

# Texas Rice Special Section

## Highlighting Research in 2004

### Agronomic Management

#### Banded Fluid Fertilizer and Early Flood Establishment on Clay Soil Offer An Economic Advantage Over Broadcast Dry Fertilizer and Conventional Flood

Our objective was to improve the economics of rice production. We compared banded, fluid fertilizer placed 2 to 3 inches below the soil surface with conventionally managed dry granular fertilizer and established the flood early (at the 4 to 5 leaf stage) or at the conventional flood time (at the 6 to 7 leaf stage) for Cocodrie rice on clay soil. Figure 1 shows that banded, fluid fertilizer increased N uptake over dry fertilizer from 66 to 93 lbs N/A under conventional flood practices and from 82 to 103 lbs N/A under early flood water management. Fluid fertilizer produced more plant growth per pound of N applied and reduced application cost \$20 to \$25/A when compared to dry fertilizer. Other advantages to early flood on the clay soils include the following:

- Two fewer flushes — a cost savings of \$18/A on the LNVA canal system.
- Less herbicide needed.
- Average rice yield for 150 lbs N/A increased 900 lbs/A (i.e., from 5,600 to 6,500 lbs grain/A)

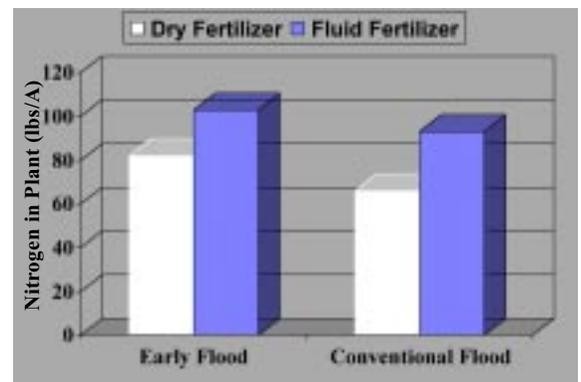


Figure 1

Apparent concerns to banding fluid fertilizer and early flood include acquiring the skill to apply fluid fertilizer, the initial cost of application equipment and time required to fill the fluid fertilizer tank. However, attaching the fluid fertilizer applicator knives to the seed drill allows fluid fertilizer to be applied while planting. In addition, level fields become even more important when flooding early because rice plants are younger and shorter and early flood is necessary to maximize the efficiency of banded fluid fertilizer.

This year, similar field plot research is being conducted on silt loam as well as clay soils. Thanks to the National Fluid Fertilizer foundation for helping support these studies and to Texas Liquid Fertilizer for providing supplies.

#### Four Types of Rice Varieties and Their Management Options Evaluated

This year's evaluation of rice varieties for Texas includes those developed by Arkansas, Louisiana, Mississippi and Texas researchers, as well as hybrids developed by private industry. This field plot research focuses on measuring main and ratoon



L to R: Mike Jund, Research Associate, Dr. Fred Turner, Professor of Soil and Plant Nutrition, and Darrell Hagler, Technician II.

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## **Agronomic Management continued...**

crop yield with and without fungicide (Quadris and Tilt) application using up to 6 N applications for the main crop and 2 applications for the ratoon crop. This year, the primary objective is to identify best management practices for increasing ratoon yield on silt loam and clay soils. The two herbicide resistant hybrids CLXL8 and CL161, are increasing in planted acreage as they offer an excellent means of red rice control without loss in grain yield or milling. Performance results from previous tests will be handed-out at field day.

The four types of rice being evaluated are Semidwarf (Cocodrie, Cheniere, Jefferson and TX 9092); Taller than semidwarf (Cybonnet and Banks); Hybrid (XP723); and Herbicide resistant varieties/hybrids (CLXL8 and CL161)

Thanks to the Texas Rice Research Foundation for providing support for this study.

## **N Management for Hybrid Rice Production**



Hybrid rice has a 10,000 lb/ac first crop yield potential.

Typically, N fertilizer is applied to hybrid rice varieties only twice during the growing season. Current hybrid varieties yield optimally with 90 lbs N/A on sandy soils or 120 lbs N/A on clay soils when applied on dry soil just prior to flooding. An additional 30 to 60 lbs N/A is applied during booting to 5% flowering. We are evaluating optimum N rate and timing for the following five hybrids on clay and silt loam soil: long grain XP723 and XP710, medium grains XP712 and XP716, and herbicide resistant CLXL8.

Hybrid varieties have the attention of rice producers because of their high yield potential (10,000 lbs/acre main crop plus 3,000 lbs/acre ratoon), which frequently surpasses the yields of conventional semidwarf varieties. Relative to non-hybrid varieties, hybrids express higher tillering, disease resistance, and improved N fertilizer efficiency with only two N fertilizer applications resulting in lower production costs. However, hybrid seed cost more and often mill lower than the best conventional varieties. However, new hybrids tend to improve grain milling. The later maturing hybrids (115 days) tend to produce higher main crop yields, while the earlier maturing hybrids (105 days) excel in ratoon yields. RiceTec funds help support the hybrid N fertilizer test.

## **Product Evaluation for Rice Production**

Agrotain is a new urea additive that can inhibit the urease enzyme and retard ammonia N volatilization under certain field conditions (i.e., when urea is applied to soil surface just prior to flooding and when field cannot be flooded within 3 days). Tests to evaluate Agrotain's ability to increase rice yield in Texas through suppression of ammonia volatilization from urea are being conducted in lab and field tests. Currently available data indicate that significant ammonia volatilization does not always occur in Texas rice fields.

The Soil and Plant Nutrition Project is also evaluating a nitrogen foliar spray from Helena named "CoRoN". The product is applied at 2 to 10 lbs N/A during the reproductive stage of rice growth. This year we are testing CoRoN with and without fungicide.

And finally, the Project is continuing to evaluate the benefit of chicken litter for "cut" areas in rice fields where the top soil has been removed during soil leveling.

These studies were conducted by Fred Turner, Mike Jund, Darrell Hagler and the Eagle Lake staff. For more information contact Dr. Turner at 409-752-2741 ext. 2223 or email [f-turner@tamu.edu](mailto:f-turner@tamu.edu).

