Volume 5 Issue 1 February 1, 2008

Rice Research Station News

LSU AgCenter Research & Extension

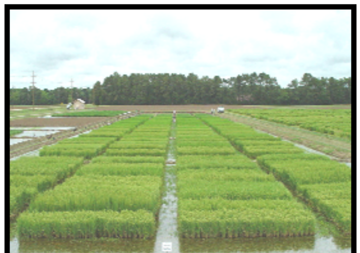
Southwest Region

Planting Dates & Seeding Rates

March April May

60-90 lb/A 90-125 lb/A

Now that we have put another year in the books and helped Les Miles coach the LSU Tigers to another BCS National Championship, it is time to finalize planting intentions for 2008. Considering the optimism surrounding several commodities we grow, a clear plan for what varieties, how much seed, and when you will plant is the key to starting the growing season off right. Variety selection, planting date, and seeding rate set the stage for the rest of the year, and good decisions here can translate into a better and more efficient harvest.



Date of Planting Study at the RRS

Date of planting studies are conducted at the Rice Research Station in Crowley to fine-tune planting date recommendations. These studies include multiple varieties and planting dates and are designed to evaluate the optimum planting dates for new and popular varieties. No two years are identical, so this test is constantly updated with newly released rice varieties and hybrids.

LSU AgCenter recommendations for planting rice are from March 15 to April 20 in southwest Louisiana and April 5 to May 10 in north Louisiana. On average, varieties planted during this time have the highest yield potential and milling quality and are favorable from a management perspective. These recommendations are based on multiple years reflecting many different environmental conditions and are a good starting point for determining when to plant. Within this range there is flexibility, most of which will be limited by weather. Average daily temperatures above 60 degrees F, calculated by adding the daily high and low temperatures and dividing by 2, are critical in obtaining an acceptable stand. Also, a well prepared seedbed with good seed-to-soil contact and sufficient seeding rates is necessary when pushing the early end of this range.

Planting early is desirable for high yield potential, good milling quality, and the option to produce a second crop, but extremely early planting can be detrimental in some cases. Slow emergence and reduced seedling vigor in cold conditions can lead to seedling disease and stand reductions. Depredation because of birds is more common in early-planted rice, so higher seeding rates are necessary to compensate for potential stand loss. On the other end of the spectrum, late-planted rice can also be challenging. In addition to lower yield potential and milling quality, most insect and disease pests are more damaging in late-planted rice. Lastly, yield loss because of high temperatures and a lower chance for a successful second crop are common in late-planted rice.

Seeding rates and planting dates are two factors that should be considered jointly. LSU AgCenter recommendations for rice varieties range from 60-90 pounds of seed per acre for drill-seeded and 90-125 pounds of seed per acre for water-seeded rice to achieve a final plant stand of 15-20 plants per square foot. Typically, the lower end of these ranges should be used when conditions are ideal and the higher end when conditions are not conducive for good germination and plant establishment. Seeding rates for hybrid rice seed are much lower than for conventional varieties and the hybrid seed representative should be consulted for recommendations. Stands too thin can result in increased weed pressure, delayed maturity, and decreased crop uniformity and quality. Conditions that justify a higher seeding rate include early planting, a poor seedbed, potential bird depredation, water-seeded systems, and any other factor that can cause stand loss and impede plant establishment. Excessively high seeding rates should be avoided as well. They are more costly and can increase disease pressure and lodging. Ultimately, the goal is to determine how much seed should be planted to ensure a plant stand of 15-20 plants per square foot, given the current field, seedbed, and weather (soil moisture, temperature, forecast, etc.) conditions.

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In this issue:

Special Dates of Interest:

Rice Technical Working Group

San Diego, CA

February 18-21, 2008

Rice Research Station Field Day

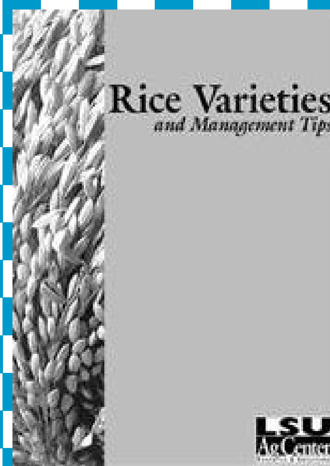
Crowley, La

June 26, 2008

Planting Dates and Seeding Rates Cont.

