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RICE RESEARCH STATION NEWS

Breeding Approaches to Increase Selection at Early Breeding Stages

The LSU AgCenter Rice Research Station considers many traits in the rice breeding program. The starting point for any breeding target is the ability to accurately and precisely measure the trait. There are many methods to measure a trait on an experimental line. For example, yield is measured directly in the field over multiple locations and years, blast and sheath blight are screened in specialized disease nurseries, and some grain quality traits are run as biochemical assays in the laboratory.

Another method used to measure the potential of a line are DNA molecular markers, which allow us to assess trait values based on the DNA makeup of the plant. Herry Utomo highlighted the marker assisted breeding work in the February 2015 Rice Research Station Newsletter. Marker assisted breeding is a valuable tool for making selections on traits that are controlled by one or few genes at known locations. However, traits that are under the control of many genes across the entire genome are better suited for an approach referred to as whole genome prediction, which uses information from the entire genome to estimate the value of a line. This approach has been successfully applied in animal breeding, as well as in corn, soybean, barley, wheat and, recently, rice. The cost of the DNA marker data has drastically dropped, and it will soon be economical to integrate this approach as part of the regular breeding process.

Grain quality traits are good examples of where investment into whole genome prediction would likely have a beneficial outcome for the breeding program and growers. As highlighted by Ida Wenefrida in the February 2015 newsletter, the Rice Research Station recently added new laboratory equipment capable of providing high precision data on grain quality traits. This equipment is having a significant impact on breeding progress of grain quality by facilitating selections for grain quality earlier in the breeding process. Although the lab equipment is accurate and efficient, the overall process is time consuming to collect and process the grain samples during harvest time. Thus, it is not logistically feasible to screen all the materials during the early stages of the breeding pipeline.

The whole genome prediction approach would use the grain quality measurement from Dr. Wenefrida from the current and previous years to estimate the effect of different segments of DNA on grain quality traits. The lab-generated measurements will continue to be conducted each year as they currently are. However, we can leverage these measurements to estimate grain quality of the early stage breeding materials based on their entire DNA profile without having to grow and test their grain quality in the lab. Thus, the whole genome predictions are not a replacement for actually measuring the quality traits; rather, it is an opportunity to apply selection for quality traits to more experimental lines, starting earlier in the breeding process. In addition to grain quality, these methods are effective for other traits such as yield, physiological disorders, pest and disease resistance, etc.

An analogy would be to say that we want to pick the 10 tallest people out of a group of 1,000. However, we can only directly measure the height of 100 people. Assuming we had the shoe size of all 1,000 people, we could use shoe size to predict which 100 people to ultimately measure. Thus, we are ultimately picking the 10 tallest based on their actual measured height, not their shoe size, but we are leveraging the shoe size to allow us to make some selection among all 1,000 people, even though we cannot directly measure all 1,000 people.

Although these methods offer a lot of potential, we need to carefully validate and optimize them as we integrate them into the breeding process to ensure we get the greatest return on our research investment. These efforts will require broad collaborations with multiple researchers at the station and across other organizations.

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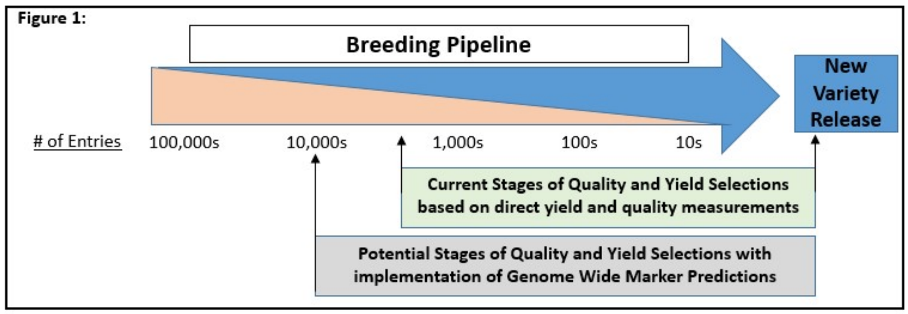

Figure 1 outlines the current varietal breeding pipeline and the number of entries associated with each stage. By utilizing whole genome marker predictions, in addition to our current field and lab screening, we strive to start making selections for yield and quality at earlier stages of the breeding process.