## **Agronomic Management continued...**

### **Water and Fertilizer Management Impact on Ratoon Crop Rice**

Production costs continue to increase and rough rice prices remain constant or have declined over time. For the Texas rice industry to survive and rebound from acreage decline over the recent years, it must take advantage of its strengths. The long growing season is a major strength and should be exploited in ratoon crop (RC) production. RC rice has a lower per unit cost as the only inputs are water and fertilizer. Research is desperately needed to better define guidelines on when to pursue a RC and develop an integrate management system to increase and stabilize RC yields.



**Dr. Garry McCauley**

These studies look at the impact of RC water and N management on RC production. RC N is defined as all N applied after main crop (MC) heading.

A split plot design with three replications was utilized. Drain and reflood times were main plots and RC nitrogen rate and timing were subplots. Drain times were 15, 20, and 25 days after 5% MC heading. RC was flooded either 1 day after harvest, 10 days after harvest, or flushed and flooded 10 days after harvest.

RC N applied pre-MC drain was applied 10 d after 5% heading in the MC, which was 5 d before the first scheduled drain. N rates for this application was one third of the total RC nitrogen, but never more than 35 lb/ac. RC N treatments were 75 or 100 lb/ac applied just prior to the RC flood or split, with one application prior to MC drain and the remainder applied prior to RC flood, and 150 lb/ac applied prior to MC drain and remaining N applied equally at pre-flood and PD. MC and RC yield and milling were monitored using standard techniques.

The MC and RC yield and RC milling were affected by RC water and N management. Based on the conditions of this study, the optimum water management would be to drain the MC 20 days after 5% heading. The RC should be flooded immediately after MC harvest. This would produce a dry period of 15 days. The optimum RC N management was 35 lb/ac applied 10 days after MC heading and 65 lb/ac applied prior to RC flood.

#### **Preliminary Results**

- The 2003 yield and milling yield were below the average for the location.
- The highest RC yield was obtained with a single application of 100 lb/ac.
- Splitting RC N increased RC whole and total milled by 3 to 5 % (Figure RC5).
- Highest RC yield was obtained when the RC was flooded immediately after MC harvest.
- Flooding immediately after MC harvest resulted in the highest total and whole RC milled rice.
- Delaying the flood 10 days resulted in the greatest decrease in milled rice (about 6%).
- The duration of the dry period between MC drain and RC flood greatly influenced RC yield.
- Optimum dry period was 10 days in this study compared to 15 days in the previous study.
- Interrupting a dry period with a flush always reduced the RC yield. Flushing at 20 days into a 30 day dry period reduced the RC yield by about 700 lb/ac.
- Differences in whole milled grain was generally less than 5%. Increasing the dry period tended to reduce the amount of whole milled grain.

Research on these projects is being conducted by Garry McCauley, Fred Turner, M.O. Way and Jack Vawter.

For more information contact Dr. McCauley at 979-234-3578 or email [gnmccaule@elc.net](mailto:gnmccaule@elc.net).

## **The Entomology Project Continues Research, Extension and Regulatory Help for Texas Rice Farmers**

### **Research**

We have experiments at Beaumont, Eagle Lake, Ganado and in commercial rice fields this year. Experiments are being conducted on stem borers, rice stink bug, chinch bug, aphids and rice water weevil. We are evaluating new insecticidal seed treatments to replace Icon. Some of these seed treatments may have a broader spectrum of activity than Icon (i.e., control rice water weevil, aphids, thrips and possibly fall armyworm). We also are evaluating etofenprox (a very common insecticide for rice insects in Japan) and dinotefuron applied pre- and post-flood for rice water weevil control.

At Eagle Lake and Ganado we are investigating timing of Mustang Max for maximum control of stem borers, planting date effects on stem borer populations and damage, and varietal susceptibility to stem borers. We are developing an easier method for sampling rice stink bug and evaluating rice stink bug residual control using tank mixes of various surfactants/oils and methyl parathion. We are determining the effects of bird cherry oat aphid on seedling rice and investigating chinch bug damage on ratoon rice.



Dr. M.O. Way

### **Extension**

The Entomology Project continues to make on-site inspections of problem rice fields. This year false chinch bug, *Nyssius raphanus*, was found in very high numbers in a stale seedbed rice field in Liberty Co. A hard rain killed the insects before further observations were made, but we will continue to be on the look-out for this insect in the future.

The Entomology Project coordinated, prepared and contributed to the 2004 Rice Production Guidelines which is available through the Beaumont Center website: <http://beaumont.tamu.edu>. In addition, we contributed to *Texas Rice* and *Rice Production Updates* and participated in County Extension Agent meetings. We believe Research and Extension must be totally integrated to provide maximum service to the Texas rice industry.

### **Regulatory**

As the technical representative for Texas on USA Rice Federation/US Rice Producers Association Environmental Affairs Subcommittee, I and other Texas colleagues have supplied necessary data and information to the committee in support of continuing the current use patterns of propanil, prolonging the registration and availability of Icon and possibly convincing EPA to grant a rice stink bug label for Orthene. The Committee is in the process of discussing the Orthene issue with the registrant to develop the best plan to approach EPA for a favorable decision.

The Entomology Project thanks Texas rice farmers for generously supporting our program. We also recognize the important financial contributions of various agrichemical companies, other private industries and USDA/CSREES CAR and RAMP programs.

Technicians in the Entomology Project are Glenn Wallace and Mark Nunez; Graduate Students are Luis Espino and Becky Wolff; Summer Student Assistants are Michael Weiss, Anthony Brown, Ryan McCormick, Chase Gibbs and Jennifer Lee. Administrative support provided by Cynthia Tribble. For more information contact M.O. Way at 409-752-2741 ext. 2231 or email [moway@aesrg.tamu.edu](mailto:moway@aesrg.tamu.edu).

## Entomology/Weed Management continued...

### Economics of Effective Weed Control in Texas

Effective weed control and the associated cost is a primary issue with Texas rice producers. Weeds reduce rice yields and grain quality. The objective of this research was to identify effective weed control programs and the associated cost using selected commercially available herbicides. Studies were conducted near Beaumont, Eagle Lake, and Ganado, Texas in 2003 and 2004. At Eagle Lake and Ganado, rice was drill seeded to moisture (approximately 1 inch deep) then culti-packed prior to the preemergence application. At Beaumont, the rice was drill seeded to a depth of approximately 0.5 inch, then culti-packed prior to the preemergence application. Plots were flushed to facilitate soil seed contact and germination. Plots were flushed as necessary until flood establishment at 6-leaf or 2-tiller. Five commercial early season herbicides treatments and six commercial pre-flood herbicides treatments were selected for evaluation. Untreated checks were included to evaluate weeds species present and relative pressure. Applications were made preemergence, early postemergence, or late postemergence (pre-flood) based on the herbicide labels. All combinations of the early and late treatments were evaluated for crop injury and weed control. Average herbicide and application costs were determined by surveying eight dealers. Effective weed control was considered effective when there was no significant yield reduction and herbicide programs providing greater than 90 % weed control at most rating periods.