Since the advent of the Clearfield and hybrid technologies, seed costs can vary widely and reduced seeding rates are attractive economically. But exercise caution and make sure planting conditions are ideal before pushing the envelope. The money saved with a lower seeding rate can quickly be spent on herbicide costs if the stand is too thin.

Another important consideration is that seed size affects the recommended seeding rates in pounds per acre. For rice varieties, a final stand of 15-20 plants per square foot is optimal. In typical conditions about 50 percent of planted seed produces a grain-bearing plant, so a target seeding rate of 30-40 plants per square foot is suggested to reach 15-20 plants per square foot. Seed size, and thus number of seed per pound, varies among varieties so a target seeding rate of 30-40 plants per square foot might require a different total seed weight per acre. For example, a seeding rate for Bengal at 35 seed per square foot would require 90 pounds of seed per acre. However, the same seeding rate for Catahoula would require only 77 pounds to have the same number of plants per acre. More information on variety seed size as well as additional information on variety selection, planting dates and seeding rates, can be found at 2008 Rice Varieties and Management Tips online. In addition you can contact your local county agent for a hard copy of this publication and for additional information on varieties.



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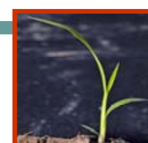
32nd RTWG

San Diego, California, February 18-21, 2008

The 32nd Rice Technical Working Group meeting will be held February 18-21, 2008, at the Westin San Diego in San Diego, California. The Rice Technical Working Group (RTWG) meets biannually and brings together scientists, extension personnel, government and industry representatives and growers involved in all aspects of rice production. The objective of the RTWG meeting is to share information, coordinate research and join efforts to find solutions for the rice industry's most important problems. Find information on all aspects of the meeting and register to attend, at the 32nd Rice Technical Working Group meeting website: http://www.plantsciences.ucdavis.edu/rtwg.

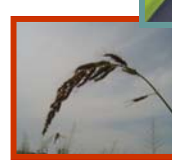
Pest of the Quarter

Barnyardgrass



Seedling

Absence of ligule



Seed head

Barnyardgrass (*Echinochloa crus-galli*) originated from tropical Asia and was considered to be closely related to grasses such as fall panicum. The weed was probably brought to the United States through the transportation of crop seed.

Barnyardgrass and rice have a similar growth habit and in many cases it is difficult to differentiate between the two. It is believed that hand weeding, used before herbicide treatments were available, selected barnyardgrass biotypes with growth characteristics similar to rice.

Barnyardgrass can grow to a height of 60 inches and is often purple at the base of the plant. It has flat leaves with no ligule. The seed heads are usually red to purple in color, and the seed are usually awned. It has been estimated that one barnyardgrass plant can produce as many as 40,000 seed in a single season. That would result in 1.6 billion seed the following season assuming each plant produces 40,000 seed with 100 percent seed viability. This is a worst-case scenario, but it provides evidence of how fast barnyardgrass can become a problem if left unchecked. It is not unusual for barnyardgrass to produce more than one generation in a growing season, which would further increase the speed of infestation.

Barnyardgrass was considered a problem weed in 36 crops grown in more than 40 countries, and it is found in every parish

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Pest of the Quarter

Barnyardgrass Cont.

in Louisiana. Aside from red rice, barnyardgrass is considered the most troublesome and competitive weed in rice. Dr. Roy Smith, a former U.S. Department of Agriculture weed scientist, published several research papers on the competitiveness of barnyardgrass with rice. Smith found that season-long competition from barnyardgrass could reduce rice yields by 70 percent. Barnyardgrass can also rob 60 percent to 80 percent of the available soil nitrogen, which is an expensive loss in a rice production system.

In the past, barnyardgrass management has involved a combination of mechanical, cultural and chemical control measures. Cultural practices include purchasing barnyardgrass free seed, increasing rice seeding rates, and selecting more competitive rice cultivars. It is believed that semi-dwarf cultivars are less competitive with barnyardgrass than taller rice cultivars. In Louisiana, water seeding rice is used as a cultural management practice to minimize weed germination and emergence.

Chemical control of barnyardgrass is usually the first choice of rice producers. Oftentimes, a rice weed control program is based primarily on the control of barnyardgrass. Producers have the option to control this weed either preemergence or postemergence in rice. Herbicides with residual activity on barnyardgrass include Bolero, Command, Facet, Grasp, Prowl, and other pendimethalin formulations. Many of these residual herbicides have postemergence activity as well. There are several herbicides that can also provide postemergence activity on barnyardgrass. However, another option that can provide both preemergence and postemergence activity is the herbicides labeled for use in the Clearfield rice production system. Whichever program is selected, it is important to apply any herbicide in a timely manner to maximize the control of barnyardgrass.

