H. Rouse Caffey Rice Research Station News

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Special Dates of Interest:

- Rice Outlook Conference
  Austin, TX
  December 9-11, 2020
- H. Rouse Caffey Rice Research Station Annual Field Day
  June 30, 2021

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Foundation Seed of Frontière, Update on New High-Protein Genotypes, and Herbicide-Resistant Lines

New Foundation Seed: The availability of foundation seed is important to support successful crop production. For that reason, a new foundation seed of the high-protein cultivar Frontière is being produced this year. Breeder's seed was grown in headrows in the previous year in collaboration with Dr. Herry Utomo. Approximately 150 selected heads were planted and increased in the winter nursery in Puerto Rico in collaboration with Dr. Adam Famoso. Both selected heads and bulked seed were then brought back for the 2020 spring planting. Rick Zaunbrecher, who oversees the Station's foundation seed program, is growing and maintaining the Frontière foundation seed. The seed will be ready for harvest soon.

Last year, Frontière was planted locally for commercial production by Michael Fruge in his field near Eunice. He is actively marketing this high-protein rice under the Prairie Acadian Rice brand. Our lab generated the data needed for product labeling (Table 1). Figure 1A depicts the commercial field near Eunice this season.

New Lines: Promising advanced high-protein lines with improved yield were obtained. Among the highest yielding lines are HP2 (7,200 lb/A) and HP3 (7,101 lb/A) (Table 2). The promising lines have protein contents ranging from 11-11.4%. Their amylose contents range from 20-21% and milling from 60/68% to 63/71%. All advanced lines have an intermediate gelatinization temperature characteristic. With improvements in both protein content and yield, these lines could provide additional choices for farmers interested in growing high-protein rice.

Research on Glyphosate and S-metolachlor Herbicide-Resistant Rice: Rice seed from cultivar Catahoula was chemically mutated using a potent mutagenic agent. The fourth generation of mutated seed (M4) was used for independent screening of two different classes of herbicide, glyphosate and S-metolachlor. The screening was done by spraying seedlings at the 3- to 5-leaf stage using a lethal dose of herbicide. Figures 1B-C document recovery of plant survivors from herbicide screening conducted in the field. Currently, promising resistant lines are being rigorously tested for verification. Seed increase is being conducted in the greenhouse that will be used in the field and plot tests this coming year. With these new types of herbicide-resistant rice, weeds (including red rice) that acquire resistance to NewPath or ACCase herbicide can be eradicated rapidly from the rice production system.

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This project was partially supported by USDA National Institute of Food and Agriculture and the Louisiana Rice Research Board.

Table 1. Specific cereal chemistry and nutritional content of Frontière.

RICE GRAIN QUALITY/PROPERTIES:	GRAIN:
® **10.22% Protein** ® **21.8% Amylose** ® **5 Alkali Spreading Value/1.7% KOH Solution** ® **Intermediate Gelatinization Temperature** ® **20% Milling Quality (% hulls)** ® **63% Milling Yield (% whole kernel)**	Seed Coat Color: …………………Speckled brown Endosperm Type: …………………Non-glutinous (non-waxy) Endosperm Translucency: ………..Clear Endosperm Chalkiness: …………..Small Scent: ………………………….….Non-scented Shape Class: ………………………Long

RICE	Alkali Spreading	GelTemp	Glutinous	Scent	Protein Content (%)
Brown	5	Intermediate	Non-glutinous	Non-scented	10.22
Milled/White	5	Intermediate	Non-glutinous	Non-scented	10.00

RICE	Total Fat (g/100g)	Total Fiber (g/100g)	Carbs (g/100g)	Water (g/100g)	Calories (kcals/100g)
Milled/White	0.8	0.44	79	10.92	360

RICE FLOUR	Crude Fat (%)	Crude Fiber (%)	Pasting Temp (ºC)	Moisture Content (%)	Protein Content (%)
Brown	2.50	0.90	87.55	12.70	10.10
Milled/White	0.45	0.27	82.73	12.89	9.25

Table 2. Yield, protein content, and grain characteristics (milling yield, amylose content, Alkali Spreading Value, Gel Temp, and pasting temperature) among advanced high-protein rice lines HP2, 3, 5, 8, 9, 10, Frontière (FNTR), and Cypress (CPRS) check.