**Eagle Lake** - The only rice injury occurred with Command applied preemergence. Injury ranged from 8 to 14 % and was not detectable at 14 d. The dominate weed at Eagle Lake was broadleaf signalgrass with moderate annual sedge. Rice yield was not reduced using 21 of the 30 herbicide treatment programs. The only effective single applications were Bolero + Propanil early postemergence and Clincher applied late postemergence. The cost of the 21 effective programs ranged from about \$31 to \$94 per acre as yields ranged from 6,284 to 7,010 lb/ac.

**Ganado** - The only rice injury occurred with Command applied preemergence. Injury ranged from 8 to 14 % and was not detectable at 14 d. Broadleaf signalgrass control was evaluated. Yield was not significantly reduced by 23 of the 30 herbicide programs. Single applications of Command preemergence and early postemergence applications of Command, Bolero + Propanil and Bolero+Propanil+Facet all provided effective weed control. The cost of the 23 programs ranged from about \$18 to \$94 per acre, and yields ranged from 6,888 to 7,664 lb/ac.

**Beaumont** -10 to 12 % rice injury was obtained with early postemergence applications of Bolero+Propanil and Bolero+Propanil+Facet. This injury was detectable during the first two ratings. The weed spectrum was more complex with barnyardgrass, hemp sesbania, and annual sedge. Rice yield was not significantly reduced using 19 of the herbicide programs. Single early postemergence applications of Bolero+Propanil and Bolero+Propanil+Facet provided effective weed control. The cost of effective control ranged from about \$29 to \$94 per acre as yields ranged from 6,864 to 7,471 lb/ac.

Research on these projects is being conducted by John O'Barr, Garry McCauley and Mike Chandler. For more information contact Dr. McCauley at 979-234-3578 or [email gnmccaule@elc.net](mailto:gnmccaule@elc.net).



Dr. Mike Chandler

### Rice Growth and Yield as Influenced by Regiment

The effects of Regiment (bispyribac-sodium) on rice growth and yield has been studied in field plots near Beaumont and Eagle Lake, TX. Regiment treatments were applied early postemergence (EPOST), pre-flood (PREFL) and post-flood (POSFL) alone; EPOST followed by (fb) PREFEL or POSFL; and PREFL fb POSFL. Regiment rates were 0.020, 0.025 and 0.030 lb ai/A for all EPOST, PREFL, and POSFL

## **Entomology/Weed Management continued...**

applications, respectively. An EPOST combination of Stam, Bolero and Facet was applied for comparison. A weedy check was included at Beaumont; while a blanket application of Command was applied in Eagle Lake to provide season long weed control throughout the study. Rice was visually evaluated for stunting, and plant samples were measured biweekly for root and shoot length and dry weight. Yield was determined by mechanically harvesting the center 4 rows of each 6-row plot.

All Regiment combinations, except for the POSFL treatment, injured rice 10 to 15% at 14 days after treatment (DAT) of PREFL at Beaumont. By 34 DAT rice had recovered from injury, with the exception of Regiment POSFL (10%). At 5 DAT in Eagle Lake, only treatments that included a PREFL application caused injury (26-30%). By 42 DAT rice injury had diminished to 5% or less. Root length decreased proportionally with increasing total amount of Regiment applied in Beaumont at 14 DAT pre-flood. By 42 DAT root stunting had diminished and did not differ between treatments. Root weight at Beaumont, 14 DAT, was significantly reduced by EPOST and EPOST fb PREFL applications. Root weight with the EPOST treatment remained significantly lower at 42 DAT but root weight with the EPOST fb PREFL treatment had recovered. At 14 DAT in Eagle Lake, only the single PREFL application significantly reduced root weight. At 42 DAT, there was no significant differences among root weights, regardless of rate or timing of applications.

Shoot length at Beaumont 14 DAT did not differ from the control, with the exception of Regiment EPOST fb PREFL. There were no differences in shoot length at 42 DAT. Regiment applied EPOST and EPOST fb PREFL reduced shoot weight at 14 DAT, but shoot weight had recovered by 42 DAT. There were no differences in shoot weight detected in Eagle Lake, at either evaluation date. Rice yield at Beaumont did not significantly differ among Regiment treatments, and all herbicide treatments yielded higher than the weedy check. Rice yields with Regiment at Eagle Lake were not different from the weed-free check. The only yield reduction with Regiment treatments occurred with Regiment PREFL (6,495 lb/ac) compared to Regiment EPOST (7,314 lb/ac).

In conclusion, Regiment application, especially at the PREFL timing injured rice up to 30%. Root injury increased with Regiment rate. Regiment treatments had little effect on shoot length and weight. Rice injury had diminished by harvest, and, in general, rice injury did not translate into yield reductions.

### **Alligatorweed Control with Grasp in Rice**

Grasp (penoxsulam or DE-638) is a new herbicide from Dow AgroScience that should have a federal label prior to the 2005 growing season. Grasp was evaluated for control of alligatorweed in producer fields near Eagle Lake, TX for two years. In the studies, herbicide treatments were made at two timings, early postemergence (EPOST) at the three leaf rice stage with alligatorweed 3 to 5 inches tall, and late postemergence (LPOST) at the five leaf rice stage and alligatorweed 6 to 8 inches tall.

Grasp was applied at 0.027 lb ai/A alone and in combination with Stam at 2.0 lb/A and Grandstand at 0.187 lb/A EPOST, and with Stam at 4.0 lb/A and Grandstand at 0.187 lb/A LPOST. A tankmix of Stam/Grandstand without Grasp was also evaluated at each application time. Grasp alone provided greater than 80% alligatorweed control for both timings. Addition of Grandstand to DE-638 improved alligatorweed control to better than 93%. A tankmix of Grasp with Stam provided less than 50% control indicating some antagonisms. A tankmix of Stam/Grandstand without Grasp provided less than 20% control. Optimum alligatorweed control was observed with Grasp under moist soil conditions with control decreasing under dry soil conditions.

