Kurtz	P.K. Bollich D.E. Groth
29th	2002	Little Rock, Arkansas	M.E. Kurtz	R.J. Norman	P.K. Bollich D.E. Groth
30th	2004	New Orleans, Louisiana	R.J. Norman	D.E. Groth	P.K. Bollich D.E. Groth
31st	2006	The Woodlands, Texas	D.E. Groth	G. McCauley	D.E. Groth M.E. Salassi
32nd	2008	San Diego, California	G. McCauley	C. Mutters	D.E. Groth M.E. Salassi
33rd	2010	Biloxi, Mississippi	C. Mutters	T.W. Walker	M.E. Salassi
34th	2012	Hot Springs, Arkansas	T.W. Walker	C.E. Wilson, Jr.	M.E. Salassi
35th	2014	New Orleans, Louisiana	C.E. Wilson, Jr	E.P. Webster	M.E. Salassi
36th	2016	Galveston, Texas	E.P. Webster	L. Tarpley	M.E. Salassi
37th	2018	Long Beach, California	L. Tarpley	B. Linquist	M.E. Salassi
38th	2020	Orange Beach, Alabama	B. Linquist	J. Bond	M.E. Salassi
39th	2023	Hot Springs, Arkansas	J. Bond	J. Hardke	M.E. Salassi
40th	2025	New Orleans, Louisiana	J. Hardke	A. Famoso	K.M. Guidry

* 1972 was the first year that an official Publication Coordinator position existed within the RTWG. Prior that, the Secretary assembled and coordinated the publication of the meeting proceedings.

Rice Technical Working Group

Manual of
Operating Procedures

2025

I. Purpose and Organization

The Rice Technical Working Group (RTWG) functions according to an informal memorandum of agreement among the State Agricultural Experiment Stations and the Agricultural Extension Services of Arkansas, California, Florida, Louisiana, Mississippi, Missouri, and Texas, and the Agricultural Research Service (ARS), the Economic Research Service (ERS), the Cooperative State Research, Education, and Extension Service (CSREES), and other agencies of the United States Department of Agriculture (USDA). Membership is composed of personnel in these and other cooperating public agencies and participating industry groups who are actively engaged in rice research and extension. Since 1960, research scientists and administrators from the U.S. rice industry and from international agencies have participated in the biennial meetings.

The RTWG meets at least biennially to provide for continuous exchange of information, cooperative planning, and periodic review of all phases of rice research and extension being carried on by the States, Federal Government, and other members. The current disciplines or Panels represented are: i) Breeding, Genetics, and Cytogenetics; ii) Economics and Marketing; iii) Plant Protection; iv) Postharvest Quality, Utilization & Nutrition; v) Rice Culture; and vi) Rice Weed Control and Growth Regulation. Each Panel has a Chair who, along with the Secretary/Program Chair, solicits and receives titles, interpretive summaries, and abstracts of papers to be presented at the biennial meeting. The papers are presented orally in concurrent technical sessions or via poster. Each Panel over the course of the meeting develops proposals for future work, which are suggested to the participating members for implementation.

Pursuant to the memorandum of agreement, the Association of Agricultural Experiment Station Directors appoints an administrative advisor who represents them on the Executive Committee and in other matters. The administrator of the USDA-ARS designates a representative to serve in a similar capacity. The Directors of Extension Service of the rice growing states designate an Extension Service Administrative Advisor.

Other members of the Executive Committee are elected biennially by the membership of the RTWG; they include the Chair who has served the previous term as Secretary/Program Chair, a Geographical Representative from each of the seven major rice-growing states (Arkansas, California, Florida, Louisiana, Mississippi, Missouri, and Texas), the Immediate Past Chair, and an Industry Representative. The rice industry participants elect an Executive Committee member from one of following areas: i) chemical, ii) seed, iii) milling, iv) brewing industries, v) producers, or vi) consultants. The Publication Coordinator also is on the Executive Committee. The Coordinator of the RTWG website is an ex-officio member of the Executive Committee.

Standing committees include: i) Nominations, ii) Rice Crop Germplasm, iii) Rice Variety Acreage, iv) Awards, and v) Location and Time.

II. Revised Memorandum of Agreement

The previous Memorandum of Agreement is published in the 33rd RTWG Proceedings in 2010. The following is a revised Memorandum of Agreement accepted by the 34th RTWG membership in 2012.

REVISED MEMORANDUM OF AGREEMENT

FEBRUARY 2012

INFORMAL UNDERSTANDING

among

THE STATE AGRICULTURAL EXPERIMENT STATIONS

and

THE STATE AGRICULTURAL EXTENSION SERVICES

of

ARKANSAS, CALIFORNIA, FLORIDA, LOUISIANA, MISSISSIPPI,
MISSOURI, AND TEXAS

and

THE AGRICULTURAL RESEARCH SERVICE,
THE ECONOMIC RESEARCH SERVICE,
THE COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

and

OTHER PARTICIPATING AGENCIES

of the

UNITED STATES DEPARTMENT OF AGRICULTURE

and

COOPERATING RICE INDUSTRY AGENCIES

Subject: Research and extension pertaining to the production, utilization, and marketing of rice and authorization of a Rice Technical Working Group.

It is the purpose of this memorandum of agreement to provide a continuing means for the exchange of information, cooperative planning, and periodic review of all phases of rice research and extension being carried on by State Agricultural Experiment Stations, State Agricultural Extension Services, the United States Department of Agriculture, and participating rice industry groups. It is believed this purpose can best be achieved through a conference held at least biennially at the worker level of those currently engaged in rice research and extension. Details of the cooperation in the seven states are provided in formal Memoranda of Understanding and/or appropriate Supplements executed for the respective state.

The agencies represented in this memorandum mutually agree that overall suggestions of cooperative review and planning of rice research and extension in the several rice producing states and the United States Department of Agriculture shall be developed by a Rice Technical Working Group (henceforth designated RTWG), composed of all personnel actively engaged in rice investigations and extension in each of the agencies, as well as participating rice industry groups.

It is further agreed that there shall be a minimum of three Administrative Advisors to the RTWG to represent the major agencies involved, including:

1) A director of an Agricultural Experiment Station from a major rice-growing state elected by the Station Directors of the rice-growing states,

2) A director of a State Cooperative Extension Service from a major rice-growing state elected by the Extension Directors of the rice-growing states, and

3) A USDA Administrative Advisor from ARS named by the Administrator of Agricultural Research Service.

The RTWG shall convene at least biennially to review results and to develop proposals and suggested plans for future work. It is understood that the actual activities in research and extension will be determined by the respective administrative authorities and subject to legal and fund authorizations of the respective agencies.

Interim affairs of the RTWG, including preparation and distribution of the reports of meetings, plans, and agenda for future meetings, functional assignments of committees, and notification of State, Federal and industry workers will be transacted by the officers (chair and secretary), subject to consultation with the remainder of the Executive Committee.

The Executive Committee shall consist of 15 members:

Officers (2):

Chair - presides at meetings of the RTWG and of the Executive Committee and otherwise provides leadership.

Secretary/Program Chair - (normally moves up to Chair).

Geographic Representatives (7):

One active rice worker in state or federal agencies from each of the major rice states -- Arkansas, California, Florida, Louisiana, Mississippi, Missouri, and Texas.

These Geographic Representatives will be responsible for keeping all governmental rice workers and administrators in their respective geographic areas informed of the activities of the RTWG.

Immediate Past Chair - provides guidance to incoming chair to facilitate a smooth transition between biennial meetings.

Administrative Advisor (one from each category) (3):

State Agricultural Experiment Station
State Agricultural Extension Service
USDA - Agricultural Research Service

Publication Coordinator - serves to handle matters related to the publication of the RTWG Proceedings.

Industry Representative - to be elected by industry personnel participating in the biennial meeting of the RTWG; represents all aspects of the U.S. rice industry and serves as liaison with other rice industry personnel; and is responsible for keeping all interested rice industry personnel informed of the activities of the RTWG.

The Officers, Geographic Representatives, and the Publication Coordinator of the Executive Committee shall be elected on the first day of each biennial meeting to serve through the close of the next regular biennial meeting.

A Panel Chair or Panel Chair and Co-Chair, at least one of whom will be an active rice worker in state or federal agencies, shall be elected by each of the active subject matter panels. Such election shall take place by the end of each biennial meeting and Panel Chairs will serve as members of the Program Committee for the next biennial meeting. Each Panel Chair will be responsible for developing the panel program in close cooperation with the Secretary-Program Chair and for seeing that the Panel Recommendations are updated at each biennial meeting and approved by the participants in the respective panel sessions.

Participation in the panel discussions, including presentation of rice research findings by rice industry representatives and by representatives from National or International Institutes, is encouraged.

At the end of each biennial meeting, after all financial obligations are met, remaining funds collected to support the programs or activities of the RTWG meeting will be transferred by the Secretary/Program Chair to the RTWG Contingency Fund, entitled ‘Rice Tech Working Group Contingency Fund,’ established at the University of Arkansas in the Agriculture Development Council Foundation. In instances where USDA or industry personnel are elected to serve as RTWG Secretary, either the Local Arrangements Chair or the Geographical Representative in the state where the next meeting is to be held will be designated by the RTWG Secretary to receive and deposit funds in station or foundation accounts.

This type of memorandum among the interested state and federal agencies provides for voluntary cooperation of the seven interested states and agencies.

III. Description of Committees, Positions, Duties, and Operating Procedures

A. Executive Committee

The Executive Committee conducts the business of the RTWG, appoints standing committees, organizes and conducts the biennial meetings and presents the awards. Interim affairs of the RTWG, including preparation and distribution of the reports of meetings, plans, and agenda for future meetings, functional assignments of committees, and notification of State, Federal and industry workers will be transacted by the officers (Chair and Secretary), subject to consultation with the remainder of the Executive Committee. A quorum (i.e., eight members, excluding the Chair) of the Executive Committee must be present for the Executive Committee to do business. A simple majority vote is needed to pass any motion and the Chair only votes in the case of a tie. The Executive Committee is composed of the following 15 members: i) three officers—Chair, Secretary/Program Chair, and Immediate Past Chair; ii) seven Geographical Representatives from each major rice producing state; iii) three administrative advisors from the major agencies of Agriculture Experiment Stations, State Agricultural Extension Services, and the USDA; iv) a Publication Coordinator; and v) a Rice Industry Representative. The Officers, Geographical Representatives, and the Publication Coordinator shall be elected to the Executive Committee at the Opening Business meeting of each biennial meeting to serve through the close of the next regular biennial meeting. Industry personnel participating in the biennial meeting elect the Industry Representative. 182

1. Chair

The Chair provides leadership to the RTWG by organizing the agenda and presiding over the Business and Executive Committee meetings, presiding over the Awards process, appointing temporary or ad hoc committees to explore and address RTWG interests, and being the official spokesperson for the RTWG during his/her period of office. If the nomination process for selecting geographical representatives and members of the Nominations committee fails to produce a candidate, then it the responsibility of the Chair to work with the state delegation in selecting a candidate from that state. The Secretary/Program Chair is usually nominated by the Nomination Committee to be Chair at the next biennial meeting. If the Chair nominated cannot serve or complete the full term of office, it is the responsibility of the Executive Committee to appoint a new Chair.

2. Secretary/Program Chair

The Secretary/Program Chair serves a two-year term and is responsible for organizing, conducting and financing the program of the biennial meetings in concert with the Chair, Panel Chairs, and Chair of Local Arrangements. The Secretary/Program Chair appoints a Local Arrangements Committee and Chair from their home state to help with organizing and conducting the biennial meeting. The Secretary/Program Chair is responsible for the minutes of all Business and Executive Committee meetings, the publishing of the minutes of these and other committees (i.e., Rice Crop Germplasm, Rice Variety Acreage, and Nominations) at the RTWG in the Proceedings and ensuring the Panel Chairs correctly publish their minutes and abstracts in the Proceedings. The Secretary/Program Chair is responsible setting up the RTWG website. The Secretary/Program Chair is responsible for the resolutions pertaining to the biennial meeting and for the Necrology Report when appropriate. The Secretary/Program Chair authors the Resolutions section of the RTWG Proceedings that expresses appreciation to individuals and organizations that contributed to making the biennial RTWG meeting a success. The Secretary/Program Chair is a member of the Executive Committee and usually resides in the state the biennial meeting is conducted. The Secretary is usually chosen by active rice workers from the meeting host state and the candidate identified to the Nominations Committee for election. If the Secretary/Program Chair nominated cannot serve or complete the full term of office, it is the responsibility of the member on the Nominations Committee of the hosting state to appoint a new Secretary/Program Chair.

3. **Immediate Past Chair**
Provides guidance to the incoming Chair to facilitate a smooth transition and lend continuity between biennial meetings. The Immediate Past Chair assists the Publication Coordinator in editing the nontechnical sections of the proceedings and revises the MOP as required. The Chair is nominated by the Nominations Committee to be the Immediate Past Chair at the next biennial meeting. The Immediate Past Chair will incorporate the changes approved by the Executive Committee in the MOP.