Special Dates of Interest:

- **Rice Station Annual Field Day Wednesday, June 29, 2016**

Inside this Issue

Pest of the Quarter - BLAST

After two years of light blast pressure, 2015 appears to be a bad blast year. Remember, current rice varieties range from resistant to very susceptible. How you manage blast on each varies greatly. Don't put a susceptible variety in a bad situation. Blast is transmitted by wind-borne spores that can travel miles from field to field. Just because you do not have leaf blast in your field does not mean you will not have rotten neck blast. Drained rice is five to 10 times more susceptible to blast than flooded rice. Keep the water on the field after permanent flood, and do not plant susceptible varieties in fields where you may have to drain for straight head, high organic matter, etc. Also, an insecticide seed treatment will greatly reduce the probability of having to drain for weevils and other insects. The later you plant your rice, the more severe blast tends to be. Late fields head when earlier fields are producing spores. The more nitrogen fertilizer used, the more severe blast is. Blast is more severe in rice planted in sandy or light textured soil and in tree-lined fields. Again, do not put very susceptible and susceptible varieties where they are likely to have problems. If leaf blast is in the field or has been reported in the same general area and if the variety is susceptible, fungicide applications are advised to reduce rotten neck blast. If a single fungicide application is used to suppress blast, it should be applied when 50 to 70 percent of the heads have begun to emerge. Application as few as five days before or after this growth stage will not provide effective control of this disease. Heading growth stage is difficult to detect, so it is important to scout for crop growth stage at the same time as scouting for disease. Allow time to obtain a fungicide, schedule the application, and work around possible poor weather conditions. Under heavy blast pressure or when growing a very susceptible variety, two applications – one at boot to suppress spore production and one at 50 to 70 percent heading to protect the head – may be needed to effectively suppress blast. Use the correct fungicide. Only the strobilurins have blast activity. Sheath blight fungus fungicide resistance management, using alternate modes of action, should not be practiced on blast-susceptible varieties.

Active spore-producing blast lesions

Variable rotten neck blast severity on the same variety due to differences in infection time, i.e. severe means earlier infection

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Rice Breeding Objectives

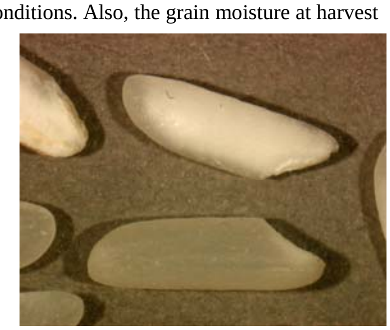
Rice breeders are often asked what they look for when making selections. The answer is complex. Rice varieties are composed of many genes that control every function of the individual plant. Some plant traits are controlled by only one gene (simply inherited) while others are controlled by many genes (polygenic). An example of a simply inherited trait is the presence (pubescence) or absence (glabrous) of leaf hairs. This trait is controlled by a single pair of genes, each inherited from a parent. An example of a polygenic trait is yield. The yield potential of a variety is controlled by many genes. In general, the physical expression of polygenic traits is subject to environmental influence. This means that even though a plant possesses a complex of genes with potential for high yield, under unfavorable environmental conditions, high yields will not be realized. For example, the rice variety Mermentau has a high yield potential, but high yields will not be realized without adequate nitrogen.

Plant breeders face a tremendous challenge in breeding successful varieties. For example, the rice grain of a long-grain variety must have certain dimensions and the grains must be uniform in size. The height of the rice plant must be tall enough to provide a structure to support high yield as well as facilitate harvest, but not too tall to be susceptible to lodging. Plant height is another example of a simply inherited trait. But, the expression of that potential is highly influenced by environmental conditions, such as adequate nitrogen fertilizer.

Disease resistance is another breeding objective for Rice Research Station breeders and pathologists. To select for this trait requires the presence of the proper disease causal agent. Sheath blight is the most troublesome disease in Louisiana rice production. To facilitate screening for resistance to this disease, the breeder will typically inoculate plots and rows with *Rhizoctonia solani*, which is the fungal organism that causes this disease. With diseases such as rice blast, planting highly susceptible varieties around breeding nurseries will typically assure high disease pressure and eliminate the need for inoculation. This illustrates the importance of knowledge of each disease and the use of that knowledge to create the most favorable environment for effective screening for that particular disease.