Research on these projects was conducted by John O'Barr, Garry McCauley and Mike Chandler. For more information contact Dr. Chandler at 979-845-8736 or email [jm-chandler@tamu.edu](mailto:jm-chandler@tamu.edu).

## Molecular Markers in Breeding

Researchers in the USDA/TAES/TAMU Molecular Genetics Laboratory are developing and analyzing markers for several economically important traits in rice. Notable progress identifying markers associated with disease resistance and rice quality traits has been made in cooperative work between the USDA Molecular Genetics, Rice Pathology, and Cereal Chemistry Laboratories, supervised by Drs. Bob Fjellstrom and Anna McClung. We recently developed improved DNA markers associated with amylose content, one of the most common measurements used to classify rice cooking quality. Building on previous research from Dr. Bill Park's lab (Dept. Biochemistry-Biophysics, TAMU), in the analyses of DNA sequences from a diverse collection of over 160 international rice cultivars, we found a specific sequence difference between intermediate and high amylose content cultivars in their granule bound starch synthase (*Waxy*) genes. Long grain cultivars with intermediate amylose content, like Lemont, Saber, Cypress, Drew, and Frances were seen to have a specific *Waxy* gene mutation, while cultivars with high amylose content, like Cocodrie, Dixiebelle, Jodon, and Rexmont, had *Waxy* gene sequences without this mutation.



Dr. Bob Fjellstrom

Also, a separate mutation in the *Waxy* gene was identified that differentiates cultivars that have weak starch pasting properties (i.e., RVA profiles) from those that have strong starch pasting properties. In our studies of high amylose content cultivars, we found cultivars like Cocodrie, L-202 and Jodon, have a specific mutation in the *Waxy* gene that confers a weak RVA profile, while cultivars like Dixiebelle and Rexmont, with strong RVA profiles, do not carry this mutation.

We have used this information to develop DNA markers that will clearly detect the presence of these natural gene mutations that influence amylose content and starch pasting properties. With these markers rice breeders could readily select or verify desired cooking quality characteristics at any stage of plant development. Genetic studies are planned to confirm that the inheritance of these *Waxy* gene mutations are directly associated amylose content and starch pasting properties.

This research has been supported in part by the Texas Rice Research Foundation and the Rice Foundation. Project participants include Ming-Hsuan Chen, Eric Christensen, Janis Delgado, Mickey Frank, Naomi Gipson, Ann Jund (deceased), Fran Pontasch, Christine Bergman, Anna McClung, and Bob Fjellstrom; Molecular Genetics, Rice Pathology, and Cereal Chemistry Programs; USDA-ARS/TAES, Beaumont, TX. For more information call Dr. Fjellstrom at 409-752-5221 ext. 2225, or email [r-fjellstrom@tamu.edu](mailto:r-fjellstrom@tamu.edu).

## Developing Rice Varieties with Improved Fissure Resistance:

### Step 1. Identifying Effective Breeder Selection Techniques



Dr. Shannon Pinson

**Problem:** Kernel cracking due to field fissuring is one of the leading causes of reduced milling quality in rice. Any reduction in fissuring will result in direct increases in whole-kernel yield and profit for both the producer and the miller. The rice industry experienced this increased profitability first hand when producers grew the fissure resistant variety 'Cypress' after its release in 1993. Breeders want to develop new, improved varieties with fissure resistance equal to Cypress', but progress is severely limited by the fact that present methods for evaluating fissure resistance all require large amounts of seed and/or labor. The presently available evaluation techniques may be used to prevent the release of a highly susceptible variety, but they cannot be used to *proactively select for* high fissure resistance among segregating breeding progeny.

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## Genetics continued...

### Research Objective & Approach:

**Drs. Shannon Pinson** (USDA, Beaumont, TX) and **Scott Osborn** (U. of AR) have joined together their Genetics and Ag. Engineering expertise to study genetic, physical, and chemical grain attributes (Fig. 1) with the aim of *identifying key factors* that could then be used by breeders to identify fissure resistance among segregating progeny. This research has received support from TRRF and the Rice Foundation.

Engineers studying post-harvest fissuring during drying and storage have identified a multitude of kernel components, such as hull chemistry and tightness, bran chemistry and thickness, and endosperm chemistry and shape, as affecting fissure rates (Fig. 1). Before Drs. Pinson and Osborn could identify which of these factors were *key determinants* of pre-harvest fissuring, they first had to develop a “measuring stick” capable of distinguishing both large and small differences in fissure response. At the initiation of this project, it was known that Cypress was more fissure resistant than ‘Lemont’, and it was suspected but not proven that ‘LaGrue’ and ‘TeQing’ were less fissure resistant than Lemont. Pinson’s and Osborn’s replicated multi-year milling stability data now document that the order of fissure resistance among the following varieties is ‘Saber’ > ‘Cypress’ > ‘Jodon’ = ‘Cocodrie’ = ‘Lemont’ = ‘LaGrue’ > ‘TeQing’ > ‘Jefferson’. ‘Saber’ consistently exhibited fissure resistance equal to or better than that of Cypress.

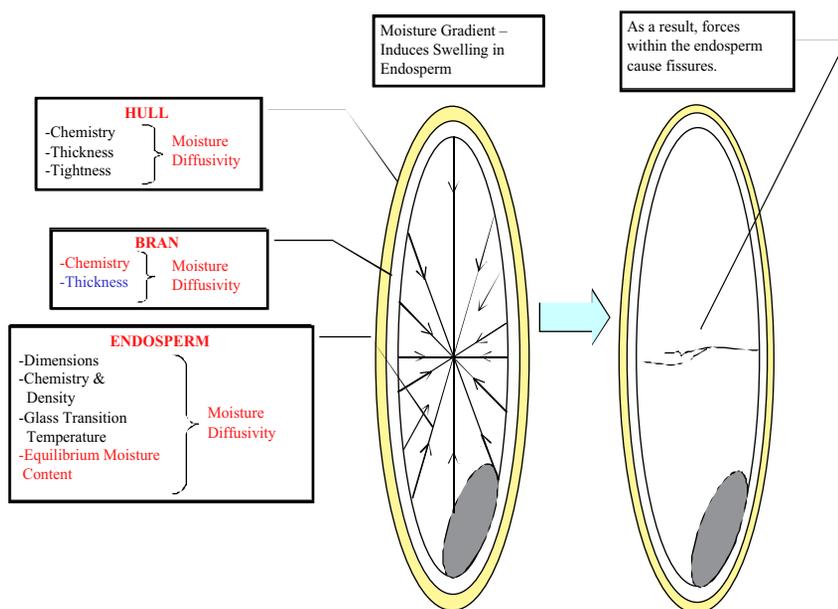


Figure 1 describes the properties studied by Pinson and Osborn to determine their relative importance to fissure resistance. Properties determined to be significantly associated with fissure resistance/susceptibility are shown in red, factors determined to not have a strong impact on fissuring are in blue, factors not yet evaluated are in black.