4. **Geographical Representatives**
There are currently seven geographical representatives representing each of the major rice producing states, Arkansas, California, Florida, Louisiana, Mississippi, Missouri, and Texas, on the Executive Committee. Each state nominates via the Nominations Committee one active rice worker from either a state or federal agency to serve a two-year term on the Executive Committee. If the Geographical Representative nominated cannot serve or complete the full term of office, it is the responsibility of the delegate on the Nominations Committee from that state to appoint a new Geographical Representative.

5. **Administrative Advisors**
The Administrative Advisors provide advice and lend continuity to the Executive Committee. A minimum of three Administrative Advisors will be appointed to the RTWG to represent the major agencies involved. They shall consist of: i) a Director of an Agriculture Experiment Station from a rice-growing state elected by the Station Directors of the rice-growing states; ii) a Director of a State Cooperative Extension Service from a rice-growing state elected by the Extension Directors of the rice-growing states; and a USDA Administrative Advisor from the ARS named by the Administrator of the Agricultural Research Service. No term limit is established.

6. **Publication Coordinator(s)**
The Publication Coordinator is responsible for assembling, editing, and publishing of the RTWG Proceedings from the biennial meeting. The Coordinator is assisted in the editing the nontechnical session portions of the proceedings by the Immediate Past Chair. The Coordinator serves on the Executive Committee to handle all matters related to the publication of the RTWG Proceedings. Currently, one publication coordinator serves this position. This is a voluntary position requiring the approval of the RTWG Executive Committee to serve. No term limit is established.

7. **Industry Representative**
The Industry Representative represents all aspects of the U.S. rice industry to the Executive Committee and serves as liaison with other rice industry personnel. Responsibilities include keeping all interested rice industry personnel informed of the activities of the RTWG. Industry personnel participating in the biennial meeting elect the Industry Representative. If the Industry Representative nominated cannot serve or complete the full term of office, it is the responsibility of the Industry members of the RTWG to appoint a replacement.

B. Standing Committees

The Executive Committee has appointed the following Standing Committees.

1. **Nominations Committee**

   The purpose of the Nominations Committee is to nominate the Secretary/Program Chair, Chair, Immediate Past Chair, and Geographical Representatives to the Executive Committee, and the members or delegates to the Nominations Committee. The Nominations Committee is composed of eight members. Seven of the members represent each of the seven major rice-producing states and one delegate is from the U.S. Rice Industry. As with the Executive Committee, each state nominates via the Nominations Committee one active rice worker from either a state or federal agency to be their delegate on the Nominations Committee and the Rice Industry is responsible for designating who their delegate is on the committee. The Chair of the Nominations Committee is from the next state to hold the RTWG biennial meeting. If a delegate on the Nominations Committee cannot serve or complete the term of office, it is the responsibility of the Geographical Representative from that state to appoint a replacement. Each delegate is responsible for polling the active rice workers in their state or industry to determine who their Geographical Representative is on the Executive Committee and who their delegate is on the Nominations Committee. The Chair of the Nominations Committee is responsible for obtaining the results from each delegate on the Nominations Committee, compiling the results, and reporting the results to the RTWG at the Opening Business meeting for a vote. When a state is next in line to host a biennial meeting, it is the responsibility of the delegate from that state to nominate the Secretary/Program Chair. Since the Secretary/Program Chair moves up to RTWG Chair and the RTWG Chair to Past Chair, it is the responsibility of the Chair of the Nominations Committee to nominate them to the RTWG members.

2. **Rice Crop Germplasm Committee**

   The Rice Crop Germplasm Committee functions not only as an RTWG committee but also as the Rice Crop Germplasm Committee for the National Plant Germplasm System. In this capacity, it is part of a specific national working group of specialists providing analysis, data and recommendations on genetic resources for rice and often-related crops of present or future economic importance. This committee represents the user community, and membership consists of representation from federal, state, and private sectors; representation from various scientific disciplines; and geographical representation for rice. There are also ex-officio members on the committee from the National Plant Germplasm System. The Rice Crop Germplasm Committee, along with the other Crop Germplasm Committees, is concerned with critical issues facing the NPGS including: i) identifying gaps in U.S. collections and developing proposals to fill these gaps through exchange and collaborative collecting trips; ii) assisting the crop curators in identifying duplications in the collections, and in evaluating the potential benefits and problems associated with the development and use of core subsets; iii) prioritizing traits for evaluation and developing proposals to implement these evaluations; iv) assisting crop curators and GRIN personnel in correcting passport data and ensuring that standardized, accurate, and useful information is entered into the GRIN database; v) assisting in germplasm regeneration and in identifying closed out programs and other germplasm collections in danger of being lost and developing plans to rescue the important material in these programs; vi) working with quarantine officials to identify and ensure new techniques for pathogen identification that will assist in the expeditious release of plant germplasm; and vii) maintaining reports on the status of rice for Congress, ARS National Program Staff and Administrators, State administrators, and other key individuals involved with the NPGS. The Committee members serve six-year terms. They rotate off of the Committee in two-year intervals. The

Rice Crop Germplasm Committee Chair appoints a committee who nominates a slate of members. This committee maintains the diversity of the membership. Nominations also are requested from the floor and elections take place among the voting members to fill the six-year terms of office. A Chair is then elected from the voting membership for a two-year term. The Chair can only be elected to two consecutive terms of office unless completing the term of a previous Chair.

3. **Rice Variety Acreage Committee**
The purpose of the Rice Variety Acreage Committee is to collect and summarize data on varieties by acreage for each state and publish the summary in the RTWG Proceedings. The Committee consists of the rice specialists from each of the seven major rice-producing states and one other representative, usually a breeder or a director of an experiment station. No more than two members can represent any one state. The Chair of the Rice Variety Acreage Committee solicits information from each of the states then compiles it for the Committee report published in the RTWG Proceedings. Members of the Rice Variety Acreage Committee solicit their own members, first based on state and then on knowledge and interest expressed by active members of the RTWG to be part of the Rice Variety Acreage Committee. The Chair of the Rice Variety Acreage Committee is elected by the members of the Committee and may serve more than one term. No term limits have been established for members of the Rice Variety Acreage Committee. English units of measure should be used for the acreage tables for continuity.

4. **Awards Committee**
The Awards Committee is composed of the Executive Committee. See section IV. C., 'Guidelines for RTWG Awards' for details regarding responsibilities and duties of the Awards Committee.

5. **Location and Time Committee**
The Location and Time Committee is made up of three individuals, two from the state next to hold the biennial meeting and one from the state following the next host state. This Committee explores when and where the next biennial RTWG meeting will be held. The incoming Chair appoints the Location and Time Committee members.

C. Website Coordinator
A third-party website host and developer will be used to maintain a permanent RTWG website. A permanent (100 years from 2010) address (www.rtwg.net) has been purchased through www.networksolutions.com. The Chair and Secretary Program Chair are to meet and transfer responsibilities no later than one year after the preceeding meetings to ensure a smooth transition from one host state to the next.

D. Revisions to the Manual of Operating Procedures
The Executive Committee with a majority vote has approved this 'Manual of Operating Procedures' for use by the Rice Technical Working Group. This 'Manual of Operating Procedures' is a working document that should be amended or modified to meet the needs of the Rice Technical Working Group. Amendments or modification to this 'Manual of Operating Procedures' can only be made by a quorum of the Executive Committee with the approval of the majority of the Executive Committee. The RTWG Chair can only vote in the case of a tie. The Immediate Past Chair will incorporate the approved changes in the MOP.

IV. Biennial Meeting Protocols

A. Biennial Meetings

The biennial meetings are hosted by the participating states in the following rotation: Arkansas, Louisiana, Texas, California, Missouri, and Mississippi. A state is allowed to host a biennial meeting if the state is deemed by the Executive Committee to have a sufficient number of rice scientists to properly conduct a biennial meeting. The Secretary/Program Chair is responsible for organizing, conducting, and financing the program of the biennial meetings in concert with the Chair, Panel Chairs, and Chair of Local Arrangements. The Secretary/Program Chair is responsible for setting up the RTWG website. The Chair organizes the agenda and presides over the Business and Executive Committee meetings and the Awards process. Panel Chairs coordinate the oral and poster presentations in their discipline with the Secretary/Program Chair, editing of abstracts with the Publication Coordinator, updating of panel recommendations, and choosing their successor. Detailed information on the business meetings; detailed responsibilities of the Publication Coordinator, Panel Chairs, and the Local Arrangements Committee; timeline of preparation for the biennial meeting; instructions for preparation of abstracts; and guidelines for the RTWG awards are listed in this section.

1. Executive Committee Meetings

The agenda for the Executive Committee meetings varies, but there is a standard protocol and a few items that are always discussed. Robert's Rules of Order govern all Executive Committee meetings. Following is a typical agenda.

a. Opening Executive Committee Meeting (held on day prior to start of meeting)

<u>Old Business</u>

i) The Chair opens the meeting

ii) The Chair gives the Financial Report of the previous RTWG meeting. The Chair then entertains a motion to accept the Financial Report.

iii) The Secretary reads the minutes of the previous RTWG Executive Committee Meetings and entertains a motion to accept the minutes.

iv) The Chair leads a discussion of any old business from the previous RTWG Closing Executive Committee Meeting.

<u>New Business</u>

The Necrology Report read by Chair.

The Chair announces RTWG award recipients and asks the Executive Committee to keep this information secret until after the Awards Banquet.

The Chair leads a discussion of any New Business that has developed since the last RTWG meeting. Several months prior to the RTWG meeting the Chair should solicit any New Business items from the Executive Committee.

b. Closing Executive Committee Meeting (held on last day of meeting)

<u>Old Business</u>

i) The Chair opens meeting

ii) The Chair leads a discussion of any topics that were not adequately addressed at the Opening Executive Committee Meeting.

iii) Executive Committee members discuss and address any business items that have become a topic of interest during the RTWG meeting.

2. **Opening General Session and Business Meetings**
The agenda for the Opening General Session and Business meetings varies, but there is a standard protocol and a few items that are always discussed. Robert's Rules of Order govern all Business meetings. Following is a typical agenda.

a. Opening General Session and Opening Business Meeting (begins the RWTG meeting)

i) The Chair opens the meeting and thanks the host state delegation for preparing the program.
ii) The Secretary welcomes the RTWG membership to their state.
iii) The Chair opens the Business Meeting by asking the Secretary to read the minutes of the Closing Business meeting from the previous RTWG meeting and the Chair then entertains a motion for acceptance of the minutes.
iv) The Chair opens the Business Meeting and informs the RTWG membership of business discussed at the Opening Executive Committee Meeting.
v) The Chair reads the Necrology Report and asks for a few moments of silence.
vi) The Nominations Committee Chair reads the nominations for the Executive Committee and Nominations Committee to the RTWG membership. The RTWG Chair then entertains a motion to accept the nominations.
vii) The Chair calls on the Chair of the Location and Time Committee of the next biennial meeting to report when and where the next RTWG meeting will be held.
viii) The Secretary informs the membership of last minute alterations in the program and any additional information on the meeting, hotel, etc.
ix) The Chair asks for a motion to adjourn the Opening Business Meeting.
x) The General Session usually ends with invited speaker(s).

b. Closing Business Meeting (ends the RWTG meeting)

i) The Chair opens the meeting and calls for Committee reports from Rice Crop Germplasm, Rice Variety Acreage, Rice Industry, and the Publication Coordinator.
ii) The Chair thanks the Publication Coordinator(s) for their efforts in coordinating, editing, and publishing.
iii) The Chair thanks the host state delegation for hosting the RTWG Meeting.
iv) The Chair then passes the Chair position to the Secretary/Program Chair. The incoming Chair thanks the Past Chair for service to the RTWG and presents the Past Chair with a plaque acknowledging their dedicated and valuable service to the RTWG as the Chair.
v) The incoming Secretary/Program Chair informs the membership of the time and place for the next RTWG meeting.
vi) The incoming Chair invites everyone to attend the next RTWG meeting and asks for a motion to adjourn the RTWG meeting.

3. **Publication Coordinator(s)**
The Publication Coordinator(s) are responsible for providing instructions for manuscript preparation, collecting abstracts from the Panel Chairs, assembling all pertinent information for inclusion in the Proceedings, final review, and publication of the Proceedings upon the conclusion of each RTWG meeting. The Publication Coordinator(s) solicit input from the Executive Committee, Panel Chairs, and the general membership for changes and/or adjustments to the RTWG Proceedings content, style, format, and

timetable. It is, however, the Publication Coordinator(s) responsibility to make the final decision on changes appropriate to ensure the Proceedings is a quality product and reflective of the goals and objectives of the organization. This flexibility is needed to ensure that publication of this information through their respective institution is done in accordance with university or other agency requirements. The Publication Coordinator(s) are responsible for updating the guidelines for submitting abstracts as needed and including this information in the published Proceedings and also on the RTWG host website once the call for abstracts is made. The Publication Coordinator(s) are responsible for mailing proceedings in electronic and hardcopy format to the general membership and also placing the Proceedings on the internet.