Milling quality is another critical aspect of a successful rice variety. There are numerous factors that will influence milling quality. One of the most important is the percentage of whole (unbroken) grains remaining after the milling process. This is an example of a trait with a high level of genetic control but also a substantial environmental influence. Grain shape and uniformity are important. Some rice varieties will always have fairly low whole-grain milling yields, regardless of the environment. Others can have high milling yields in favorable environments but much lower yields under unfavorable conditions. Also, the grain moisture at harvest can have a significant impact on this characteristic as can the field conditions under which the plants are grown and the conditions under which the grain is artificially dried after harvest. Drying at excessive temperatures can dramatically reduce milling yields. This illustrates why this trait is a difficult one to select for, and the true measure of this trait comes when samples are actually milled.

Another important aspect of grain quality is the amount of chalk present. Chalky rice occurs when part of the grain is whiter than the rest because the starch has not developed properly. This is a point of weakness that can increase breakage during the milling process. Even if the grain does not break, chalky rice is aesthetically unpleasing and can greatly reduce the quality of the rice sample. This is another trait controlled by genetics but also highly influenced by the environment under which the grain develops. Typically, levels of chalk are higher when the rice grain grows under higher temperatures. Some varieties are inherently more resistant to chalk formation even under high temperatures, and their identification is important during the breeding process.



Decreasing chalk in milled grains is an important objective.

The traits discussed are just a few of the multitude of traits that must be considered when a rice breeder is making selections. Others include seedling vigor, cold tolerance (both at the seedling and reproductive stage), response to plant growth regulators, cycle (number of days from emergence to maturity), grain shattering, herbicide tolerance or resistance, insect resistance, panicle exertion, seed dormancy and ratooning (second cropping) characteristics.

Putting all of these traits together in a package is what keeps rice variety development intriguing and worthwhile.

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2015 RICE STATION FIELD DAY HIGHLIGHTS

Photos by Bruce Schultz
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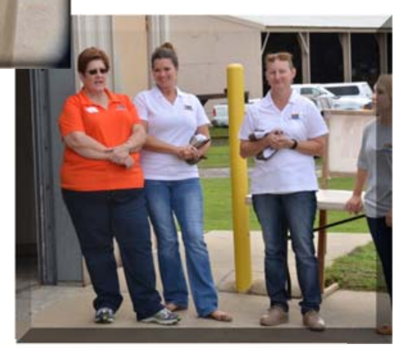

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Soybean Research at the Rice Research Station

While most people are aware of the wide range of rice-focused research conducted at the Rice Research Station, many may not be aware that a considerable amount of research is conducted annually with soybeans. Probably the most visible research conducted on a yearly basis at the Rice Station is the soybean official variety trial (OVT). The OVT contains maturity group III, IV and V soybeans. All in all, this year's trial contains approximately 364 soybean entries, which are replicated four times.

The OVT at the Rice Station this year was initially planted on May 7; however, after planting, several rainfall events occurred that caused standing water to collect on the newly emerged seedlings. Needless to say, the stand and the trial were compromised. The trial was replanted on June 5; therefore, even though the planting date may be late, we will have data to report this year.

In addition to the Rice Station location, there are seven other OVT locations across the state. Results of the Rice Station's soybean variety trial (along with the results of the other seven soybean OVTs) are published annually in the AgCenter's *Louisiana Soybean Performance Trials* publication, which can be accessed online at the AgCenter's website (www.lsuagcenter.com). Printed copies are also available at your local LSU AgCenter extension office.

LSU AgCenter soybean official variety trial (OVT) planted at the Rice Research Station South Farm. There are eight soybean OVT locations throughout the state.

Another ongoing soybean research project is an evaluation of optimum planting dates for late maturity group IV and early maturity group V soybeans in southwest Louisiana. Current recommendations for the optimum planting date window for soybeans were determined with research conducted in the northeast region of the state at the Macon Ridge Research Station in Winnsboro (32.2 degrees latitude) and in the central region at the Dean Lee Research Station in Alexandria (31.1 degrees latitude). The Rice Research Station (representative of the southwest region) is located at approximately 30.2 degrees latitude. Therefore, past date-of-planting research may not adequately reflect optimum planting dates in the southwest region.