### Key Findings and Future Research Directions:

1. Field studies focussed on fissuring should be planted after May 5. Fissure-causing environments are more prevalent later in the growing season, making plots planted early in the season less informative than plots planted later in the season.
2. Cypress’ fissure resistance is predominantly due to the hull barrier. When the hull keeps moisture out of the kernel, less swelling and pressure occurs within the kernel. If the underlying causes of Cypress’ low moisture transfer through the hull (i.e., hull tightness versus permeability) are identified, they may then be exploited as rapid, small-sample methods for identifying fissure resistance among breeding progeny.
3. Saber’s fissure resistance appears to be predominantly due to endosperm characteristics. High endosperm diffusivity allows reabsorbed moisture to disperse throughout the endosperm rather than becoming concentrated in outer layers to cause swelling and pressure.
4. It may be possible to create varieties with even higher levels of fissure resistance by combining key attributes from Saber with those of Cypress.

Technicians in the USDA Rice Genetics project are Faye Seaberg, Piper Roberts and Josh Burrows. For more information contact Dr. Pinson at 409-752-5221 ext 2266, email [spinson@ag.tamu.edu](mailto:spinson@ag.tamu.edu).

## **Physiological Bases for Texas Rice Ratoon Crop Management**



Dr. Lee Tarpley

Most Texas rice acreage is in good ratooning varieties, thus inconsistent ratoon stand is due to an interaction of environment and physiology. A low cutting height of the main crop along with pulverization of the straw can increase ratoon yield by a) decreasing shading of the developing ratoon tillers, b) increasing photosynthetic capacity of the developing ratoon crop, c) removing inhibition due to the presence of upper growth, and d) optimizing the proportion of basal tillers that have good supporting resources and a longer developmental period. In addition to unraveling the above effects, leading to improved management schemes, we are developing the application of gibberellin at several days post-flowering to stimulate early ratoon tiller growth and ratoon stand establishment starting about one week post-treatment. Gibberellin at 4 g a.i./A significantly increased ratoon yields of 1) XL-7 at Eagle Lake in 2003 from 4,671 to 4,995 lbs/A (and combined yield from 12,936 to 13,378 lbs/A), 2) XL-7 at Beaumont in 2003 from 3,022 to 3,761 lbs/A (and combined yield from 10,239 to 11,044 lbs/A), and 3) XL-8 at Beaumont from 2,671 to 3,121 lbs/A (and combined yield from 9,378 to 9,568 lbs/A). These ratoon yield gains of 300 to 700 lbs/A are typical of the average gains of about 500 lbs/A for Cocodrie seen during 2001 and 2002. These result in a net benefit of about \$25-30/A or more when the treatment is combined with other treatments (e.g., insecticidal) commonly applied about that time. Yields of other varieties were not significantly increased by the gibberellin treatment this season. Neither yield nor quality has been adversely affected by this treatment. This research is generously funded by the Texas Rice Research Foundation.

## **High Temperatures and Low Ultraviolet Radiation Due to Shading Can Possibly Decrease Texas Rice Grain Filling, Seed Set, Ratoon Tiller Establishment, and Yield**

Environmental factors can diminish the yield of Texas rice crops by affecting specific developmental processes or through longer-term effects on the rate of crop production. For example, high temperatures, as experienced in Texas, can potentially lower rice yields by increasing respiration rates and shortening the period of crop development. In Texas we can also have shorter periods of high nighttime temperatures coinciding with and negatively impacting critical stages of rice development, such as pollen initiation.

A study utilizing rice plants grown in different night temperature regimes (ambient, ambient plus 2 and ambient plus 4°C) has been started to determine the effects of high nighttime temperatures on plant respiration, enzymatic activities, and metabolite profiles, with an eye on developing chemical practices to prevent or remediate the heat damage. This study will also facilitate development of indirect techniques to evaluate heat tolerance in rice.

Another study is evaluating the effects of ultraviolet-B (UV-B) radiation on rice physiology with special emphasis on tiller development of both the main and ratoon crops. Previous studies indicate that enhanced UV-B radiation increased tillering in rice. The low levels of UV-B that can be found below the canopy in densely planted rice fields might affect ratoon tillering. Plants will be grown under control, ambient and twice ambient UV-B conditions to study its impact on tillering. Our previous results showed low tillering with sub-ambient level, but normal tillering with ambient and twice ambient levels of UV, suggesting that UV can play an important role in tiller initiation or early development. This research is generously funded by the Texas Rice Belt Warehouse through support of Abdul Razack Mohammed's graduate studies.

Research on this project was conducted by Abdul Razack Mohammed and Dr. Lee Tarpley.

## Plant Physiology continued...

### Invertase manipulation and its impact on Texas rice yield

This is the first year for our study with the objective of understanding the role of sucrose hydrolysis, and the potential impact of its manipulation in commonly used rice varieties in Texas. We are looking at enzyme manipulation during early seed set in the bottom third of the panicles, heat stress at early grain filling, and ratoon tiller establishment.

Photosynthesis by the rice plant produces sugars, in the form of sucrose, that are distributed throughout the plant where they are used for (1) energy, by being broken down during respiration, (2) construction of chemical building blocks, such as the units of the cellulose polymer that makes up a lot of the plant's structural material, and (3) storage compounds, such as starch, for later use. Partial breakdown (hydrolysis) of these sugars by a sucrose-specific enzyme called invertase is the typical route dedicating the sugars' use for energy via respiration. Because of the critical position of invertase in the important process of respiration, we are examining the possible role of invertase in several developmental events known to strongly impact Texas rice yield and quality.