4. **Panel Chairs**

A Panel Chair or Panel Chair and Co-Chair, at least one of whom will be an active rice worker in state or federal agencies, shall be elected by each of the six disciplines or Panels. The current Panels are: i) Breeding, Genetics, and Cytogenetics; ii) Economics and Marketing; iii) Plant Protection; iv) Postharvest Quality, Utilization, and Nutrition; v) Rice Culture; and vi) Rice Weed Control and Growth Regulation. Such elections shall take place by the end of each biennial meeting and Panel Chairs will serve as members of the Program Committee for the next biennial meeting. Each Panel Chair will be responsible for developing the Panel program in close cooperation with the Secretary-Program Chair. Program development involves scheduling of oral and poster presentations, securing moderators to preside at each panel session, editing of abstracts, seeing that the Panel Recommendations are updated at each biennial meeting and approved by the participants in the respective Panel sessions, and election of a successor. Since the Secretary is from the RTWG host state, the Panel Chairs elected should also be from the host state if possible to facilitate close cooperation with the Secretary and other Panel Chairs. If an elected Panel Chair cannot serve or fulfill the duties, then it is the Secretary's responsibility to replace the Panel Chair with someone preferably from the same discipline.

Each Panel Chair is responsible for collecting all of the Panel abstracts prior to the RTWG biennial meetings. The appropriate due date will be identified in the Call for Papers for the RTWG meeting. Each Panel Chair is responsible for assembling the Panel abstracts into one common MS Word file that is consistent with the above guidelines, with the abstracts appearing in the order presented. Paper abstracts will be presented first and poster abstracts second. A Table of Contents should be included with each panel section. Panel Chairs are responsible for editing all abstracts for their panel. A common file should be developed prior to the beginning of the RTWG meeting and submitted to the Publication Coordinator(s) to accommodate preliminary preparation of the Proceedings prior to the meeting. The Panel Chairs are strongly encouraged to edit the abstracts for content clarity and RTWG format to expedite publication of the Proceedings. These materials will be merged in the final Proceedings in the format submitted. Final editing will be performed by the Publication Coordinator(s), Rice Research Station secretarial staff, and the incoming Chair.

In addition, Panel Chairs are to prepare and submit both a paper copy and MS Word computer file version of the (1) final Panel Recommendations and (2) a list of panel participants by the conclusion of the meeting. A copy of the previous recommendations and panel participants will be provided to each Panel Chair prior to the meeting.

Panel Chairs are to organize the oral presentations in the concurrent Technical Sessions and the posters for the Poster Sessions with the Secretary/Program Chair.

5. **Local Arrangements**
The Local Arrangements Committee and the Chair of this Committee are typically appointed by the Secretary/Program Chair to help with meeting site selection and organizing and conducting the biennial meeting. Thus, they usually reside in the state the biennial meeting is conducted due to logistics. Typical responsibilities include: a survey of possible meeting sites and establishments; working with the hotels for rooms, meeting space, and food functions; securing visual aids; helping with spouse activities; solicitation of donations; and providing speakers and entertainment.

6. **Financing Biennial Meeting, Start-up Money, and the Contingency Fund**

   a. The biennial RTWG meetings are financed through registration fees and donations from industry and interested parties. The Executive Committee established a base amount of $6,000 that is to be transferred from one host state to the next as start-up money to begin preparations for the RTWG meeting prior to when donations or registration fees can be collected.

   b. At the end of each biennial meeting, after all financial obligations are met, remaining funds collected to support the programs or activities of the RTWG meeting will be transferred by the Secretary/Program Chair to the RTWG Contingency Fund, entitled 'Rice Tech Working Group Contingency Fund', established at the University of Arkansas in the Agriculture Development Council Foundation. In instances where USDA or industry personnel are elected to serve as RTWG Secretary, either the Local Arrangements Chair or the Geographical Representative in the state where the next meeting is to be held will be designated by the RTWG Secretary to receive and deposit funds in station or foundation accounts.

   c. The Contingency Fund was established as a safety net for states hosting the biennial meetings. It is to be used by the host state when the startup money transferred from the previous state to host the biennial meetings is insufficient or when a state goes into debt hosting the biennial meetings.

      i. If the previous host state is unable to provide any or all of the $6,000 in start-up money for the next host state to initiate meeting preparations, the current Chair should be informed of this situation as soon as possible (as the Chair will normally have served as Secretary of the previous meeting, he/she will probably be aware of this situation). The Chair should then communicate to the Executive Committee how much money will be needed from the Contingency Fund to provide the next host state the full $6,000 in start-up funds. The Chair will then ask for approval from the Executive Committee to make arrangements to have the appropriate funds transferred from the Agriculture Development Council Foundation at the University of Arkansas to the appropriate account in the next host state. Providing the next host state adequate ($6,000) start-up funds will be the highest priority for the use of contingency funds.

      ii. If a host state has gone into debt as a result of hosting the annual meeting and will request the use of contingency funds to cover all or part of that debt (over and above the inability to provide the $6,000 in start-up funds to the next host state), it must submit a detailed request for approval of the use of these funds to the Chair, who will than make this request available to the Executive Committee. The request should include a detailed accounting of all financial aspects of the hosted meeting, including all funds received and sources thereof, as well as a detailed accounting of all expenses incurred as a result of hosting the meeting. The Chair will have discretion on how to proceed with polling the Executive Committee (e.g., email or conference call) on approval of the use of contingency funds to cover all or part of the incurred debt. The Executive will then decide through parliamentary procedure whether to use contingency funds to cover all or part of the incurred debt. The Chair will then make arrangements to have the amount of any funds approved by the Executive Committee for this purpose transferred from the Agriculture Development Council Foundation at the University of Arkansas to the appropriate account in the host state. No repayment of these funds will be required.

7. **Complimentary Rooms, Travel Reimbursements, and Registration Fee Waivers**
   Complementary rooms (Suite) are provided during the meeting for the Chair and Secretary. Typically, the hotel will provide rooms free of charge in association with a certain number of booked nights. Invited speakers may be provided travel funds, free room, or registration, depending on meeting finances. The Local Arrangement Committee usually does not provide any travel assistance for attendees. Registration can be waived or refunds given on the discretion of the Local Arrangement Committee based on their financial situation. Possibly, a certain amount should be specified non-refundable before registration is begun. Distinguished Service Award recipients usually have their registration fee waived for the day of the Award Banquet if they are not already registered.

8. **Biennial Meeting Preparation Timeline**

May 1, 2026	Secure Hotel
May 1, 2026	Secure Hotel
May 1, 2026	Pre-RTWG planning meeting
June 15, 2026	Announcement of when and where the RTWG meeting will be held. (E-mail only)
July 1, 2026	Invite guest speakers and begin soliciting for donations. Upon receipt of donations, send out acknowledgment letters.
Aug.1, 2026	First call for papers and a call for award nominations
Sept. 15, 2026	Second call for papers (Reminder; e-mail only)
Oct. 15, 2026	Titles and interpretive summaries due
Dec. 1, 2026	Abstracts due
Dec. 1, 2026	Award nominations due to Chair
Dec. 1, 2026	Registration and housing packet sent
Jan. 3, 2027	Reminder for registration and hotel (e-mail only)
Jan. 29, 2027	Last day for hotel reservations
Jan. 30, 2027	Abstracts due to Publication Coordinator(s) from Panel Chairs
Jan. 30, 2027	Registration due without late fee
February 2027	41st RTWG meeting

9. **Program Itinerary**

The biennial meetings begin on Sunday afternoon with committee meetings followed by a social mixer in the evening. The meetings end on Wednesday morning with the Closing Business meeting. The Awards presentations are made at dinner Monday or Tuesday evening or at a luncheon on Tuesday. See programs from previous RTWG meetings for more details.

Sunday: Registration usually begins Sunday afternoon and standing committees and ad hoc committees meet Sunday afternoon. A Sunday evening social mixer is hosted by the RTWG.

Monday: Registration continues Monday morning and posters are usually setup prior to the Opening General Session. The Opening General Session starts the biennial meeting with opening remarks from the Chair, a welcome from the Secretary/Program Chair, the opening business meeting, and ends with invited speakers. The concurrent technical sessions (i.e., oral presentations) of the six Panels begins after the Opening General Session on Monday. Posters are on display throughout the meeting or removed Monday evening and new ones placed on display Tuesday morning and removed Tuesday evening, depending on the number of posters and poster sessions.

Tuesday: The concurrent technical sessions continue on Tuesday and extend through Tuesday afternoon, depending on the number of papers. Each concurrent technical session ends with the review of the panel recommendations. If there are a sufficient number of posters, a second poster session is held on Tuesday.

Wednesday: The biennial meeting usually ends on Wednesday with the Closing Executive meeting and then the Closing Business meeting.

10. Symposium

Symposia are welcomed in conjunction with the RTWG biennial meetings. Symposia must not interfere with the RTWG biennial meetings and are to be held prior to the committee meetings on the first day (i.e., Sunday) of registration or after the Closing Business meeting.

11. Functions by Industry and Other Groups

Functions held in conjunction with the RTWG biennial meetings are welcomed as long as they do not interfere with the RTWG biennial meetings. Thus, these functions must be held prior to the committee meetings on the first day (i.e., Sunday) of registration or after the Closing Business meeting. Exceptions are informal, brief functions held at the meal breaks of breakfast, lunch, or dinner.

B. Instructions for Preparation of Abstracts for Biennial Meetings

Beginning with the Proceedings for the 24th Rice Technical Working Group meeting, Desktop Publishing software was chosen for expediting the post-meeting publication process using Microsoft Word (Windows). If individuals do not have access to MS Word, submission of materials in ASCII format (DOS compatibility is essential) is acceptable. Each electronic file should include: i) title of materials, ii) corresponding RTWG Panel, iii) corresponding author's name, daytime telephone number, e-mail address, and iv) computer format (i.e., MS Word and version number). These criteria apply uniformly to i) presented paper abstracts, ii) poster abstracts, iii) symposia abstracts, iv) panel recommendations, and v) list of panel participants. More details with respect to each of these items follow below.

As soon as a web page is established by the host state, a link will be provided to the RTWG web page where current submission instructions will be maintained.

1. Presented Paper, Poster, and Symposia Abstracts

To be published in the printed Proceedings, presented paper, poster, and symposia abstracts for the RTWG meetings must be prepared as follows. Please follow these instructions -- doing so will expedite the publishing of the Proceedings.

a. Both a paper copy and an electronic file are required. Hard copy and electronic file are to be submitted to the respective Panel Chairs 2 ½ months prior to the RTWG meeting, or earlier as stated in the Call for Papers issued by the RTWG meeting Chair and/or Panel Chairs. Please e-mail the abstract to the Panel Chair by the deadline and mail the hard copy thereafter. If e-mail is not available, mail the electronic file to the panel chair on a IBM compatible CD or floppy disk.

The respective Panel Chairs for each RTWG meeting and their e-mail and mailing addresses are presented in the 'Instructions for Preparation of Abstracts" in each Proceedings. In case of other questions or if unable to access the Call for Papers, contact:

Dr. Kurt Guidry
H. Rouse Caffey Rice Research Station
1373 Caffey Road
Rayne, LA 70578
Phone: (337) 788-7531
Email: kmguidry@agcenter.lsu.edu

b. Margins: Set 1-inch for side margins; 1-inch top margin; and 1-inch bottom margin. Use a ragged right margin (do not full justify) and do not use hard carriage returns except at the end of paragraphs.

c. Type: Do not use any word processing format codes to indicate boldface, etc. Use 11 point Times New Roman font.

d. Heading:
   i) Title: Center and type in caps and lower case.
   ii) Authors: Center name(s) and type in caps and lower case with last name first, then first and middle initials, with no space between the initials (e.g., Groth, D.E.).
   iii) Affiliation and location: DO NOT GIVE AFFILIATION OR LOCATION. Attendance list will provide each author's affiliation and address.

e. Body: Single space, using a ragged right margin. Do not indent paragraphs. Leave a single blank line between paragraphs.

f. Content is limited to one page.
   i) Include a statement of rationale for the study.
   ii) Briefly outline methods used.
   iii) Summarize results.

g. Tables and figures are not allowed.

h. Literature citations are not allowed.

i. Use the metric system of units. English units may be shown in parantheses.

j. When scientific names are used, *italicize* them – do not underline.