	FNTR	**CPRS**	**HP2**	**HP3**	**HP5**	**HP8**	**HP9**	**HP10**
Yield (lb/A)†	5,879	6,530	7,200	7,101	6,455	6,780	6,872	6,565
Protein Content (%)ł	10.3	8.1	11.2	11	11.4	11.3	11	11.1
Milling Yield (% whole)	63	61	61	63	58	61	60	59
Amylose (%)	21.8	21.8	20.1	21	22.6	20.2	21	20.3
Alkali Spreading Value	5	5	3.5	3.6	4	3.7	3.3	3.7
Gel Temp	Int	Int	Int	Int	Int	Int	Int	Int
Pasting Temp (ºC); Brown	87.6	89.1	80.1	82.1	77.1	88.9	87.1	88.8
Pasting Temp (ºC); White	82.7	83.3	74.3	73.2	71.2	83.1	82.4	83.2

†Averaged values of samples from multi-year replicated Preliminary Yield trials (PY 2017, 2018, 2019).
ł Based on N-combustion method.

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Figure 1. A. High-protein cultivar Frontière grown on Michael Fruge's Farm, spring 2020); B. Rice survivor from 1.5X S-metolachlor field treatment; C. Rice plant survivor from 0.75X glyphosate field treatment; and D. Rice survivor from 1.5X S-metolachlor field treatment.

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Identity Preservation in Rice and Updates on Specific Added Value

Rice growers in Louisiana have the skills and experience to produce high-quality rice. There is, however, no mechanism to reward these. Very often superior quality is lost through commingling with other lower quality products during normal storage, handling, and shipping procedures.

Identity Preservation (IP) can overcome this problem. IP refers to a system of production, handling, and marketing practices that maintains the integrity and purity of commodities. In other crops such as corn, soybean and wheat, demand for an IP system is increasing because of the increased need to segregate crops for specific uses. IP will give customers assurance that the product is what they want. Buyers are willing to pay a higher price for grains that can be guaranteed to possess a unique characteristic. These special characteristics may relate to physical attributes, such as seed color (white wheat, for example) or nutritional values and metabolic factors (high oil, protein, phytochemicals).

Rice cultivars, both conventional and specialty, offer a variety of specific properties, grain characteristics, and nutritional values. Certain cultivars may produce grain product characteristics that fit a certain type of market but not the others and vice versa. With an IP system, this precise marketing can be done effectively. More importantly, an IP system will directly benefit rice

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farmers by giving them better returns through its premium price. Therefore, implementing an IP system in rice will be worthwhile. The uniformity in an IP crop provides stability in maintaining required product consistency. Growers can control many of these trait and quality levels with management. Grain processors then utilize these special products to secure a market premium and reduce manufacturing losses using these unique differentiated products.

In line with the IP concept, one aspect of our research that is funded partly by the Louisiana Rice Research Board this year is aimed to breed, select, and characterize new rice lines to have a specific quality, such as improved baking quality, reduced glycemic index, and increased beneficial phytochemicals. These traits can be enhanced to meet industrial standards as new products that will have broader appeal and real functions in, for example, the $6 billion gluten-free baking industry. With the IP system, farmers will benefit from the premium price by growing these types of rice.

Table 1 below has a list of some promising lines being developed to carry specific characteristics. A rice line with a notable change in its baking quality component [pasting temperature in both brown rice (BR) and white rice (WR)] is shown in HP11. Other new lines, HP2, 3, 8, and 11, have improved bran oil content (percent crude fat) in both BR and WR. Elevated crude fiber content is found in HP4, 5, and 9 in their BR, and HP3 and 9 in their WR. Lines HP5, 10, and 11 show higher resistant starch, a base for developing a lower glycemic index. All of these promising lines have yields ranging from 6,033 to 7,218 lb/A, which are higher compared to the cultivar Frontière (5,879 lb/A).