We are looking at over-the-top applications of chemical activators and inhibitors of invertase activity to determine how these affect yield and other factors contributing to yield. We anticipate that short-term manipulations of this enzyme's activity could increase the efficiency of the rice plant at certain developmental periods with resultant increases in yield of the main crop, ratoon crop, or their combined yield. Generous funding for this project has been provided by the Texas Rice Research Foundation.

Research on this project conducted by Elliott W. Rounds and Dr. Lee Tarpley. For more information contact Dr. Tarpley at 409-752-2741 or email [ltarpley@tamu.edu](mailto:ltarpley@tamu.edu).

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## Variety Improvement

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### New Rice Varieties Coming in 2005

Two new rice cultivars have been developed at the Texas A&M University System Agricultural Research and Extension Center at Beaumont, TX, by the USDA-ARS in cooperation with the Texas Agricultural Experiment Station, the Texas Rice Improvement Association, and the Texas Rice Research Foundation.

**TX 9092** was developed from a cross between Jefferson and Maybelle with the objective to produce a variety which had the yield potential, lodging resistance, early maturity, and disease resistance of Jefferson with improved milling quality and grain appearance. TX 9092 produces main crop yields within 7% of Cocodrie but has a 30% higher ratoon crop yield. Thus, TX 9092 may be particularly well suited to ratoon cropping areas. In addition, the milling quality of TX 9092 has been equivalent to that of Cypress (62/70) in experimental trials. This conveys a milling quality premium of \$0.385 as compared to \$0.165 for Cocodrie. TX 9092 has also inherited the *Pi-z* blast resistance gene from Jefferson which provides resistance to several major races of blast disease that occur in the southern US. TX 9092 appears to be slightly more tolerant to sheath blight than Jefferson and Cocodrie. Additional field data is being collected on TX 9092 this summer prior to deciding on its release.



A research field of TX 1123, an experimental rice cultivar with superior parboiling and canning properties.

**TX 1123** is a new, high yielding experimental rice cultivar that has superior parboiling and canning properties like Dixiebelle. It was developed from a cross of Dixiebelle with RU9302165, an experimental line from the Louisiana Agricultural Experiment Station. In trials conducted across the southern region since 2001, TX 1123 has demonstrated superior yield potential as compared with Dixiebelle. TX 1123 is very similar to Dixiebelle in heading but is taller, like Cocodrie.

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## Variety Improvement continued...

The grain size of TX 1123 is also very similar to Dixiebelle and its milling yield is just two points less than Cypress. The disease reaction of TX 1123 is similar to Dixiebelle; it's considered susceptible to blast and sheath blight. TX 1123 and Dixiebelle have unique grain quality characteristics that are desired in parboiled rice which is used primarily in restaurants, cafeterias, and canned foods (i.e. soups).

The Puerto Rico nursery was used to produce headrow seed of TX 1123 during the winter of 2003-2004 so that the Texas Rice Improvement Association (TRIA, Beaumont, TX) could produce foundation seed this summer. It is expected that TX1123 will be publicly released for commercial production in 2005.

### Performance of TX 1123 as compared to commercial check cultivars in experiments conducted throughout the south.

Trait	No. Tests	Jefferson	Cocodrie	Cypress	Saber	Dixiebelle	TX1123
Yield (lb/ac)	20	7408	8126	7338	7103	6907	7858
Heading (days)	24	80	81	84	83	81	81
Height (cm)	24	91	94	96	98	88	93
Lodging (%)	20	6	4	9	2	0	2
Whole Milling (%)	20	60	60	63	63	61	61
Total Milling (%)	20	69	69	70	69	69	70
Test Weight (bu/ac)	11	42	45	44	44	42	43
Kernel Weight (mg)	3	19.46	19.15	18.10	14.75	15.94	16.27

For more information contact Anna McClung at 409-752-5221 ext. 2234, email [amcclung@ag.tamu.edu](mailto:amcclung@ag.tamu.edu).

## Development of High Yielding Rice Varieties for Texas



Dr. Rodante Tabien

Past breeding efforts have largely focused on increasing yield and grain quality. Pathogen resistance genes have been incorporated to reduce yield losses. The recent Vision 2020 planning process has identified high yield, grain quality, herbicide tolerance and seedling cold tolerance as important traits, thus a focus of the state breeding program is the incorporation of herbicide tolerance and seedling cold tolerance into high yielding breeding materials. Weeds are a perennial problem to farmers in all rice production areas in Texas and on average reduce yields and grain quality by 17%. Herbicide tolerant rice has tremendous value in rice weed management and the development of such varieties is an important component of this program. Seedling cold tolerance is important in early establishment of rice crops. With unpredictable cold spells during early spring, seedling cold tolerance will favor early season planting, uniformity of field emergence, and development of vigorous seedlings and tillers. Early planting increases main crop and ratoon yields by allowing the crop to develop prior to the hotter parts of the summer.

The first year of the breeding project focused on the identification of available germplasm and initial development of genetic resource to begin selection for herbicide tolerance. However, due to absence of donor for herbicide resistance, initially 123 crosses for high yield, grain qualities and disease resistance were conducted using the germplasm generously shared by U.S. rice breeders. All  $F_1$  plants were grown in the greenhouse and the  $F_2$  population for selection is currently planted. The 82 segregating populations kindly shared by Dr. Steve Linscombe of LSU in 2003 has undergone selection and some lines were advanced at Puerto Rico Nursery. Pedigree nursery with 1,030  $F_1$  lines and more than 3,000  $F_2$  lines for further phenotypic selection is currently being maintained. These lines and the  $F_2$  populations will be the main genetic materials for the identification of

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## Variety Improvement continued...

desirable phenotypes in 2004. The selection for important phenotypes will be accomplished at the Beaumont Center and the selected panicles will be grown in Puerto Rico nursery. The new crosses will focus on germplasm that is known to be tolerant to cold temperature during the seedling stage and multiple crosses will be conducted using the current F<sub>1</sub> plants and the popular US varieties.

### An Update on the Generation and Identification of Herbicide Tolerant Germplasms



Test for herbicide tolerance showing one lone survivor.