C. Guidelines for RTWG Awards

1. The RTWG Chair shall solicit nominations, and when appropriate, award on a biennial basis the following types of awards, namely:

a. The Distinguished Rice Research and/or Education Award

i) Individual category – An award may be made to one individual at each RTWG meeting in recognition of recent achievement and distinction in one or more of the following: (1) significant and original basic and/or applied research and (2) creative reasoning and skill in obtaining significant advances in education programs, public relations, or administrative sills – which advance the science, motivate progress, and promise technical advances in the rice industry.

ii) Team category – Same as the induvial category, one team many be recognized at each RTWG meeting. All members of the team will be listed on each certificate.

b. The Distinguished Service Award – Awards to be made to designate individuals who have given distinguished long-term service to the rice industry in areas of research, education, international agriculture, administration, or industrial rice technology. Although the award is intended to recognize contributions of a long duration, usually upon retirement from active service, significant contributions over a period of several years shall be considered as a basis of recognition.

2. The Awards Committee shall consist of the Executive Committee.

3. Responsibilities and duties of the Awards Committee are as follows:

a. To solicit nominations for the awards in advance of the biennial meeting of the RTWG. Awards Committee members cannot nominate or write letters of support for an individual or team for the RTWG awards. If a member of the Awards Committee is nominated for an award in a given category, it is common courtesy to abstain from voting in that category

b. In the event that a real or perceived conflict of interest regarding award nominations packets exist, the Chair reserves the right to pass the responsibilities of award elections to the immediate past chair, the secretary, or an executive committee member who does not have a conflict of interest.

c. To review all nominations and select worthy recipients for the appropriate awards. Selection on awardees will be determined by a simple majority (highest number of votes) vote once a quorum is mustered. A quorum for the Awards Committee is when at least eight members vote, excluding the Chair. The Awards Committee Chair (RTWG Chair) can only vote in the case of a tie. The names of recipients shall be kept confidential, but recipients shall be invited to be present to receive the award.

d. The Awards Committee shall arrange for a suitable presentation at the biennial RTWG meeting. The Chair of the RTWG shall present the awards by speaking briefly about the accomplishments of the award recipient(s) and after presenting the award allow the recipient(s) an opportunity to express their appreciation.

e. The Awards Committee shall select appropriate certificates for presentation to the recipients of the awards.

4. **Those making nominations for the awards shall be responsible for supplying evidence to support the nomination, including three recommendation letters, pertinent biographies of each nominee, and a concise but complete explanation of the accomplishments. Electronic submissions of the nominations are preferred; these should be submitted as a single pdf file, with exception of a one-page summary of accomplishments that should be provided at the same time, but as a MS Word file. Hard copies can be submitted, in which case fifteen (15) complete copies of each nomination must be submitted, and a one-page summary of accomplishments include with each nomination. This summary will be published in the RTWG Proceedings if the award is granted.**

    a. Nominees for awards should be staff personnel of Universities or State Agricultural Experiment Stations, State Cooperative Extension personnel, cooperating agencies of the United States Department of Agriculture, or participating rice industry groups.

    b. A member of an organization, described in 4.a., may nominate or co-nominate two persons.

    c. Nominations are to be sent to the Awards Committee for appropriate consideration.

    d. The deadline for receipt of nominations shall be three months preceding the biennial meeting. The executive committee reserves the right to entertain Distinguished Service Award packets at the opening executive committee meeting.

    e. Awards need not be made if, in the opinion of the Awards Committee, no outstanding candidates have been nominated.

D. Off-Year Executive Committee Business Meeting

The Executive Committee of the 2004 RTWG Meeting voted to have an Off-Year Executive Committee Business Meeting to add continuity, indoctrinate new Executive Committee members, and discuss pertinent topics more timely. The time and place of the Off-Year meeting is flexible and the possibility of conducting the meeting through distance education is a viable alternative to meeting at a designated location. The best time for the meeting is from February to August in the off-year, and it can be held in conjunction with such meetings as the Breeders' Conference or the organizational meeting for the next RTWG. The meeting can also be held independently at a central location or at the next RTWG meeting site to allow the Executive Committee to become familiar with the hotel and available facilities. A quorum (i.e., eight members are present, excluding the Chair) of the Executive Committee must be present for the Executive Committee to do business. It is the responsibility of the RTWG Chair and the Secretary/Program Chair to call this meeting and set the agenda in concert with the other members of the Executive Committee.

Drafted by Richard J. Norman and approved by the 31st RTWG Executive Committee on March 1, 2006; revised by Garry McCauley and approved by the 32nd RTWG Executive Committee on February 21, 2008; revised by Cass Mutters and approved by the 33rd RTWG Executive Committee on February 25, 2010; revised by Tim Walker and approved by the 34th RTWG Executive Committee on March 1, 2012

40TH RTWG ATTENDANCE LIST

Ablao, Ali
University of Missouri-Columbia
108 Water Hall
Columbia, MO 65211
Email: aaafky@umsystem.edu
Phone: (870) 316-2890

Acharya, Ashmita
Louisiana State University
Ivanhoe Street
Baton Rouge, LA 70802
Email: aacha11@lsu.edu
Phone: (225) 441-1387

Adviento-Borbe, Arlene
USDA/ARS
504 University Loop W
Jonesboro, AR 72401
Email: arlene.adviento-borbe@usda.gov
Phone: (870) 253-3130

Agenjos Moreno, Alba
Universitat Politècnica de València.
Camino de vera s/n
Valencia, Spain 46022
Email: alagmo@etsiamn.upv.es
Phone: 3 4636740534

Agpawa, Earl
Texas A&M University
253 Fieldstone Pl
College Station, TX 77845
Email: earl.agpawa@ag.tamu.edu
Phone: (402) 314-5027

Al-Khatib, Kassim
University of California-Davis
279A Robbins Hall - MS-4
Davis, CA 95616
Email: kalkhatib@ucdavis.edu
Phone: (530) 210-0529

Allen, Tom
Mississippi State University
82 Stoneville Road
Stoneville, MS 38776
Email: tallen@drec.msstate.edu
Phone: (662) 402-9995

Allmon, Tommy
Gowan USA
19505 Newton Ave
Stilwell, KS 66085
Email: tallmon@gowanco.com
Phone: (913) 343-2194

Ameyaw Owusu, Evans
The University of Arkansas
2650 Young Ave
Fayetteville, AR 72704
Email: eameyawo@uark.edu
Phone: (479) 332-8387

Andrade Leite Mengez, Gabriela
University of Arkansas
1354 W Altheimer Dr
Fayetteville, AR 72704
Email: ga020@uark.edu
Phone: (479) 249-0354

Angira, Brijesh
LSU AgCenter
1373 Caffey Road
Rayne, LA 70578
Email: bangira@agcenter.lsu.edu
Phone: (337) 455-0360

Ardoin, Ryan
USDA Agricultural Research Service
1100 Allen Toussaint Blvd
New Orleans, LA 70125
Email: ryan.ardoin@usda.gov
Phone: (504) 284-4459

Atungulu, Griffiths
University of Arkansas
2650 N Young Avenue
Fayetteville, AR 72704
Email: atungulu@uark.edu
Phone: (479) 575-6843

Avent, Tristen
University of Arkansas
1354 West Altheimer Drive
Fayetteville, AR 72704
Email: thavent@uark.edu
Phone: (901) 634-6442

Badarch, Bayarbat
University of Arkansas
58 E Joliet St
Farmington, AR 72730
Email: bbadarch@uark.edu
Phone: (310) 948-4999

Baisakh, Niranjan
LSU AgCenter
104 Madison B Sturgis Hall
Baton Rouge, LA 70803

Banik, Susmita
FAO
House 103 Road 01 Block F
Banani, Dhaka 1213

Barber, Tom
University of Arkansas
2001 Hwy 70 East
Lonoke, AR 72007

Bateman, Nicholas
UADA
1111 Penny Place
Stuttgart, AR 72160
Email: nbateman@uada.edu
Phone: (870) 456-8486

Baxley, Rhet
University of Arkansas
245 Rogers Road
Pocahontas, AR 72455
Email: rcbaxley@uark.edu
Phone: (870) 810-2517

Baxley, Rhet
University of Arkansas
245 Rogers Road
Pocahontas, AR 72455
Email: rcbaxley@uark.edu
Phone: (870) 810-2517

Beard, Bradley
LSU AgCenter
102 Woodlawn Dr
Crowley, LA 70526
Email: bbeard@agcenter.lsu.edu
Phone: (337) 781-0685

Beaty, Tony
University of Arkansas
2900 Hwy 130 East
Stuttgart, AR 72160
Email: beaty@uark.edu
Phone: (870) 509-2255

Beaty, Amy
Riceland Foods, Inc.
P.O. Box 927
Stuttgart, AR 72160
Email: arbeaty@riceland.com
Phone: (870) 830-1514

Beebout, Sarah
USDA
5601 Sunnyside Avenue
Beltsville, MD 20705
Email: sarah.beebout@usda.gov
Phone: (240) 584-6568

Belmar, Scott
University of Arkansas
1806 Peachtree
Stuttgart, AR 72160
Email: sbelmar@uark.edu
Phone: (870) 673-2661

Bera, Tanumoy
Texas A&M AgriLife Research Center
1509 Aggie Dr.
Beaumont, TX 77713
Email: tanumoy.bera@ag.tamu.edu
Phone: (409) 245-8626

40th RTWG ATTENDANCE LIST (continued)

Bernaola, Lina
Texas A&M University
1509 Aggie Drive
Beaumont, TX 77713
Email: lina.bernaola@agnet.tamu.edu
Phone: (225) 328-2740

Bessa de Lima, Gustavo Henrique
University of Arkansas
1354 W Altheimer Dr
Fayetteville, AR 72703
Email: ghenriqueblima@gmail.com
Phone: (479) 480-0823

Bhattarai, Kamal
South Dakota State University
1808 8th Street Apt 37
Brookings, SD 57006
Email: kamal.bhattarai@sdstate.edu
Phone: (605) 690-7428

Bheemanahalli, Raju
Mississippi State University

Mississippi State, MS 39762
Email: rajubr@pss.msstate.edu
Phone: (785) 317-6810

Black, David
Syngenta
272 Jaybird Lane
Searcy, AR 72143
Email: david.black@syngenta.com
Phone: (501) 278-6127

Blackmon, Bret
LSU AgCenter
14458 Brenda Dr.
Gonzales, LA 70737
Email: bblackmon@lsu.edu
Phone: (225) 247-8003

Borges, Karina
Louisiana State University
1373 Caffey Road
Rayne, LA 70578
Email: kborges@agcenter.lsu.edu
Phone: (352) 709-5245

Borges, Bruno
Louisiana State University
7264 S LA 13
Crowley, LA 70526
Email: bborges@agcenter.lsu.edu
Phone: (352) 709-5403

Borjas, Anna
Cibus LLC
32 D and N Rd
Stuttgart, AR 72160
Email: aborjas@cibus.com
Phone: (225) 421-7407

Boue, Stephen
USDA
1100 Allen Toussaint Blvd
New Orleans, LA 70124
Email: steve.boue@usda.gov
Phone: (504) 286-4346

Brim-DeForest, Whitney
University of California
142 Garden Hwy
Yuba City, CA 95991
Email: wbrimdeforest@ucanr.edu
Phone: (530) 822-7515

Bruno, Jobelle
Louisiana State University
302 Life Science Building
Baton Rouge, LA 70803
Email: jbruno@agcenter.lsu.edu
Phone: (225) 512-5862

Bulloch, Jill
University of Arkansas
2900 Hwy 130 E.
Stuttgart, AR 72160-5629
Email: jbulloch@uark.edu
Phone: (870) 830-8247

Burcham, Timothy
University of Arkansas
3108 Annadale Cove
Jonesboro, AR 72404
Email: tburcham@uada.edu
Phone: (731) 514-6366

Calhoun, Mathew
University of Central Arkansas
LSC 180, Biology, UCA
Conway, AR 72035
Email: Mcalhoun5@cub.uca.edu
Phone: (501) 450-5472

Calloway, Matt
Farmers' Rice Cooperative
2223 W Ridge Dr
Sutter, CA 95982
Email: mcalloway@farmersrice.com
Phone: (530) 870-0328

Campos, Manuel
Nichino
4110 Bridgewood Ct
College Station, TX 77845
Email: mcampos@nichino.net
Phone: (979) 213-9772

Carlin, John
University of Arkansas
2549 N. Hatch Ave
Fayetteville, AZ 72704
Email: jfcarlin@uark.edu
Phone: (479) 426-0805

Carr, Wesley
LSU AgCenter
5890 Brierdale Ave
Memphis, TN 38120
Email: carr.wesley.wps@gmail.com
Phone: (901) 491-1209

Carroll, Sam
University of Arkansas
911 N Leverett Ave
Fayetteville, AR 72701
Email: srcarrol@uark.edu
Phone: (501) 538-5591

Carvalho-Moore, Pâmela
University of Arkansas
679 Richland Creek Ave
Elkins, AR 72727
Email: pcarvalh@uark.edu
Phone: (479) 216-1285

Castillo, Cameron
Texas A&M University
Room 351 AGLS
College Station, TX 77843
Email: ccastillo.518@tamu.edu
Phone: (979) 845-5913