Barnyardgrass has been confirmed to be resistant to propanil and Facet, and populations have been identified as showing potential resistance to Clincher, Ricestar, and Command. It is important for producers to use an IPM approach in areas where herbicide resistance is suspected, and herbicide rotation should always be a part of an IPM program.

Although many herbicides have activity on barnyardgrass – and these herbicides have been available for years – this weed continues to be a problem in rice production. This indicates that barnyardgrass is an adaptable weed, and it will most likely remain a problem in rice production. However, by selecting the proper weed control strategies and cultural practices, this weed can be managed.

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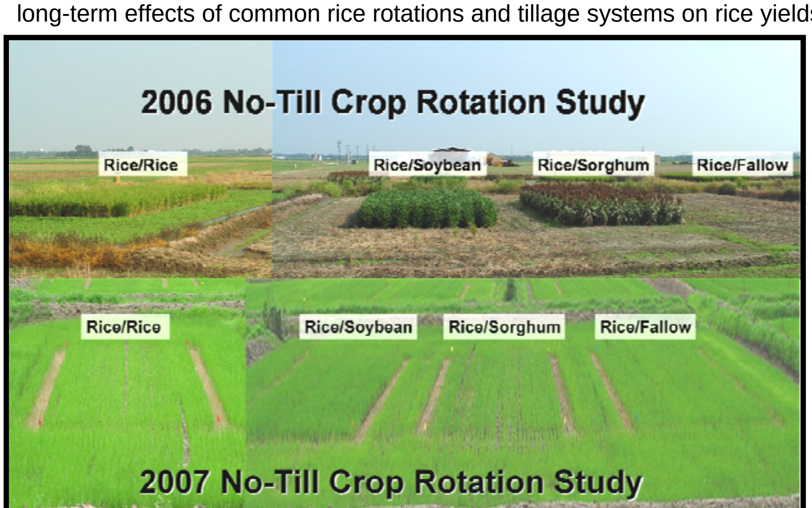
Tillage and Crop Rotation Research

Several annual management decisions contribute to the success or failure of a rice crop. Examples include decisions on when and how to control weeds, insects and diseases. The management practices used to control these in-season pests provide us with an immediate and measurable crop response. Other management decisions may not have such visual and immediate impact during one growing season; rather, they may have an impact over the course of several seasons. These decisions include the choice of a rotational crop and a tillage practice. However, little research in the past has focused on the long-term effects of common rice rotations and tillage systems on rice yields and soil properties.



With that in mind, a long-term crop rotation and tillage system study was established in 2005 at the LSU AgCenter's Rice Research Station South Farm. Rice rotations include: rice-rice, rice-soybean, rice-grain sorghum and rice-fallow. Two tillage systems, no-till and conventional till, are also included in the study. The objectives of the study are: 1) to evaluate agronomic changes associated with common tillage and rice-based rotation systems over time and 2) to evaluate annual changes in selected soil physical and chemical properties under differing tillage and rice-based rotation systems. Some of the agronomic data gathered during the study includes grain yield, moisture content, plant height, and days to 50% heading. Soil data includes bulk density (P_d), organic matter (OM) content, total soil N and C, pH, and soil test extractable nutrients

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Tillage and Crop Rotation Research Cont.

Table 1. Agronomic results for the main effects of tillage and rotation for 2007.

	Plant Ht.	50% Heading	Yield
	cm	days	kg ha^{-1}
Tillage			
Conventional	99 a†	89 a	7427 b
No-Till	96 b	87 b	7936 a
Rotation			
Rice-Rice	99 ab	88 a	7884 a
Rice-Fallow	96 b	88 a	7605 ab
Rice-Soybean	96 b	88 a	7313 b
Rice-Sorghum	100 a	88 a	7953 a

†Means within each column followed by a different letter are significantly different at the P = 0.05 level of confidence as determined by the Duncan post hoc test.

Table 2. Selected physical and chemical property results for the main effects of tillage and rotation in 2007.