Table 1. Characteristics of promising rice lines with their specificity on cereal chemistry, baking components, brand oil, resistant starch, and yield.†

	FNTR	***CPRS***	***HP1***	***HP2***	***HP3***	***HP4***	***HP5***	***HP6***	***HP7***	***HP8***	***HP9***	***HP10***	***HP11***
Bran Oil:													
Crude Fat (%); BR	2.5	2.4	2.1	3.4*	4.1*	2.2	2.1	2.1	1.8	4.1*	2.3	2.4	3.2*
Crude Fat (%); WR	0.5	0.4	0.3	1.8*	2.0*	0.4	0.5	0.5	0.3	2.2*	1.1	1.0	1.4*
Crude Fiber (%); BR	0.9ϒ	0.9	1.2	0.8	0.7	1.6*	2.0*	0.8	0.7	0.6	1.8*	1.0	1.1
Crude Fiber (%), WR	0.3ϒ	0.3	0.5	0.3	0.6*	0.3	0.3	0.4	0.4	0.3	0.7*	0.5	0.4
Baking Component:													
Pasting Temp (°C); Brown	87.6	89.1	75.0	80.1	82.1	76.0	77.1	76.2	76.8	88.9	87.1	88.8	91.0*
Pasting Temp (°C); White	82.7	83.3	72.0	74.3	73.2	72.2	71.2	70.5	72.1	83.1	82.4	83.2	85.9*
Resistant Starch†† (%)	6.2	4.1	6.9	6.2	7.8	5.2	8.9*	9.1	5.2	4.1	4.3	9.4*	9.6*
Yield (lb/A)	5,879	6,530	7,218	7,200	7,101	6,980	6,455	6,430	6,332	6,780	6,872	6,565	6,033

†Averaged values based on multi-year replicated Preliminary Yield trials (PY 2017, 2018, 2019); ϒ Data from Paz, G.M. 2019. High-protein rice flour in the development of gluten-free muffins and bread. LSU Master's Theses 4967. ††Dry weight basis (Modified Patindol's method); *Statistically significant improvement for the trait. FNTR (cultivar Frontière); CPRS (cultivar Cypress).

Image/Logo – courtesy of Agricultural Marketing Service, USDA

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Rice Disease Resistance to Bacterial Panicle Blight

Bacterial panicle blight is a major rice disease in Louisiana, along with blast, sheath blight, and narrow brown leaf spot (also called Cercospora leaf spot). Unlike other major rice diseases caused by fungal pathogens, bacterial panicle blight cannot be managed with fungicides because its causal agents are bacterial pathogens (Burkholderia glumae and Burkholderia gladioli). The antibiotic compound, oxolinic acid, is used to manage bacterial panicle blight in other rice-growing countries, but this product is not registered in the United States for agricultural purposes. Regardless of its availability, oxolinic acid is not a reliable measure for long-term usage due to frequent occurrence of antibiotic-resistant pathogens. In the absence of any product that effectively manages bacterial panicle blight, growing disease-resistant rice varieties is an ideal way to overcome this disease problem. Unfortunately, most of the commercial varieties and elite lines grown in the United States are susceptible to bacterial panicle blight. Highly resistant U.S. rice for this disease has not been available; although, several U.S. varieties exhibit a certain degree of partial resistance (Table 1).

*Table 1. The U.S. rice varieties showing partial resistance to bacterial panicle blight based on recent data from Arkansas, Louisiana, and Mississippi.**

Variety	Susceptibility/Resistance to Bacterial Panicle Blight**
Catahoula	Moderately Resistant
CL151	Moderately Resistant
Presidio	Moderately Resistant
Taggart	Moderately Resistant
Bowman	Moderately Susceptible
Cheniere	Moderately Susceptible
CL111	Moderately Susceptible
Francis	Moderately Susceptible
Jupiter	Moderately Susceptible
Neptune	Moderately Susceptible
Rondo	Moderately Susceptible
Sabine	Moderately Susceptible
Wells	Moderately Susceptible

* This table is recreated from the publication: Shew A.M., Durand-Morat A., Nalley L.L., Zhou X-G., Rojas C., and Thoma G. (2019) Warming increases Bacterial Panicle Blight (*Burkholderia glumae*) occurrences and impacts on USA rice production. PLoS ONE 14(7): e0219199. https://doi.org/10.1371/journal.pone.0219199

** Susceptibility/Resistance rating of each variety may vary depending on the planting areas and years.

The genetic study of disease resistance is critical not only to understand the mechanism underlying a given disease resistance trait but also to breed disease-resistant varieties. Identification of a genetic location (called locus, or loci for plural) linked to a disease resistance trait can lead to the development of reliable molecular markers that allow efficient screening of disease-resistant breeding lines without laborious disease tests. Only a few genetic loci have been known to contribute significantly to a rice's resistance to bacterial panicle blight. One of them was identified from Teqing, a Chinese high-yielding indica variety, on Chromosome 3. This locus is also closely linked to the trait of days-to-heading. Another major locus associated with the resistance to bacterial panicle blight was identified from Kele, a traditional lowland indica variety developed in India, on Chromosome 1.