Cerezo, Belen
Universidad Politécnica de Valencia
San Cayet ano nº 12 bajo
Alfafar, 46910
Email: macemuo@hotmail.com
Phone: 3 4669357210

Chaffee, Olivia
USDA-ARS
1100 Allen Toussaint Blvd
New Orleans, LA 70124
Email: olivia.chaffee@usda.gov
Phone: (619) 851-9286

Chandel, Amaresh
Bayer Bioscience Private Limited

Hyderabad, Telangana 500081
Email: amaresh.chandel@bayer.com
Phone: 91 7566272272

Chaudhary, Chanderkant
LSU AgCenter
216 M.B. Sturgis Hall
Baton Rouge, LA 70808
Email: cchaudhary@agcenter.lsu.edu
Phone: (225) 828-4479

Chlapecka, Robyn
University of Missouri Extension
2709 S Mallori Cir
Kennett, MO 63857-4139
Email: robynmulloy@missouri.edu
Phone: (870) 672-1291

40th RTWG ATTENDANCE LIST (continued)

Chlapecka, Justin
University of Missouri
147 State Hwy T
Portageville, MO 63873
Email: jchlapecka@missouri.edu
Phone: (870) 206-5491

Chou, Nanyen
Nutrien Ag Solutions
676 County Rd 324
El Campo, TX 77437
Email: nanyen.chou@nutrien.com
Phone: (979) 253-0090

Chukkapalli, Devisree
University of Arkansas
2650 Young Ave
Fayetteville, AR 72704
Email: dc054@uark.edu
Phone: (770) 363-7367

Clark, Troy
University of California
142 garden hwy
Yuba City, CA 95991
Email: troclark@ucanr.edu
Phone: (530) 859-5582

Clayton, Tara
UADA
110 North Leslie Street
Almyra, AR 72003
Email: taralmoss@yahoo.com
Phone: (870) 659-5983

Collie, Leah
University of Arkansas
2001 Hwy 70 E
Lonoke, AR 72086
Email: lmcollie@uada.edu
Phone: (501) 288-6250

Cook, Don
Mississippi State University
MSU DREC, P.O. Box 82
Stoneville, MS 38756
Email: dcook@drec.msstate.edu
Phone: (662) 255-1899

Cortes, Jose
LSU AgCenter
302 Life Science Building
Baton Rouge, LA 70803
Email: jcortes@agcenter.lsu.edu
Phone: (225) 276-3302

Costello, Richard
Boeuf Delta Ag
250 Costello Rd
Oak Grove, LA 71263
Email: rcostello742@gmail.com
Phone: (318) 376-1629

Covington, Karson
UADA/ARS
504 University Loop W
Jonesboro, AR 72401
Email: kcoving@uada.edu
Phone: (870) 256-5424

Cruz, Maribel
Bioversity & CIAT Alliance
Cra. 114B No. 17-120
Cali, 760008
Email: maribel.cruz@cgiar.org
Phone: 57 3187952263

Cutrano, Chance
Resource Renewal Institute
8 Bolinas Rd
Fairfax, CA 94930
Email: ccutrano@rri.org
Phone: (312) 403-3702

da Cruz Cerutti, Anderson
Rice Station - LSU - AgCenter
111 Efferson Ln
Rayne, LA 70578
Email: andersonccerutti@gmail.com

Dalla Lana, Felipe
LSU AgCenter
1373 Caffey Rd
Rayne, LA 70578
Email: fdallalana@agcenter.lsu.edu

Darikandeh, Dorsa
University of Arkansas
2900 highway 130E
Stuttgart, AR 72160
Email: ddarikan@uada.edu

Dartez, Valerie
LSU AgCenter
1373 Caffey Road
Rayne, LA 70578
Email: vdartez@agcenter.lsu.edu
Phone: (337) 788-7531

De Guzman, Christian
University of Arkansas
7017 Pearl Valley Cove
Alexander, AR 72002
Email: deguzma@uark.edu
Phone: (501) 408-8028

De la Rosa, Zaida
University of Puerto Rico
Po Box 2684
San German, PR 00683
Email: delarosazaida@yahoo.com
Phone: (787) 543-9215

De Leon, Teresa
California Rice Research Foundation
955 Butte City Hwy
Biggs, CA 95917
Email: Tdeleon@crrf.org
Phone: (530) 868-5481

de Paula, Samuel
University of Arkansas
1617 Coker Hampton Dr.
Stuttgart, AR 72160
Email: sdepaula@uada.edu
Phone: (870) 456-0610

Deliberto, Michael
LSU AgCenter
101 Martin D. Woodin Hall
Baton Rouge, LA 70803
Email: mdeliberto@agcenter.lsu.edu
Phone: (225) 578-7267

Dodd, Jacob
Mississippi State University
82 Stoneville Rd.
Stoneville, MS 38776
Email: jbd297@msstate.edu
Phone: (662) 588-0467

Dodde, Michael
University of Arkansas
1354 W Altheimer Dr
Fayetteville, AR 72704
Email: mdodde@uark.edu
Phone: (616) 250-4554

Dou, Fugen
Texas A&M AgriLife Research Center
1509 Aggie Dr.
Beaumont, TX 77713
Email: fugen.dou@agnet.tamu.edu
Phone: (214) 797-7745

Driver, Tony
Syngenta Crop Protection
110 Twisted Oak Lane
Crawford, TX 76638
Email: tony.driver@syngenta.com
Phone: (254) 723-5555

Du, Hanlin
Sanya Huadu Ag Development Ltd.
7226 Beja Court
Elk Grove, CA 95757
Email: hanlin_du@yahoo.com
Phone: (279) 800-1458

Dunlap, Heather
USDA ARS
2890 Hwy 130 East
Stuttgart, AR 72160
Email: heather.box@usda.gov
Phone: (870) 672-6113

40th RTWG ATTENDANCE LIST (continued)

Durand-Morat, Alvaro
University of Arkansas
AGRI 217
Fayetteville, AR 72701
Email: adurand@uark.edu
Phone: (479) 575-2377

Edwards, Jeremy
USDA ARS
2890 Hwy 130 East
Stuttgart, AR 72160
Email: jeremy.edwards@usda.gov
Phone: (870) 672-6109

Eizenga, Georgia
USDA ARS
2890 Highway 130 East
Stuttgart, AR 72160
Email: georgia.eizenga@usda.gov
Phone: (870) 672-3288

Espino, Luis
University of California
5 County Center Dr
Oroville, CA 95965
Email: laespino@ucanr.edu
Phone: (530) 635-6234

Eubank, Will
Mississippi State University
253 Avondale Rd.
Greenville, MS 38703
Email: eubank.will@yahoo.com
Phone: (662) 378-7042

Everett, Mallory
Valent
3088 Hwy 64 E
Wynne, AR 72396
Email: mever@valent.com
Phone: (662) 822-1477

Famoso, Adam
LSU AgCenter
1373 Caffey Road
Rayne, LA 70578
Email: afamoso@agcenter.lsu.edu
Phone: (337) 788-7531

Ferreira, Ana Carla
University of Arkansas
32 D and North Road
Stuttgart, AR 72160
Email: aferreira@uada.edu
Phone: (870) 671-8996

Flasco, Madison
LSU AgCenter
302 Life Sciences Building
Baton Rouge, LA 70803
Email: mflasco@agcenter.lsu.edu
Phone: (330) 620-6333

Fletcher, Anderson
University of Arkansas
7693 HWY 70 W
Scott, AR 72142
Email: afletcher@uada.edu
Phone: (501) 414-3404

Floyd, Chase
University of Missouri
147 State Highway T
Portageville, MO 63873-8502
Email: chasefloyd@missouri.edu
Phone: (901) 493-2377

Fluitt, Jacob
LSU AgCenter
1373 Caffey Road
Rayne, LA 70578
Email: jfluitt@agcenter.lsu.edu
Phone: (337) 230-7707

Frey, Blaise
LSU AgCenter
384 Ray Milner
Iota, LA 70543
Email: bmfrey@agcenter.lsu.edu
Phone: (337) 789-5549

Fritz, Hannah-Grace
University of Central Arkansas
LSC 180, Biology, UCA
Conway, AR 72035
Email: hfritz@cub.uca.edu
Phone: (501) 450-5472

Frizzell, Donna
University of Arkansas
2900 HWY 130 E
Stuttgart, AR 72160
Email: dfrizze@uada.edu
Phone: (870) 723-1523

Frost, Ford
Frost Ranch Ltd.
2930 Rever St. Box 300
Houston, TX 77098
Email: frost-ht@swbell.net
Phone: (713) 252-9644

Furlan, Flavia
Louisiana State University
415 West Parker Blvd Apt.15
Baton Rouge, LA 70808
Email: ju.frl@hotmail.com
Phone: (225) 715-6404

Gambino, Christine
LSU AgCenter
404 Life Sciences Building
Baton Rouge, LA 70803
Email: cgambino@agcenter.lsu.edu
Phone: (504) 330-8010

Goetze, Paul
Texas A&M University
496 Olsen Blvd
College Station, TX 77843-2132
Email: paul.goetze@ag.tamu.edu
Phone: (806) 930-6373

Goldberg, John
USA Rice
1899 L Street NW
Washington, DC 20036
Email: jgoldberg@thenormandygrp.com
Phone: (703) 244-0275

Gomez, Marc
University of Arkansas
2604 E Kantz Dr
Fayetteville, AR 72703
Email: marcg@uark.edu
Phone: (479) 530-3520

Gomez, Leo
Farmer
2604 E Kantz Dr
Fayetteville, AR 72703
Email: marcg@uark.edu
Phone: (479) 530-3520

Gonzalez, Eddie
University of Arkansas
119 S. Harrison St.
DeWitt, AR 72042
Email: ecastane@uada.edu
Phone: (870) 344-0486

Goyal, Raghav
LSU AgCenter
225 Martin D Woodin Hall
Baton Rouge, LA 70808-1316
Email: rgoyal@agcenter.lsu.edu
Phone: (225) 578-4567

Greenwalt, Scott
Nutrien Ag Solutions
PO Box 806
Carlisle, AR 72024
Email: scott.greenwalt@nutrien.com
Phone: (870) 672-2608

Grettenberger, Ian
University of California, Davis
2249 Millsap Ct
Woodland, CA 95776
Email: imgrettenberger@ucdavis.edu
Phone: (360) 790-0035

Grunden, Quynh
USDA ARS
2890 Hwy 130 East
Stuttgart, AR 72160
Email: quynh.grunden@usda.gov
Phone: (870) 672-6115

Gu, Xingyou
South Dakota State University
Box 2140C
Brookings, SD 57007
Email: xingyou.gu@sdstate.edu
Phone: (605) 590-0749

Guardado, Krizzia
Louisiana State University
Sturgis Hall
Baton Rouge, LA 70803
Email: kguard1@lsu.edu
Phone: (225) 620-8684

Guidry, Kurt
LSU AgCenter
1373 Caffey Road, Rayne, LA, USA
Baton Rouge, LA 70803
Email: kmguidry@agcenter.lsu.edu
Phone: (225) 281-5948

Guo, Minghao
University of Arkansas
32 D and N Rd, Apt 2
Stuttgart, AR 72160
Email: minghaog@uark.edu
Phone: (806) 252-1329

Gutierrez, Jose
Nichino America
23775 El Caminito Ct
Chowchilla, CA 93610
Email: Jgutierrez@nichino.net
Phone: (559) 760-6497

Habib, Muhammad Ashraful
International Rice Research Institute
House 103 Road 01 Block F Banani
Dhaka, 1213
Email: m.habib@irri.org
Phone: 880 1816111127

Hale, Kenneth
University of Arkansas
2900 Hwy 130 East
Stuttgart, AR 72160
Email: khale@uada.edu
Phone: (870) 830-2851

Ham, Jong Hyun
LSU AgCenter
302 Life Sciences Building
Baton Rouge, Louisiana, LA 70803
Email: jham@agcenter.lsu.edu
Phone: (225) 578-6798

Hambrick, Madelyn
University of Arkansas
649 Jackson 917
Newport, AR 72112
Email: mhambrick@uada.edu
Phone: (501) 827-5903

Han, Joohun
University of Arkansas
224B Agriculture Building
Fayetteville, AR 72701
Email: Joohunh@uark.edu
Phone: (405) 334-7789

Hardke, Jarrod
University of Arkansas
2900 Hwy. 130 E.
Stuttgart, AR 72160
Email: jhardke@uada.edu
Phone: (501) 772-1714

Harrell, Dustin
California Rice Research Foundation -
P.O. Box 306 (955 Butte City Hwy)
Biggs, CA 95917
Email: dharrell@crrf.org
Phone: (530) 868-5481

Hartley, Hannah
University of Arkansas
14219 Old River Dr
Scott, AR 72142-9121
Email: hhartley@uada.edu
Phone: (501) 676-8120