	Total N		Total C		OM		P_d	
	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
	---g kg^{-1}---		--------------------g kg^{-1}--------------------				---g cm^{-3}---	
Tillage								
Conventional	1.50 b†	1.26 b	9.3 b	11.8 b	19.0 b	20.5 b	1.21 b	1.31 b
No-Till	1.60 a	1.43 a	10.0 a	13.3 a	20.5 a	24.2 a	1.42 a	1.41 a
Rotation								
Rice-Rice	1.50 a	1.35 a	9.5 b	12.3 ab	19.7 ab	21.9 ab	1.37 a	1.41 a
Rice-Fallow	1.53 a	1.29 a	9.3 b	11.9 b	18.9 b	20.9 b	1.36 a	1.34 a
Rice-Soybean	1.59 a	1.36 a	9.8 ab	12.5 ab	19.9 ab	22.4 ab	1.30 a	1.35 a
Rice-Sorghum	1.58 a	1.38 a	10.1 a	13.5 a	20.5 a	24.2 a	1.37 a	1.34 a

†Means within each column followed by a different letter are significantly different at the P = 0.05 level of confidence as determined by the Duncan post hoc test.

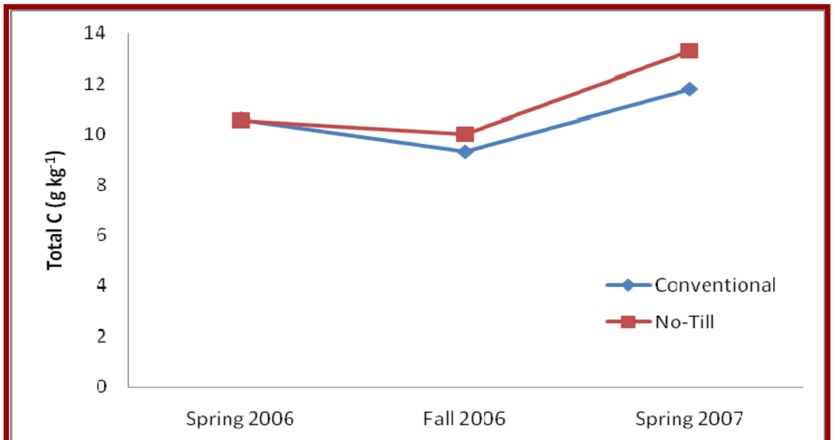

Figure 1. Change in total soil C as affected by tillage system in rice production over time.

While this long-term study is really still in its infancy, we have already begun to see some differences. The main effects of tillage and crop rotation from the third year of the study (2007) are presented in Table 1. Rice grain yields were 509 kg ha^{-1} higher under no-till compared with conventional tillage across all rotations. Rice plants were taller and reached 50% heading later in the conventional compared with the no-till plots across rotations.

Selected physical and chemical properties from 2007 are presented in Table 2. Regardless of tillage or rotation system, total soil N was higher in soil samples collected before rice planting compared with post-harvest samples collected in the fall. Soil N in the upper 15 cm was higher in no-till compared with conventional till plots at both samplings. Both total C and OM were higher under no-till than conventional tillage at both samplings in 2007. In the fall of 2006, after completion of the initial rotational crop phase of the study, total soil C levels were similar for both tillage systems across all rotations (Figure 1). However, from the fall of 2006 to the spring of 2007, total soil C levels in conventional till plots decreased at a much faster rate. This can be partially explained by the faster residue decomposition rates associated with plant residues tilled into the soil after harvest. A rotation effect was also detected in 2007. Generally, C and OM were increased under the rice-grain sorghum rotation compared with the rice-fallow rotation. Soil P_d was higher in the no-till system than the conventional at both the spring and fall 2007 samplings. Changes in P_d values from the spring to the fall were observed in the conventional tillage system while no-till P_d remained relatively constant between samplings. Root penetration was not a problem in no-till rice plots prior to permanent flood establishment because P_d values were below 1.6 cm m^{-3}, a value many believe to be where root penetration problems begin.

Rice tillage and rotations systems can have considerable impact on agronomic as well as soil physical and chemical properties over time. As this study continues, we will continue to track these changes and evaluate their agronomic impact.