In addition, date-of-planting trials at the Rice Station are conducted using the most common cultural practices used by commercial soybean producers in the area. The practices include planting on leveled ground (not on beds), seeding using a grain drill with 16-inch spacing, and not using irrigation. While there are several proven production practices, such as planting on beds and irrigating, which most certainly improve soybean yields in the region, we wanted our trial to be reflective of the most common practices by commercial producers of the region. The trial is in its third year, and it will take several years of data before a sound conclusion can be made.

Other soybean trials conducted by Rice Station personnel include trials focused on validating current soil test-based soybean fertilizer recommendations, evaluating phosphorus and potassium fertilizer time of application, and evaluation of new fertilizer technologies. These trials are conducted at an off-station cooperator location near Mamou.

AgCenter scientists from the LSU campus collaborating on this research are Clayton Hollier and Jeff Davis. Dr. Hollier, a plant pathologist, focuses on current and experimental fungicide efficacy for various soybean diseases. Dr. Davis' research focuses on soybean entomology. All-in-all, Dr. Davis has approximately 5 acres worth of research at the South Farm location of the Rice Research Station. All of the soybean research conducted at the Rice Research Station is funded by the generous support of the Louisiana Soybean and Grain Research and Promotion Board.

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Update on Rice Disease Issues in 2015

It is still a little early to know how bad diseases will be in 2015. But in general, disease pressure is higher this year in Louisiana than in 2013 and 2014. Even with the cold winter, blast got an early start on CL151 and Jupiter. Most of the fields with severe leaf blast lost their floods sometime after permanent flood. Fungicide use was high with most susceptible varieties treated with at least a single heading application. It appears that most of these applications were effective in suppressing blast, except in a couple of situations where rain occurred soon after application or a different mode of action fungicide with poor blast activity was used.

Sheath blight did not develop to severe levels, even with all the rain we received during the early season, and most fields were treated for sheath blight. Exceptions were in areas where strobilurin fungicides were used, and the fungicide-resistant sheath pathogen was apparently present. Indications are that the strobilurin-resistant sheath blight pathogen continues to spread to new areas. The new fungicides, Sercadis and Convoy, which have a different mode of activity, were effective against the resistant fungus, and producers were generally satisfied with the control. The consensus is that sheath blight is becoming more of a problem on hybrid varieties, and fungicide applications have become more common.

Because of a lack of extreme day and night time high temperatures in early 2015, bacterial panicle blight did not develop extensively as in previous years, except in isolated incidences. Bacterial panicle blight was severe in fields planted with Jazzman 2, which is very susceptible. Recent high temperatures in mid-July will put late-planted rice at risk. The good news is that the same high temperatures are severely limiting further sheath blight and blast development. No effective chemical control agents are available for BPB.

Cercospora was present but light in most fields in 2015, except in a few fields. Fungicide applications were not as effective as anticipated in isolated fields, and higher rates and multiple applications of propiconazole-containing fungicides may be needed. Fungicide timing should also be adjusted with earlier applications the later rice is planted. Cercospora will probably be severe in the second crop if weather conditions are favorable (wet) in the fall. Unfortunately, no fungicides are labeled for second crop, and propiconazole is not that effective in controlling Cercospora in the second crop. Stubble management – including rolling, mowing and stubble removal – are effective at reducing Cercospora in the ratoon crop.

Leaf blast due to lack of water.

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Focus

Brandon Frey

Brandon Frey, research specialist in the breeding department at the Rice Research Station, has a long tradition of farming in his family.

His father, Francis Frey, farmed rice and crawfish near Iota, and grandfathers on both sides of the family also farmed.

He graduated from Iota High School in 2003 and earned an associate degree in business from LSU-Eunice.

"I farmed for a couple of years," Frey said.

In November 2012, he started his career at the station, planting a crop, maintaining it, and harvesting.

"It's close to farming, and that's what I enjoy."

In mid-July, he and the others in the breeding department harvested F-1 crosses made last year. He also is involved in making crosses that could lead to new varieties.

He has had to make a few trips to Puerto Rico to the winter nursery where Dr. Steve Linscombe plants numerous plots during the off-season in the U.S.

Frey said the trips to the U.S. possession are anything but a tropical vacation. "You land in Puerto Rico and then drive to the other side of the island and work."

Frey and his wife, Lacey, live in Iota. When he's not working, he enjoys duck hunting, riding 4-wheelers and attending rodeos.

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