Helms, Trey
G & H Associates
2304 Shady Grove Rd
Stuttgart, AR 72160
Email: margarethelms@centurytel.net
Phone: (870) 830-1533

Helms, Ashley
G & H Associates
2304 Shady Grove Rd
Stuttgart, AR 72160
Email: margarethelms@centurytel.net
Phone: (870) 830-1533

Helms, Ronnie
G & H Associates
2304 Shady Grove Rd
Stuttgart, AR 72160
Email: ronniehelmsgha@gmail.com
Phone: (870) 830-3080

Henry, Christopher
University of Arkansas
2900 Hwy 130 E.
Stuttgart, AR 72160
Email: cghenry@uark.edu
Phone: (870) 830-2213

Herrman, Wesley
University of Arkansas
1354 W Altheimer Drive
Fayetteville, AR 72704
Email: wtherrma@uark.edu
Phone: (314) 707-9359

Hilbun, Brian
LSU AgCenter
101 Martin D. Woodin Hall
Baton Rouge, LA 70803
Email: bhilbun@agcenter.lsu.edu
Phone: (225) 578-2377

Huang, Binru
Nutrien
676 County Rd 324
El Campo, TX 77437
Email: qiming.shao@nutrien.com
Phone: (979) 219-6903

Huggins, Trevis
USDA ARS
2890 Hwy 130 East
Stuttgart, AR 72003
Email: trevis.huggins@usda.gov
Phone: (870) 672-6140

Inci, Deniz
University of California, Davis
One Shields Avenue
Davis, CA 95616
Email: inci@ucdavis.edu
Phone: (530) 965-7840

Isbell, Chris
Zero Grade Farms
732 Isbell Road
England, AR 72046
Email: chris@isbellfarms.com
Phone: (501) 454-9670

Jeong, Changyoon
LSU AgCenter
262 Research Station Drive
Bossier City, LA 71112
Email: cjeong@agcenter.lsu.edu
Phone: (337) 591-1990

Jerden, Marissa
University of Delaware
1315 Delaware Avenue, Apt. 4
Wilmington, DE 19806
Email: mljerden@udel.edu
Phone: (919) 793-4988

Jia, Yulin
USDA ARS
2890 Hwy 130 East
Stuttgart, AR 72160
Email: yulin.jia@usda.gov
Phone: (870) 672-6107

Jia, Melissa
USDA ARS
2890 Hwy 130 East
Stuttgart, AR 72160
Email: melissa.jia@usda.gov
Phone: (870) 672-6130

40th RTWG ATTENDANCE LIST (continued)

Jiang, Junda
Lundberg Family Farms
5311 Midway
Richvale, CA 95974
Email: jjiang@lundberg.com
Phone: (530) 592-5209

Jo, Young-Ki
Texas A&M University
496 Olsen Blvd,
College Station, TX 77843-2132
Email: ykjo@tamu.edu
Phone: (979) 862-1758

Johnson, Alton
University of Arkansas
2900 Hwy 130 East
Stuttgart, AR 72160
Email: altonj@uada.edu
Phone: (601) 400-4526

Jones, Harrison
Zero Grade Farms
511 Isbell Road
England, AR 72046
Email: harrison@isbellfarms.com
Phone: (501) 285-0702

Jones, Carl
Mars
424 G St Suite 200
Davis, CA 95616
Email: carl.jones@effem.com
Phone: (530) 392-1702

Jorgensen, Brandon
Wintersteiger North America
439 Keely Mill Rd
Bradford, TN 38316
Email: brandon.jorgensen@wintersteiger.com
Phone: (515) 306-7130

Jugulam, Mithila
Texas A&M AgriLife Research Center
1509 Aggie Dr.
Beaumont, TX 77713
Email: m.jugulam@ag.tamu.edu
Phone: (409) 245-8644

Jyoti, Subroto Das
Texas A&M AgriLife Research Center
1509 Aggie Drive
Beaumont, TX 77713
Email: subroto.jyoti@tamu.edu
Phone: (979) 204-2130

Keller, Kris
University of Arkansas
2900 Hwy 130 East
Stuttgart, AR 72160
Email: kkeller@uada.edu
Phone: (870) 830-1133

Kenty, Michael
Helena Agri-Enterprises, LLC
255 Schilling Blvd Ste 200
Collierville, TN 38017
Email: kentym@helenaagri.com
Phone: (901) 409-6525

Ketchum, Cory
University of Arkansas
1354 W Altheimer Dr
Fayetteville, AR 72704
Email: cketchum@uark.edu
Phone: (352) 817-2140

Khan, Muhammad Danyal
LSU AgCenter
4141 Burbank Drive
Baton Rouge, LA 70808
Email: mkhan56@lsu.edu
Phone: (225) 361-9989

Khanal, Sabin
Texas A&M AgriLife Research Center
1509 Aggie Dr
Beaumont, TX 77713
Email: sabin.khanal@ag.tamu.edu
Phone: (575) 571-5739

King, Tanner
Mississippi State University
82 Stoneville Rd
Stoneville, MS 38776
Email: tak196@msstate.edu
Phone: (901) 832-0031

King, David
Nichino
PO Box 592000
San Antonio, TX 78259
Email: dking@nichino.net
Phone: (302) 528-2016

Klawinsky, Katelyn
Texas A&M University
Room 351 AGLS
College Station, TX 77843
Email: katelyn.klawinsky@ag.tamu.edu
Phone: (979) 845-5913

Klein, Michael
USA Rice
2101 Wilson Boulevard
Arlington, VA 22201
Email: mklein@usarice.com
Phone: (703) 475-2072

Kodadinne Narayana, Nisarga
Mississippi State University

Mississippi State, MS 39762
Email: nk581@msstate.edu
Phone: (662) 617-1858

Kondi, Ravi
LSU AgCenter
4040 Burbank Dr, Apt 8
Baton Rouge, LA 70808
Email: rkondi1@lsu.edu
Phone: (225) 493-7498

Kongchum, Manoch
LSU AgCenter
1373 Caffey Road
Rayne, LA 70578
Email: mkongchum@agcenter.lsu.edu
Phone: (337) 788-7531

Lafontaine, Scott
University of Arkansas
2650 Young Ave
Fayetteville, AR 72703
Email: scottla@uark.edu
Phone: (479) 789-3292

Lambert, Eden
Texas A&M University
Room 351 AGLS
College Station, TX 77843
Email: eden3102@tamu.edu
Phone: (979) 845-5913

Lamichhane, Suman
Texas A&M AgriLife Research
1509 Aggie Dr
Beaumont, TX 77713
Email: suman.lamichhane@ag.tamu.edu
Phone: (409) 752-2741

Larazo, Wency
ASU/ARS
504 University Loop W
Jonesboro, AR 72401
Email: wency.larazo@gmail.com
Phone: (870) 627-0939

Lasar, Hendra Gonsalve W
Texas A&M AgriLife Research Center
1509 Aggie Dr
Beaumont, TX 77713
Email: hendralasar@tamu.edu
Phone: (979) 326-8378

Leinfelder-Miles, Michelle
UC Cooperative Extension
2101 E. Earhart Ave., Ste. 200
Stockton, CA 95206
Email: mmleinfeldermiles@ucanr.edu
Phone: (209) 953-6100

Leon, Chris
FMC Corp
142 Chapel Lane
Madison, MS 39110
Email: chris.leon@fmc.com
Phone: (601) 927-9410

40th RTWG ATTENDANCE LIST (continued)

Leonards, James
H.R.C. Rice Research Station
1373 Caffey rd.
Rayne, LA 70578
Email: jleonards@agcenter.lsu.edu
Phone: (337) 788-7531

Levy, Ronnie
LSU AgCenter
8098 Roberts Cove Rd
Rayne, LA 70578
Email: rlevy@agcenter.lsu.edu
Phone: (337) 581-4390

Limmer, Matt
University of Delaware
531 S. College Ave
Newark, DE 19716
Email: limmer.7@gmail.com
Phone: (419) 276-5358

Linn, Jared
University of Arkansas
456 N Campus Walk
Fayetteville, AR 72701
Email: linn@uark.edu
Phone: (972) 898-7331

Linquist, Bruce Linquist
University of California, Davis
Department of Plant Sciences
Davis, CA 95616
Email: balinquist@ucdavis.edu
Phone: (530) 902-2943

Linscombe, Steven
USA Rice
4156 FM 1340
Mountain Home, TX 78058
Email: slinscombe@usarice.com
Phone: (337) 296-6858

Linscombe, Judy
USA Rice
4156 FM 1340
Mountain Home, TX 78058
Email: jlinscombe@gmail.com
Phone: (337) 581-0426

Lipsey, Hunter
Mississippi State University
3816 Hwy 124
Enterprise, LA 71425
Email: hl866@msstate.edu
Phone: (318) 481-5400

Lockhart, William
Mississippi State University
82 Stoneville Road
Stoneville, MS 38776
Email: wcl126@msstate.edu
Phone: (601) 832-3464

Loewer, Jackie
Loewer Bros Farms
4362 White Oak Hwy
Branch, LA 70516
Email: jploewer@aol.com
Phone: (337) 581-5179

Long, Dennis
Belchim USA
PO BOX 165
Summitville, TN 37382
Email: dennis.long@belchim.com
Phone: (931) 800-9569

Long, Stephanie
University of Central Arkansas
LSC 180, Biology, UCA
Conway, AR 72035
Email: slong17@cub.uca.edu
Phone: (501) 450-5472

Lynch, Michael
UC Davis
606 9th st
davis, CA 95616
Email: mjlynch@ucdavis.edu
Phone: (510) 755-7808

Lytle, Mary Jane
Mississippi State University
82 Stoneville Road
Stoneville, MS 38776
Email: mjl449@msstate.edu
Phone: (870) 692-9266

Malone, Darrin
AMVAC
33 Hill Home Dr
Paragould, AR 72450
Email: darrinm@amvac.com
Phone: (870) 215-3706

Malone, James
University of Arkansas
Altheimer Laboratory
Fayetteville, AR 72701
Email: jcmalone@uark.edu
Phone: (870) 476-1240

Manangkil, Jennifer
LSU AgCenter
1443 Brightside Drive, Unit# 1522
Baton Rouge, LA 70820
Email: JManangkil@agcenter.lsu.edu
Phone: (504) 400-6495

Manangkil, Oliver
Philippine Rice Research Institute
129 Maturanoc
Guimba, Nueva Ecija 3115
Email: revilo0514@gmail.com
Phone: 63 9338142404

Mane, Ranjitsinh
Arkansas Economic Development Institute
2801 South University
Little Rock, AR 72204
Email: rmane@ualr.edu
Phone: (501) 916-5958

Mangialardi, Alex
Mississippi State University
82 Stoneville Rd
Stoneville, MS 38776
Email: gam220@msstate.edu
Phone: (662) 588-7385

Manigbas, Norvie
Philippine Rice Research Institute
PhilRice Staffville
Munoz, Nueva Ecija 03119
Email: norviemanigbas@gmail.com
Phone: 63 9219909200

Maris, Patrick
University of Arkansas
2900 Hwy 130 E
Stuttgart, AR 72160
Email: pmaris@uada.edu
Phone: (501) 590-3713

Marsh Janish, Sarah
UCCE
PO Box 180
Colusa, CA 95932
Email: smarsh@ucanr.edu
Phone: (530) 203-8585

Martin, Joey
California Rice Research Foundation
P.O. Box 306 (955 Butte City Hwy)
Biggs, CA 95917
Email: jmartin@crrf.org
Phone: (530) 845-1677

Massey, Joseph
USDA/ARS
504 University Loop W
Jonesboro, AR 72401
Email: joseph.massey@usda.gov
Phone: (662) 418-0081

Maulana, Frank
California Rice Research Foundation
2740 Levi Ln
Chico, CA 95973
Email: frankmaulana19@gmail.com
Phone: (785) 341-0549

Mazzanti, Ralph
University of Arkansas
2506 Little Weaver Cv
White Hall, AR 71602
Email: rmazzanti@uada.edu
Phone: (870) 659-5507

McCarty, Daniel
University of Arkansas
Po Box 53
Humnoke, AR 72072
Email: dmccarty@uark.edu
Phone: (870) 830-1541

McKenzie, Andrew
University of Arkansas
102 Lake Road
Springdale, AR 72764
Email: mckenzie@uark.edu
Phone: (479) 841-7303

Meaux, Kody
USDA/NRCS
3727 Government St Suite 116
Alexandria, LA 71302
Email: kody.meaux@usda.gov
Phone: (318) 473-7618

Mendez, Kharla
ASU/USDA
504 University Loop W
Jonesboro, AR 72401
Email: ksm485@msstate.edu
Phone: (870) 530-6696

Mendoza, Princess Tiffany
Kansas State University
1515 College Ave
Manhattan, KS 66502
Email: ptiffany@ksu.edu
Phone: (515) 520-4532