Use of herbicide resistant crops is an important breakthrough in weed control. It offers a broader spectrum of useable herbicides, an option for in-crop weed control for enhanced herbicide rotation to delay selection for resistant weeds, better control of certain species like red rice, control of larger weed species, increased production efficiency and simplicity for the growers. However, currently a limited number of genes have been discovered for herbicide tolerance and these are all patented, thus gene discovery is continuing.

Two approaches were initiated in 2003 to find herbicide tolerant germplasms: the use of EMS and MNU as chemical mutagens and the screening of available germplasms from the US gene bank and rice breeders' collection. These different plant types were evaluated at seedling stage for herbicide tolerance using Roundup and Liberty.

Accessions or lines that survived the first screening were re-evaluated to remove potential escapes during the first screening. Initial screening of more than 1,396 accessions from 53 countries and US breeders showed 248 and 85 entries with some degree of tolerance to Liberty and Roundup, respectively. Among 137 early survivors in Liberty, 53% failed to produce any seed. Several plants produced full seeds but failed to germinate. Among survivors with seeds, only 16% survived the second screening. For Roundup, in 36 accessions with survivors, only 9 were sterile. Among seed producers, however, none survived the second screening. Currently, there were 117 new transplants from Liberty and 49 from Roundup. For mutation breeding, seeds from 16,200 plants from EMS seed treatment and 1,800 from treated florets were generated. In initial screening of 1,200 M EMS lines, only 2 plants survived spraying of Liberty and none for Roundup. Screening is on-going to evaluate these materials and re-evaluate all survivors from previous screenings.

For more information, contact Dr. Rodante Tabien at 409-752-2741 ext 2210  
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### Development of an Ultra-High Yielding Cultivar

Rice production at Texas currently involves growing the main crop and ratoon crop. A new ultra-high yielding rice cultivar that has a sufficiently higher main crop yield than the current short season cultivars would be economically profitable even without the second crop. Furthermore, an ultra high-yielding rice cultivar, if broadly adapted, would reduce Texas rice water use by about 147,000 to 304,000 acre-feet of water per year, compared to the requirement for the main crop and ratoon crop of short-season cultivars.

The best combination of traits for an ultra-high yielding cultivar for the Gulf Coast Environment was identified for the based on 187,500 different plant type simulations using the *Rice Population Simulation Model* and on field studies of rice lines that exhibited the new plant type traits. The breeding for a commercially acceptable, ultra-high yielding cultivar, that would have a yield potential of at least 10.5 t ha<sup>-1</sup> was initiated by the Texas A&M University System, Agricultural Research and Extension Center in 2002, with financial support

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## Variety Improvement continued...

from the Lower Colorado River Authority. In comparison to existing short season cultivars, this new plant type will have 20% faster leaf production rate, 1 or 2 more leaves on its main plant, 20% heavier leaf weight, and it would take 4 to 7 days longer to mature.

In 2004 cropping season, there are over 8,500 lines (F3, F4, F5, and backcross lines) being grown in the field for evaluation and selection for traits of the ultra-high yielding cultivar. There are also hybridization blocks containing lines and cultivars (with desirable traits), which will serve as parents in this season's hybridization work.

Breeding nursery plots being grown for evaluation in Beaumont.



Research on this project is conducted by Lloyd T. Wilson, Rodante Tabien, Stanley Omar PB. Samonte and, James C. Medley. For more information, contact Ted Wilson at 409-752-3045 ext. 2210 or email [lt-wilson@aesrg.tamu.edu](mailto:lt-wilson@aesrg.tamu.edu).

## Targeting Cultivars onto Rice Growing Environments Using AMMI and SREG GGE Biplot Analyses

Rice was grown on 205,820 acres at Texas in 2002, with Cocodrie (79.8%), Jefferson (6.5%), Saber (4.5%), CL121 (3.9%), Cypress (2.4%), and Wells (0.7%) being the most commonly planted varieties. Although the high yields of Cocodrie explain the popularity of Cocodrie, rice producers and breeders are aware that variety yield rankings differ from location to location, indicating that genotype x environment (GE) interaction is present. It is difficult to target varieties onto specific locations when GE interactions are present because grain yield is less predictable and cannot be interpreted based only on genotype (G) and environment (E) means.

We are currently conducting analyses to estimate the magnitude of GE interaction relative to the magnitude of G and E effects that affect grain yield, and to identify the rice variety that yields best for a specific rice growing environment. The statistical analyses used were the additive main effects and multiplicative interactions (AMMI) model and the sites regression (SREG) model G plus GE interaction (GGE) biplots analyses. These interpreted the GE interaction present when 6 rice varieties (Cocodrie, Cypress, Jefferson, Lemont, Saber, and Wells) were grown at 4 locations (Bay City, Matagorda County; Eagle Lake, Colorado County; Ganado, Jackson County; and Beaumont, Jefferson County) for 3 years (2000, 2001 and 2002).

The results indicate that Wells is adapted to environments with slightly lower minimum heat indices (combined effect of temperature and relative humidity) such as Ganado and Beaumont. On the other hand, Cocodrie performed best at Eagle Lake and Bay City. Furthermore, Cocodrie was identified as the best of the six varieties that were evaluated, due to its high and stable estimated yield across the tested environments. It should be noted that these results were based on raw grain yield and not milled grains. Had grain quality been considered, Wells would have performed badly at all tested locations.

Project participants are Stanley Omar PB. Samonte, Lloyd T. Wilson, Anna M. McClung, and James C. Medley. For more information, contact Dr. Samonte at [sosamonte@aesrg.tamu.edu](mailto:sosamonte@aesrg.tamu.edu).



L to R: Jim Medley, Dr. Omar Somante and Dr. Ted Wilson

## **Evaluating Variations in the Amylose and Amylopectin of Rice Endosperm**

Rice cooking and eating qualities are strongly impacted by its starch chemical properties. Starch is composed of relatively linear carbohydrate molecules called amylose and highly branched carbohydrate molecules called amylopectin. The granule-bound starch synthase enzyme, which is encoded by the *Waxy* gene, controls much of the variation in amylose content in rice endosperm. The variation in the fine structure of amylopectin is strongly associated with the starch gelatinization temperature (GT), and has been mapped to the *Starch Synthase IIa* gene. There are no established relationships between amylose molecular weight distribution and amylopectin structure with rice functional properties and gene sequence variations. This is in part due to limitations in the rice starch analytical methods available.