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Marker-Assisted Selection *and* How it Works

Breeders and other plant developers have a new tool in their tool box to enhance and increase the speed and effectiveness in developing new and more productive rice varieties. Molecular markers are physical landmarks of the chromosomes. Since the genes are located along the chromosomes, their physical locations can be identified using these biological marks. The best markers would be the ones right on the gene itself. However, a few adjacent markers that have high probability to co-segregate with the gene of interest can also be used during selection. Thousands of unique molecular markers have been identified along the 12 chromosomes of rice. Among them are small sequence repeats or microsatellites, single nucleotide polymorphisms (SNPs), RFLP and dominant markers such as RAPD and SCAR.

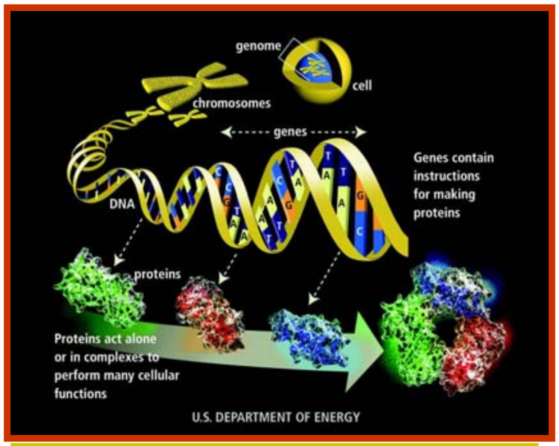

Figure 1. Genetic information is stored in the DNA. A different sequence of DNA stretch leads to a different type of protein that has an effect on the field performance of rice. (Graphic obtained from www.doegenomes.org)

Phenotypic traits such as plant height, grain type, maturity and chlorophyll content are governed by genes. A gene is a stretch of DNA molecules that code for amino acids that link together to make proteins, the building blocks of life (Fig. 1). The interaction and structure of proteins, which are in the rice plant determine its characteristics. The expressions of the gene that are visible or can be measured using certain equipment are influenced by environments where rice is grown. Several genes are less affected by environment, but some are highly affected. Since DNA markers are linked directly to the gene, such environmental effects that can potentially hamper trait selections can be avoided when marker-assisted selection is employed. Because the expression of the genes is not required, marker-assisted selection can be conducted in any season in the greenhouses or growth chambers. Thus, it potentially can shorten time required during cultivar development. In the case of plant disease, markers can be used to incorporate the corresponding disease-resistant genes into the adapted U.S. rice germplasm without a need to deal with the disease agents.

The whole operation of marker-assisted selection can be divided into three steps: sample collection, DNA extraction-PCR amplification and marker detection. Each step has its own specific requirements that most conventional breeders may not be accustomed to since the steps are commonly laborious, must be handled with laboratory type-neatness and involve expensive equipment. The Rice Research Station MAS lab has successfully simplified and synchronized the entire process, from taking leaf samples in the field to DNA extraction, PCR amplification and marker detection, into either a 96 or 384 format to allow streamlining marker-assisted selection.

Not too long ago, it took the whole day just to isolate rice DNA from leaf tissue. Now, it only takes a couple of minutes to liberate the DNA of 192 different rice lines that can be used in marker-assisted selection. A tiny bit of leaf tissue together with a few small stainless steel beads are added to a micro-tube containing 10 drops of buffer solution. It takes a minute or two to grind the leaf tissue through violent agitation using a mechanical beater, such as a Minibead Beater, resulting in complete homogenization of tissue. This crude extract that contains free genomic DNA can readily be used in marker analyses (Fig. 2).

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Figure 2. Leaf sample collection, DNA extraction, PCR amplification and electrophoresis for DNA size fractionation

Marker-Assisted Selection and How it Works

Cont.

A pair of primers, a small fragment of DNA of about 30 base molecules containing a unique sequence that is complementary to the DNA target in the rice genome harboring or associated with the target gene, is needed to produce thousands of copies of the target area using a thermal cycler or PCR machine. It takes about three hours to finish amplification. Using iCycler from BioRad, separate DNA samples from 384 lines can be amplified in a single run.

Once the target regions have been amplified, these markers must be examined or visualized for scoring purposes. The marker is a fingerprint of the target gene and identified based on its unique molecular size. Size fractionation of amplified DNA fragments can be done through a number of ways. In an agarose or polyacrylamid gel system, the amplified piece of DNA can be separated in an electric field that forces the fragments to migrate through a gel. Because a DNA molecule is negatively charged, it will migrate from negative to positive potential. The gel at a molecular level looks much like a random intricate network. Longer molecules migrate more slowly because they are more easily 'trapped' in the network. This process will allow separation of amplified DNA fragments based on size and normally takes about two hours to complete.