Meullenet, Jean-Francois
University of Arkansas
1371 West Altheimer Drive
Fayetteville, AR 72704
Email: calessi@uark.edu
Phone: (479) 502-9800

Milholland, Bob
Helena Agri-Enterprises, LLC
255 SCHILLING BLVD STE 200
Collierville, TN 38017
Email: milhollandr@helenaagri.com
Phone: (901) 286-7012

Mohottige, Dulakshi
LSU AgCenter
4066 Burbank Dr, Apt 5
Baton Rouge, LA 70808
Email: DMohottige@agcenter.lsu.edu
Phone: (225) 497-9831

Mondragon, Isabella
ASU/ARS
504 University Loop W
Jonesboro, AR 72401
Email: isabellamondragon02@gmail.com
Phone: (870) 831-1954

Montiel, Maria
Horizon Ag LLC
525 Alonda Dr
Lafayette, LA 70503
Email: mmontiel@horizonseed.com
Phone: (225) 409-5696

Moore, Maya
Columbia Climate School
88 Pleasant Avenue
Burlington, VT 05408
Email: myamourdc@gmail.com
Phone: (207) 494-0071

Moreno-Garcia, Beatriz
University of Arkansas
15 E Davidson Street Unit 1
Fayetteville, AR 72701
Email: bmorenog@uark.edu
Phone: (479) 957-1220

Morrison, William
USDA-ARS
1515 College Ave.
Manhattan, KS 66502
Email: william.morrison@usda.gov
Phone: (785) 776-2796

Moser, Jonathan
USDA ARS
2890 Hwy 130 East
Stuttgart, AR 72160
Email: jonathan.moser@usda.gov
Phone: (870) 672-6143

Moskowitz, Deborah
Resource Renewal Institute
8 Bolinas Rd, Suite 3A
Fairfax, CA 94960
Email: debmosk@gmail.com
Phone: (415) 613-9675

Mukherjee, Arijit
University of Central Arkansas
LSC 180, Biology, UCA
Conway, AR 72035
Email: amukherjee@uca.edu
Phone: (608) 628-6557

Munkaila, Mohammed
Texas A&M AgriLife Research Center
1509 Aggie drive
Beaumont, TX 77713
Email: mmunkail@tamu.edu
Phone: (307) 761-4236

Musgrove, Tyler Ray
LSU AgCenter
7856 Clover Ridge Ave.
Baton Rouge, LA 70820
Email: tmusgrove@agcenter.lsu.edu
Phone: (318) 463-2567

Nalley, Lawton
University of Arkansas
217 AGRI Building
Fayetteville, AR 72701
Email: llnalley@uark.edu
Phone: (479) 575-6818

Neuhaus, Dylan
University of Central Arkansas
LSC 180, Biology, UCA
Conway, AR 72035
Email: dneuhaus@cub.uca.edu
Phone: (501) 450-5472

Newkirk, Trevor
Syngenta Crop Protection
501 Teal Loop
West Monroe, LA 71291-9113
Email: trevor.newkirk@syngenta.com
Phone: (318) 319-7046

Nicolli, Camila
University of Arkansas
2900 Hwy 130 E
Stuttgart, AR 72160
Email: cnicolli@uada.edu
Phone: (870) 830-2232

Noble, Ann
Rice Researchers, Inc.
1439 Mulberry St
Chico, CA 95928
Email: anoble@riceresearchers.com
Phone: (530) 966-8228

Norsworthy, Jason
University of Arkansas
13664 Mineral Springs Rd
West Fork, AR 72774
Email: jnorswor@uark.edu
Phone: (479) 313-1265

Okamuro, Jack
USDA-ARS
5601 Sunnyside Ave
Beltsville, MD 20705
Email: jack.okamuro@usda.gov
Phone: (202) 285-9520

Olaoni, Samuel
University of Arkansas
2650 Young Ave
Fayetteville, AR 72704
Email: soolaoni@uark.edu
Phone: (479) 332-9885

Osako, Maria
Texas A&M University
1718 Leona Dr
College Station, TX 77840
Email: maria.mimbuosako@agnet.tamu.edu
Phone: (979) 344-7136

40th RTWG ATTENDANCE LIST (continued)

Osoko, Taiwo
University of Arkansas
1551 N Leverett Ave
Fayetteville, AR 72703
Email: tosoko@uark.edu
Phone: (806) 831-4536

Ottis, Brian
RiceTec, Inc.
PO BOX 1305
Alvin, TX 77512
Email: bottis@ricetec.com
Phone: (281) 212-5100

Ouma, Faith
University of Arkansas
2704 South 20th Street
Rogers, AR 72758
Email: fachieng@uark.edu
Phone: (479) 404-9647

Outlaw, Joe
Texas A&M University
Room 351 AGLS
College Station, TX 77843
Email: joutlaw@tamu.edu
Phone: (979) 845-5913

Ouzts, Randy
Nutrien Ag Solutions
3138 HIGHGATE DRIVE
GERMANTOWN, TN 38138
Email: Randy.ouzts@nutrien.com
Phone: (901) 850-6533

Palumbo, Melissa
ASU/ARS
504 University Loop W
Jonesboro, AR 72401
Email: melissaadellepalumbo@gmail.com
Phone: (870) 371-4092

Payne, Geoffrey
USDA/ARS
504 University Loop W
Jonesboro, AR 72401
Email: geoffrey.payne@usda.gov
Phone: (662) 607-3463

Pedrozo, Rodrigo
USDA ARS
2890 Hwy 130 East
Stuttgart, AR 72160
Email: rodrigo.pedrozo@usda.gov
Phone: (870) 672-9300

Perdiguerra, Kim Nyka
Texas A&M AgriLife Research Center
1509 Aggie Dr Beaumont Tx
BEAUMONT, TX 77713
Email: kimnyka.perdiguerra@agnet.tamu.edu
Phone: (409) 229-3120

Pereira, Jocilene
University of Arkansas
32 D and NR
Stuttgart, AR 72160
Email: jpereira@uada.edu
Phone: (870) 360-5642

Perry, Hunter
Corteva agriscience
32 Martin Road
Belden, MS 38826
Email: hunter.perry@corteva.com
Phone: (662) 820-5758

Petrowicz, Holly
Texas A&M AgriLife Research Center
1509 Aggie Drive
Beaumont, TX 77713
Email: holly.petrowicz@ag.tamu.edu
Phone: (409) 245-8613

Picha, David
LSU AgCenter
104-B Sturgis Hall
Baton Rouge, LA 70803
Email: dpicha@agcenter.lsu.edu
Phone: (225) 578-1032

Pierce, Lane
University of Arkansas
954 S Wichita Ave
Fayetteville, AR 72404
Email: ldpierce@uark.edu
Phone: (870) 316-4006

Pitre, John
Direct Agronomics LLC
2568 Vidrine Rd
Ville Platte, LA 70586
Email: jpitre2@yahoo.com
Phone: (337) 501-0230

Ponce, Kimberly
Texas A&M AgriLife Research
1509 Aggie Drive
Beaumont, TX 77713
Email: kimsuazoponce@gmail.com
Phone: (409) 752-2741

Pontes Guimaraes, Bernardo
University of Arkansas
1112 West Hendrix Street
Fayetteville, AR 72703
Email: bpg002@uark.edu
Phone: (479) 332-8820

Poveda Sanchez, Martin
Rice Industry
2825 Burrows Farm CV
Germantown, TN 38138
Email: mpoveda@cibus.com
Phone: (901) 831-0064

Price, Trey
LSU AgCenter
212A Macon Ridge Road
Winnsboro, LA 71295
Email: pprice@agcenter.lsu.edu
Phone: (318) 235-9805

Price, Mitchell
ASU/ARS
504 University Loop W
Jonesboro, AR 72401
Email: mitchell.price@smail.astate.edu
Phone: (870) 919-2278

Priess, Lawson
FMC
1221 Ira Williams Rd
Benton, AR 72019
Email: lawson.priess@fmc.com
Phone: (817) 304-1315

Punzalan, Jomar
LSU AgCenter
1373 Caffey Road
Rayne, LA 70578
Email: jpunzalan@agcenter.lsu.edu
Phone: (337) 785-6699

Quinones, Cherryl
ASU/ARS
504 University Loop W
Jonesboro, AR 72401
Email: cherryloquinones@gmail.com
Phone: (870) 761-2055

Radtke, James
Cibus Inc.
2800 Mount Ridge Rd.
Roseville, MN 55113
Email: jradtke@cibus.com
Phone: (612) 308-4096

Rana, Shalika
USDA-ARS-SRRC
USDA-ARS-SRRC
New Orleans, LA 70124
Email: shalika21paul@gmail.com
Phone: (504) 547-2309

Rana, Prabhat
LSU AgCenter
4083 Burbank Drive, Apt 4
Baton Rouge, LA 70808
Email: prana1@lsu.edu
Phone: (225) 220-2710

Ranasinghe H Arachchige, Nuwan Hettiarachchi
Texas A&M AgriLife Research Center
1509 Aggie Dr
Beaumont, TX 77713
Email: nuwanrha@tamu.edu
Phone: (979) 326-8984

Ranniku, Reti
University of Arkansas
1069 S. Olympic Pl.
Fayetteville, AR 72701
Email: rranniku@uark.edu
Phone: (479) 332-8276

Reba, Michele
USDA/ARS
504 University Loop W
Jonesboro, AR 72401
Email: michele.reba@usda.gov
Phone: (870) 819-2708

Riaz, Awais
University of Arkansas
Room # 115 Plant Science Building
Fayetteville, AR 72701
Email: ariaz@uark.edu
Phone: (479) 480-0096

Ricarte, Beatriz
Universitat Politècnica de València
Camino de Vera s/n
Valencia, 46022
Email: bearibe@mat.upv.es
Phone: 3 4963877000

Richards, Jonathan
LSU AgCenter
302 Life Science Building
Baton Rouge, LA 70803
Email: jrichards@agcenter.lsu.edu
Phone: (225) 578-3479

Richardson, Will
University of Arkansas
1900 N. Garland Ave #45
Fayetteville, AR 72703
Email: wprichar@uark.edu
Phone: (501) 580-8283

Riddle, Craig
California Rice Commission
1231 I St Suite 205
Sacramento, CA 95814
Email: criddle@calrice.org
Phone: (916) 812-3468

Rivera, Anthony
University of Puerto Rico
101 Hwy km 8.4
Lajas , PR 00667
Email: anthony.rivera5@upr.edu
Phone: (787) 368-5523

Roberts, Trent
University of Arkansas
1354 West Altheimer Drive
Fayetteville, AR 72704
Email: tlrobert@uada.edu
Phone: (479) 935-6546

Rohila, Jai
USDA ARS
2890 Hwy 130 East
Stuttgart, AR 72160
Email: jai.rohila@usda.gov
Phone: (870) 672-6139

Ronning, Bruna
University of Arkansas
32 D and N Road Apt C-3
Stuttgart, AR 72160
Email: bronning@uada.edu
Phone: (870) 456-1645

Rosado, Baileigh
University of Delaware
158 Lawn Avenue
Sellersville, PA 18960
Email: bcrosado@udel.edu
Phone: (215) 720-4445

Ross, Aidan
University of Arkansas
1354 W Altheimer Dr
Fayetteville, AR 72704
Email: aidandr@uark.edu
Phone: (501) 912-9527

Runkle, Benjamin
University of Arkansas
374 N Fletcher Ave
Fayetteville, AR 72701-1324
Email: brrunkle@uark.edu
Phone: (479) 305-3692

Rustom, Sam
Texas A&M AgriLife Extension
2963 FM 102
Eagle Lake, TX 77434
Email: srustomjr@gmail.com
Phone: (662) 299-5434

Samonte, Stanley Omar
Texas A&M AgriLife Research Center
1509 Aggie Drive
Beaumont, TX 77713
Email: stanley.samonte@ag.tamu.edu
Phone: (409) 454-6269

San Bautista, Alberto
Universidad Politécnica de Valencia
Camino de Vera s/n
Valencia, 46022
Email: asanbau@upv.es
Phone: 3 4679662280

Sanchez, Darlene
Texas A&M AgriLife Research Center
1509 Aggie Drive
Beaumont, TX 77713
Email: darlene.sanchez@ag.tamu.edu
Phone: (409) 245-8609

Santos, Laila
Louisiana State University
681 Jennifer Jean Drive
Baton Rouge, LA 70808
Email: lailasantos@agcenter.lsu.edu
Phone: (225) 220-2002

Sarfaraz, Qamar
University of Arkansas
1354 W Altheimer Dr
Fayetteville, AR 72704
Email: qamars@uark.edu
Phone: (479) 799-3582

Sarkar, Nupur
Texas A&M AgriLife Research Center
1509 Aggie Drive
Beaumont, TX 77713
Email: nupur.sarkar@ag.tamu.edu
Phone: (409) 245-8616