Our genetic study has been performed primarily to identify genetic loci for bacterial panicle blight resistance from U.S. varieties and lines. So far, only one conspicuous locus has been found from Jupiter, a moderately-resistant medium-grain U.S. variety, as a major contributor to bacterial panicle blight resistance. Interestingly, this locus is also closely linked to the days-to-heading trait, and its position is similar to the one previously identified from Teqing on Chromosome 3. This suggests that Jupiter and Teqing could share the same genetic element (gene) for bacterial panicle blight resistance, which is closely linked to the days-to-heading trait. Currently, we are trying to identify and characterize the gene that accounts for the disease resistance of Jupiter within the major locus in order to elucidate the biological mechanism of bacterial panicle blight resistance. For breeding of disease-resistant rice, the molecular markers for the major locus identified in our study are a useful tool to incorporate a major genetic element of bacterial panicle blight resistance into elite varieties and lines.

Although the genetic locus we identified on Chromosome 3 is important for the bacterial panicle blight resistance of Jupiter (and probably Teqing, too), the resistance locus may not be the same in different rice varieties. For example, as mentioned above, the main locus for the bacterial panicle blight resistance of Kele is located on Chromosome 1. One of our approaches for enhancing the bacterial panicle blight resistance is to introduce those two known major loci (one from Jupiter and the other from Kele) simultaneously into commercial varieties through repeated backcrosses, expecting their additive effects on disease resistance. We also have been making efforts to find more genetic resources of bacterial panicle blight resistance through screening of disease-

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resistant lines from various sources. Several lines identified from our multi-year screening process show great disease resistance traits against bacterial panicle blight (Table 2 and Figure 1), as well as sheath blight. We will identify new genetic loci for bacterial panicle blight resistance from those disease-resistant lines through cutting-edge techniques of bioinformatics, such as genome-wide association study and genotyping by sequencing. We expect that the additional genetic loci identified from this study can be utilized for step-wide improvements (called pyramiding) of disease resistance to bacterial panicle blight through high-throughput breeding procedures assisted with appropriately designed molecular markers.

Table 2. Rice lines identified from our tests of bacterial panicle blight resistance.

Variety Name or Line Code	Disease Rating for Bacterial Panicle Blight*
IR28	1.7
PGC7804	2.3
Tetep	1.7
PGC141	2.0
Bengal	6.3

* With a scale of 0 - 9, where 0 indicates no visible symptom and 9 indicates more than 90% of symptomatic area in a panicle.

Figure 1. Bacterial panicle blight symptoms of a susceptible rice (left, Bengal) and a moderately-resistant rice (right, PGC141).

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Focus

Joseph John II

Joseph John II has been working at the HRC Rice Research Station since January as a research associate in the breeding project.

He grew up on a farm near Crowley where his father, Joseph John, raised rice and crawfish.

He graduated from Notre Dame High School, then earned his bachelor's degree in 2008 from the University of Louisiana at Lafayette in general studies and applied science. After college, he worked in the oil and gas industry as a landman in Wyoming, Colorado, Texas, and Louisiana, looking up property records in courthouses and knocking on doors to obtain mineral leases and rights-of-way.

Joseph knew he wanted to return to have a career in agriculture. "I finally made my way back here to get back on the farm."

He started raising vegetables and working for his father but knew the job at the Rice Research Station would mesh well with his love of agriculture.

"I could never sit back behind a desk," he said. "I like putting my boots on and getting dirty."

Even though he had a background in rice farming, he was surprised by what his job would involve. "I had no idea how detailed the work is and how much they did over here."

In his spare time, Joseph will be working in his garden and a new 100-foot long high-tunnel greenhouse where he is growing tomatoes and hot peppers for his own brand of hot pepper sauce. Joseph said some of what he has learned from the rice breeding project has application in his horticulture work.

Dr. Adam Famoso, LSU AgCenter rice breeder, said Joseph has become an asset for the breeding program as a hardworking, organized employee.

"Joseph has hit the ground running in our breeding program. He came with a broad skill set and has experience with farming and operating equipment. We are very happy to have him on the team."

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