After the separation is completed, the fractions of DNA fragments of different lengths inside the gel are soaked in a fluorescent dye specific for DNA. The dye that binds to the DNA will glow upon UV light illumination and the image can be captured and saved as a digital file (Fig. 3). Fragment size determination is done by comparison to commercially available DNA ladders containing linear DNA fragments of known length. The marker for a target gene must be unique and different in regard to its size when compared with the amplified fragment of a non-target gene. This specific band will indicate the presense of target genes among segregating progeny lines. Progeny that does not possess the markers can then be discarded. Currently, markers are being used to pyramid blast genes and to incorporate aroma and grain quality during development of breeding lines. Effort is being initated to introgress drought tolerance from a foreign indica type into adapted U.S. germplasm.

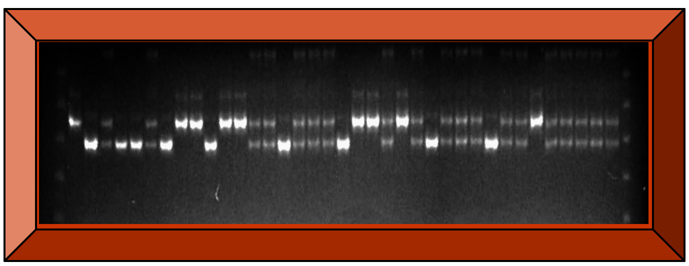

Figure 3. Digital image of UV illuminated gel that reveals the presence of the Pi-ta^2 blast-resistant gene among progeny lines of rice. Each lane represents one progeny line. The lower bands correspond to the DNA marker for the Pi-ta^2 blast-resistant gene. The upper bands correspond to the DNA marker for the wildtype non-resistant gene. The presence of both bands in one lane indicates that the progeny is in the heterozygous state for the blast gene.

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Rice Station Produces Foundation Seed

An important function of the Rice Research Station is the production of foundation rice seed. Foundation seed is the first step in the commercialization of a rice variety. This seed is purchased from the station by seed growers who plant it to produce registered seed. Registered seed is then planted to produce certified seed, which is the most common type of seed planted by rice growers to produce commercial rice.

Larry White, director of the Foundation Seed Program

Each seed field in the state, regardless of class, must pass a two-stage inspection process conducted by employees of the Louisiana Department of Agriculture and Forestry (LDAF). The first step is the field inspection. Just before harvest, each seed field is thoroughly inspected by field inspectors, who walk the field looking for noxious weeds, off-types and other factors that might disqualify the field, according to rice seed certification requirements.

The second step is laboratory analysis of a representative sample of each seed lot. After each lot has been dried, processed and packaged for distribution, LDAF personnel will sample the packages to produce a representative sample that is sent to the state seed lab in Baton Rouge. There, the sample is subjected to a number of analyses to determine germination percentage, absence of red rice, purity, etc., again according to certification standards. If a lot of seed passes this rigorous testing regime, seed tags are provided to be attached to the seed packages indicating the seed has qualified to be sold as a class of certified seed.

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Rice Station Produces Foundation Seed Cont.

The Rice Research Station produces foundation seed primarily of varieties developed by the station. However, if a variety produced at another university looks to have potential benefits for Louisiana producers, the program will produce that seed also. Similarly, foundation seed of Louisiana-developed varieties are often produced by foundation seed programs in Arkansas, Mississippi, Missouri and Texas.

Foundation seed is allocated to Louisiana producers by a formula, based on the previous year's rice acreage in each parish. Thus, if a certain rice-producing parish had 20 percent of the total rice acreage in the state in 2007, that parish will be allocated 20 percent of the foundation seed of each variety available in 2008. After these initial allocations are met in each parish, any remaining seed is allocated to producers whose requests were not met initially. If any seed remains after the requests of all Louisiana producers have been met, seed is then sold to out-of-state seed growers.

Limited amounts of foundation seed of the following varieties will be available for the 2008 season: Cheniere, Cocodrie, Cypress, Trenasse, Jupiter and Della. In addition, seed of the station's two newest releases, Catahoula and Neptune (highlighted in a separate article below), will be available.

If you are interested in purchasing foundation seed or you would like additional information on the program, contact Mr. Larry White, Director of the Foundation Seed Program, at lwhite@agcenter.lsu.edu or 337-788-7531.