Schafer, Mark
LSU AgCenter
101 Martin Woodin Hall
Baton Rouge, LA 70810
Email: mschaf1@lsu.edu
Phone: (225) 229-7765

Schmidt, Lance
Gowan USA
907 Amy Rd
Pocahontas, AR 72455
Email: lschmidt@gowanco.com
Phone: (870) 378-7273

Scott, Robert
University of Arkansas
135 Morden Rd
Ward, AR 72176
Email: bscott@uada.edu
Phone: (501) 837-0273

Scott, Susan
NAU Country
135 Morden Rd
Ward, AR 72176
Email: susanscott@esagdata.com
Phone: (501) 743-9401

Scott, Carri
University of Arkansas
1354 West Altheimer Drive
Fayetteville, AR 72704
Email: carrilulu77@gmail.com
Phone: (479) 530-9823

Sells, Laduska
USDA ARS
2890 Hwy 130 East
Stuttgart, AR 72160
Email: laduska.sells@usda.gov
Phone: (870) 672-6123

40th RTWG ATTENDANCE LIST (continued)

Septiningsih, Endang
Texas A&M University
370 Olsen Blvd., 2474 TAMU
College Station, TX 77843
Email: eseptiningsih@tamu.edu
Phone: (979) 220-0389

Seyfferth, Angelia
University of Delaware
531 S College Avenue
Newark, DE 19716
Email: angelias@udel.edu
Phone: (302) 831-4865

Sha, Xueyan
University of Arkansas
2900 Hwy 130 E
Stuttgart, AR 72160
Email: xsha@uark.edu
Phone: (870) 659-8628

Shahi, Dipendra
LSU AgCenter
4033 Burbank Drive
Baton Rouge, LA 70808
Email: dshahi@agcenter.lsu.edu
Phone: (352) 317-8283

Shao, Qiming
Nutrien
676 County Rd 324
El Campo, TX 77437
Email: qiming.shao@nutrien.com
Phone: (979) 219-6903

Sharma, Nirmal
California Rice Research Foundation
955 Butte City Highway
Biggs, CA 95917
Email: nsharma@crrf.org
Phone: (217) 721-0568

Sharma, Jyoti
LSU AgCenter
404 Life Sciences Building
Baton Rouge, LA 70803
Email: jsharm4@lsu.edu
Phone: (225) 433-7017

Shinoto, Yoshiya
NARO
Gaines Hall, Room 4204A-1
Jonesboro, AR 72401
Email: shinoto@affrc.go.jp
Phone: (870) 333-8908

Simeon Brocal, Ruben
Universitat Politècnica de València
Camino de Vera s/n
Valencia, 46022
Email: rusibro@upv.edu.es
Phone: 3 4695485425

Singh, Gurjeet
Texas A&M AgriLife Research Center
1509 Aggie Drive
Beaumont, TX 77713
Email: gurjeet.singh@ag.tamu.edu
Phone: (409) 658-7380

Slaton, Nathan
University of Arkansas
1371 W. Altheimer Street
Fayetteville, AR 72704
Email: nslaton@uark.edu
Phone: (479) 502-9803

Smartt, Alden
University of Arkansas
1354 Altheimer Dr
Fayetteville, AR 72704
Email: adsmartt@uark.edu
Phone: (479) 233-1778

Smith, Tanner
University of Arkansas
619 N Keats Dr.
Fayetteville, AR 72704
Email: tms027@uark.edu
Phone: (901) 574-0856

Smith, Brennan
USDA Agricultural Research Service
1100 Allen Toussaint Blvd
New Orleans, LA 70124
Email: Brennan.smith@usda.gov
Phone: (504) 286-4448

Smyly, Anna
Mississippi State University
180 Stevens Rd.
Hollandale, MS 38748
Email: ac3794@msstate.edu
Phone: (870) 830-9883

Soileau, Kyle
Ducks Unlimited
125 Southpark Road
Lafayette, LA 70508
Email: ksoileau@ducks.org
Phone: (337) 322-4565

Sookaserm, Tiffany
USDA ARS
2890 Hwy 130 East
Stuttgart, AR 72160
Email: tiffany.sookaserm@usda.gov
Phone: (870) 672-6148

Sopher, Steve
UPL NA, Inc
7615 Tradition Pkwy
Amarillo, TX 79119
Email: ryan.bryant-schlobohm@upl-ltd.com
Phone: (405) 747-0004

Sparks, Gavin
LSU AgCenter
2908 Tide Dr
Baton Rouge, LA 70810
Email: gsparks@agcenter.lsu.edu
Phone: (501) 593-3443

Stoker, Ben
LSU AgCenter
2908 Tide Dr
Baton Rouge, LA 70810
Email: sstoker@agcenter.lsu.edu
Phone: (662) 417-8506

Stout, Michael
LSU AgCenter
404 Life Sciences Building
Baton Rouge, LA 70803
Email: mstout@agcenter.lsu.edu
Phone: (225) 892-2972

Subudhi, Prasanta
LSU AgCenter
215 Sturgis Hall
Baton Rouge, LA 70810
Email: psubudhi@agcenter.lsu.edu
Phone: (225) 578-1303

Sun, Huihui
University of Arkansas

Fayetteville, AR 72701
Email: huihuis@uark.edu
Phone: (865) 221-5168

Tai, Thomas
USDA-ARS
10 Captain Court
Sacramento, CA 95831
Email: thomas.tai@usda.gov
Phone: (530) 400-5530

Takahashi, Sol
University of Arkansas
PO Box 2340
State University, AR 72467
Email: stakahas@uada.edu
Phone: (510) 316-7355

Talukder, Shyamal
Texas A&M AgriLife Research Center
1509 Aggie Drive
Beaumont, TX 77706
Email: shyamal.talukder@ag.tamu.edu
Phone: (785) 313-4202

Theunissen, Brent
LSU Rice Research Station
111 Theunissen Lane
Rayne, LA 70578
Email: btheunissen@agcenter.lsu.edu
Phone: (337) 581-3856

40th RTWG ATTENDANCE LIST (continued)

Thomas, Julie
UADA
495 N Campus Dr
Fayetteville, AR 72701
Email: jt008@uark.edu
Phone: (631) 943-1298

Thomson, Michael
Texas A&M University
370 Olsen Blvd., 2474 TAMU
College Station, TX 77843
Email: m.thomson@tamu.edu
Phone: (979) 220-3173

Torres Toro, Edgar Alonso
RiceTec Inc
1925 FM 2917
Alvin, TX 77511
Email: etorres@ricetec.com
Phone: (346) 407-1399

Trevino, Michael
Texas A&M AgriLife
2466 65th Street
Port Arthur, TX 77640
Email: michael.trevino@agnet.tamu.edu
Phone: (409) 749-4597

Tucker, River
California Rice Research Foundation
P.O. Box 306 (955 Butte City Hwy)
Biggs, CA 95917
Email: dharrell@crrf.org
Phone: (402) 917-7757

VanWeelden, Matthew
Cooperative Extension/UF/IFAS
559 North Military Trail
West Palm Beach, FL 33415
Email: ebroullo@pbcgov.org
Phone: (561) 233-1712

Venghiattis, Philippe
Arrocera Venllano
4408 Jefferson Court
Napa, CA 94558
Email: avsa.pcv@gmail.com
Phone: (707) 738-1638

Vickmark, Hannah
The University of Arkansas
3506 W Harvard St
Fayetteville, AR 72704
Email: hevickma@uark.edu
Phone: (479) 422-9192

Vincent, Todd
ALMACO
99 M Avenue
Nevada, IA 50201
Email: vincentt@almaco.com
Phone: (515) 450-6392

Walker, Timothy
Horizon Ag LLC
8275 Tournament Dr Ste 255
Memphis, TN 38125
Email: twalker@horizonseed.com
Phone: (901) 590-9564

Wang, Jim
LSU AgCenter
104 Sturgis Hall-LSU
Baton Rouge, LA 70803
Email: jjwang@agcenter.lsu.edu
Phone: (225) 578-1360

Wang, Qin
The Pennsylvania State University
419 Life Sciences Building
University Park, PA 16802
Email: quw11@psu.edu
Phone: (814) 867-0300

Watkins, Kenton
University of Arkansas
AGRI 224, University of Arkansas
Fayetteville, AR 72701
Email: kbwatki@uark.edu
Phone: (501) 681-7861

Webber, Joe
Helena Agri Enterprises, LLC
255 Schilling Blvd Ste 200
Collierville, TN 38017
Email: webberj@helenaagri.com
Phone: (956) 607-6227

Webster, Eric
University of Wyoming
PO Box 1647
Laramie, WY 82073
Email: ewebste2@uwyo.edu
Phone: (225) 281-9449

Webster, Connor
LSU AgCenter
4115 Gourrier Ave
Baton Rouge, LA 70808
Email: Lwebster@agcenter.lsu.edu
Phone: (256) 694-3815

Whitt, Dalton
Mississippi State University
82 Stoneville, Rd
Stoneville, MS 38776
Email: drw370@msstate.edu
Phone: (662) 822-1160

Wiley, Kent
Rice Researchers
7875 Country Rd 32 1/2
Glenn, CA 95943
Email: Kwiley@riceresearchers.com
Phone: (530) 934-3828

Williams, Brady
LSU AgCenter
617 N. Avenue J
Crowley, LA 70526
Email: blwilliams@agcenter.lsu.edu
Phone: (337) 250-1173

Williams, Evelyn
LSU AgCenter
4115 Gourrier Ave
Baton Rouge, LA 70808
Email: EMWilliams@agcenter.lsu.edu
Phone: (940) 735-2392

Williamson, Stephanie
University of Arkansas
1354 West Altheimer Drive
Fayetteville, AR 72704
Email: steph.m.williamson@gmail.com
Phone: (479) 841-6117

Wilson, Lloyd "Ted"
Texas A&M AgriLife Research Center
1509 Aggie Dr.
Beaumont, TX 77713
Email: lt-wilson@aesrg.tamu.edu
Phone: (409) 752-3045

Wilson, Blake
LSU AgCenter
404 Life Science Building
Baton Rouge, LA 70803
Email: bwilson@agcenter.lsu.edu
Phone: (985) 373-6193

Woodruff, Richard
UADA/ARS
504 University Loop W
Jonesboro, AR 72401
Email: rcwoodruff5@gmail.com
Phone: (870) 284-0912

Workman, Richard
Helena Agri-Enterprises, LLC
255 Schilling Blvd Ste 200
Collierville, TN 38017
Email: workmanr@helenaagri.com
Phone: (501) 658-5170

Wurlitzer, Brad
Wurlitzer Farms
721 Sheridan Avenue
Chico, CA 95926
Email: bradnmare@aol.com
Phone: (530) 570-5153

Xu, Huayu
South Dakota State University
622 6th Ave Apt4
Brookings, SD 57006-1792
Email: huayu.xu@sdstate.edu
Phone: (605) 592-4783

40^{th} RTWG ATTENDANCE LIST (continued)

Yabes, Jonalyn
Texas A&M University
401 Southwest Pkwy, Apt. 722
College Station, TX 77840
Email: jmcyabes23@tamu.edu
Phone: (225) 715-8647

Yanes, Jaime
Albaugh, LLC
949 Winleaf Dr.
Collierville, TN 38017
Email: JaimeY@albaughllc.com
Phone: (901) 355-4123

Yanes, Celeste
Albaugh, LLC
949 Winleaf Dr.
Collierville, TN 38017
Email: JaimeY@albaughllc.com
Phone: (901) 355-4725

Yang, Yao
University of Arkansas
465 N Campus Walk
Fayetteville, AR 72701
Email: yaoy@uark.edu
Phone: (984) 255-3648

Yang, Bing
University of Missouri - Columbia
340e Bond Life Science Center
Columbia, MO 65211
Email: yangbi@missouri.edu
Phone: (573) 882-7705

Yang, Yinong
The Pennsylvania State University
405C Life Sciences Building
University Park, PA 16802
Email: yuy3@psu.edu
Phone: (814) 867-0324

Young, Shelby
USA Rice
2101 Wilson Boulevard
Arlington, VA 22201
Email: syoung@usarice.com
Phone: (806) 292-1915

Zaunbrecher, Gretchen
California Rice Research Foundation
955 Butte City Hwy #306
Biggs, CA 95917
Email: gzaunbrecher@crrf.org
Phone: (337) 296-5780

Zaunbrecher, Rick
H. Rouse Caffey Rice Research Station
1373 Caffey Road
Rayne, LA 70578
Email: rzaunbrecher@agcenter.lsu.edu
Phone: (337) 207-9788

Zeigler, Robert
Global Rice Research Fund
6701 SW Canyon Crest Drive
Portland, OR 97225
Email: bob@zeiglermail.net
Phone: (650) 798-7939

ZHOU, XINGEN "Shane"
Texas A&M AgriLife Research
1509 Aggie Dr
Beaumont, TX 77713
Email: xzhou@aesrg.tamu.edu
Phone: (409) 223-0178