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Rice Station Releases Foundation Seed of Two New Varieties for Production in 2008

Catahoula

Neptune

The LSU AgCenter Rice Research Station has released two new rice varieties for production in 2008 – Neptune and Catahoula.

Neptune is a high-yielding, good-milling and short-stature medium-grain rice variety that has grain size similar to Bengal. The new variety, which was tested under experimental designation LA2028, has very high yield potential, similar to Jupiter, but much higher than Bengal. In 41 yield trials across the southern rice growing region during 2003-2007, the average main crop yield of Neptune was 8,300 pounds per acre compared with 8,498 and 7,790 for Jupiter and Bengal, respectively.

In Louisiana trials, Neptune consistently had higher head and total rice milling yields than both Jupiter and Bengal. Neptune is about 1 to 2 inches shorter than both Jupiter and Bengal and should have better lodging resistance. Even though Neptune heads one day later than Jupiter or Bengal, it matures 2-3 days earlier than both of these popular varieties. It also appears Neptune will have the best ratoon potential among the three.

In both leaf inoculated and naturally infested trials, Neptune was more resistant to blast (especially rotten neck blast) and narrow brown leaf spot diseases than both Jupiter and Bengal. Neptune is more tolerant to bacterial panicle blight compared with Bengal. Like Bengal, Neptune appears to be moderately susceptible to straighthead.

Catahoula (tested as LA2082) is a high-yielding, semidwarf, long-grain variety with good milling and other quality characteristics. In 75 yield trails across the southern rice growing states from 2002-2007, Catahoula had an average yield of 7,357 pounds per acre compared with 7,237 and 7,119 for Cocodrie and Cheniere, respectively. Catahoula has also shown comparable milling yields to these two older varieties in numerous milling studies conducted during this time span.

Catahoula is similar to Cocodrie in plant type, height and days to 50 percent heading – although harvest maturity is 2-3 days earlier. The new variety is similar to Cheniere in sheath blight susceptibility and is rated as moderately susceptible to this disease. It is rated as moderately susceptible to straighthead. Catahoula has displayed very good second crop potential as well as good seedling vigor. It has typical long-grain cereal chemistry and cooking quality.

These varieties will only be available as foundation seed for 2008, but should be available for limited commercial production in 2009.

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After more than 3 decades of research to help farmers, Dr. Richard Dunand has retired from his position as LSU AgCenter plant physiologist at the Rice Research Station. Much of his work focused on the use of plant growth regulators to improve rice production. Dr. Dunand is now living in Baton Rouge.

Jennifer Nash has left the Rice Research Station after 11 years as a research associate. Her lab work involved analyzing DNA to find out if a line of rice had desired traits. Jennifer is attending McNeese State University to get a medical lab technician degree.

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Focus on Research Associates

Corey Conner has worked as a research associate at the Rice Research Station since August 2002.

He graduated from the University of Louisiana at Lafayette in 2000 with a degree in plant science. After school, he went to work for RiceTec in Alvin, Texas, but then returned to Louisiana to work at the Rice Research Station.

"I wanted to be home, back where I was from," he said.

Corey had previously worked at the station while a student from 1997 until 1999.

Corey said the job is interesting because no two growing seasons are the same.

"Each year is a different year as far as crop management. I enjoy agriculture and I enjoy doing the things associated with it," he said. "You learn a lot of new things in this job."

He said harvest time at the end of the summer is strenuous "but it only lasts for a month and a half."

Corey works with Dr. Steve Linscombe, LSU AgCenter rice breeder, to develop new rice varieties. About twice a year, he travels with Linscombe to work at the LSU AgCenter winter nursery in Puerto Rico.

"We do the same things down there that we do up here," he said.

In his spare time, he helps his father, Ed Conner, manage a 650-acre farm. Corey and his wife have two children, a 3-year-old boy and a 2-year-old girl.

His life has focused on agriculture since he was a boy. Corey said his father owned a fertilizer business in Lake Arthur.

"I was 10 or 11 when my father started farming," he said.

Corey said he started driving a tractor at that time, and when other classmates were at a party or event, he was in the fields.

Linscombe said Conner has several attributes that enhance his contributions to the breeding program. "Corey's agricultural background and good common sense make him an invaluable employee," Linscombe said. "But beyond that, he has a strong dedication to his work and the Rice Research Station."

Research partially funded by the Louisiana Rice Research Board