The Cereal Chemistry Laboratory, in collaboration with Dr. Christine Bergman and Dr. Bob Fjellstrom, is developing methods for analyzing rice amylose molecular weight and amylopectin chain length distributions using size-exclusion chromatography coupled with multiple angle laser light scattering and differential refractive index detection. Using these techniques, Dellmont, a cultivar with an intermediate amount of amylose, has been found to have a greater amount of high- and intermediate-molecular weight amylose compared to the amylose molecular weight distribution of Bengal, a low-amylose cultivar. The differences in the % mole distribution of amylopectin fine structure, between an intermediate-GT cultivar (Dellmont) and a low-GT cultivar (Bengal), are compared. Dellmont has a higher mole % of amylopectin chain length of 19 to 28 degrees of polymerization (DP) and lower mole % of less than 18 DP compared to Bengal. These methods are being used to elucidate the association of starch structure with rice functionality and genetics. The research was funded in part by the Rice Foundation.

Project participants include Ming-Hsuan Chen, Janis Delgado, Naomi Gipson, Ann Jund (deceased), Bob Fjellstrom and Christine Bergman (consultant). For more information call Dr. Chen at 409-752-5221 ext.2242 or email [mchen@ag.tamu.edu](mailto:mchen@ag.tamu.edu).  
Ann Jund (*in memoriam*)

## **Foundation Seed Program**

### **Texas Rice Improvement Association**



Robert Weatherton

Since 1941 TRIA (Texas Rice Improvement Association) has produced improved public varieties of rice released by USDA here in Beaumont, TX. In today's market and reduced acres of rice grown, TRIA has had to diversify its involvements to include much more than Foundation Seed rice for the state of Texas. TRIA still produces Foundation Seed for Texas and it is still the main focus, but they also produce rice of specialty varieties for industry partners. They currently produce historic varieties for customers on the east coast and have moved into the future with sustainable and organic rices.

Secondary involvement is comprised of historic varieties, organic rice and contract growing. One historic variety grown under contract is Carolina Gold. This is the oldest rice variety ever grown in the United States. It has very specific flavors and cooking properties that make it still unique today. The current market lies on the east coast where this variety originated. It has gained in popularity with many affluent restaurants on the east coast. Currently, the Organic Carolina Gold is in extremely high demand. Current Organic rough rice is mainly grown here and shipped to South Carolina where it is milled and processed for shipping to as far north as New York City.

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## Foundation Seed Program continued...

Another variety growing in popularity is Organic Arborio'. This variety is originally from Italy. Small amounts have been shipped to the Center and quarantined before we could plant.

The demand for organic Arborio out weighs its supply. This variety is mainly used in Risotto dishes. Organic rice is a growing market as consumers demand more and more.

All of what TRIA produces is for either seed rice or has contracts in place, which allows specific set prices. TRIA strives to make improvements that will have positive effects on the rice industry. Trends are important to follow and take notice of, only if to take advantage of what the market will bear. But TRIA will never compromise the integrity of the Foundation Seed program.

The following varieties are being produced for 2005 Foundation Seed sales: TX 9092, TX 1123, Jefferson, Sierra, Della, and Jasmine. Two new varieties that have release potential are TX 9092 and TX 1123. Both of these varieties are early maturing long grain varieties. One, TX 1123, is a industry type rice with great yield potential which can also be co-mingled with regular long grain. The other that may be released is TX 9092. This is an early long grain with high milling.

The Texas Rice Improvement Association doesn't plan to change their most important goal, which is the production of high quality Foundation Seed. Expanding into organic production allows TRIA to take advantage of opportunities that will help maintain their viability at the Center and in the rice industry.

For more information contact Robert Weatheron at 409-752-2741 ext. 2230 [rweather@ag.tamu.edu](mailto:rweather@ag.tamu.edu).



TX 9092, currently being produced for 2005 foundation seed sales.

## Education

### Beaumont Center Web Site

The Beaumont Center Web Site Project was started in March 2002, and involved participation by numerous Center faculty and staff. The web site has been open to the public since March 2003, and it continues to improve, with new features added every month.

The web site focuses on information and technology related to agricultural crops in Texas and the world, especially rice. The purpose of the web site is to serve the rice industry, to promote the transfer of knowledge from research to technology to production, to facilitate communications and interactions between rice research, extension and educational communities, and to enhance the dissemination and access of information and knowledge related to rice research and production.

<http://beaumont.tamu.edu>



The web site includes information on the history of the Beaumont Center, research programs, teaching, Extension programs, personnel, foundation seed, an electronic library, a plant physiology forum, communication and outreach programs and farm services.

We are currently working on an on-line weather retrieval/delivery system, and are also planning on developing a web-based rice knowledge/management system. As we strive to improve our web site and continue to add new contents and features, we would appreciate your comments and suggestions so that future enhancements may best serve the rice industry, and the research, extension and educational communities.

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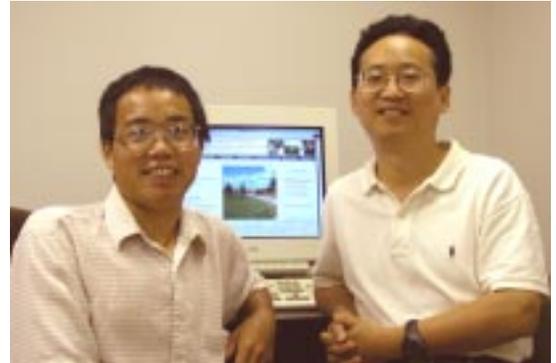
## Education continued...

The web project team includes Dr. Ted Wilson, Dr. Yubin Yang, Peter Lu, Jenny Wang, Brandy Morace, James Medley and Jay Cockrell.

### Rice Development Advisory Program

In 1976, Dr. Jim Stansel developed the concept, methodology, and original data for forecasting rice development based on usable heat units. In 1986, Jack Vawter (TAMUS-Eagle Lake) wrote a DOS-based computer program ("DD50") based on Dr. Stansel's concept and methodology.

There are a number of limitations regarding the DOS-based DD50: (1) access to weather data for only two weather stations (Eagle Lake, and Beaumont), (2) need to manually input up-to-date weather data, (3) limited user interface, (4) accessible to only a small group of users, and (5) need to update and send out new copies of the program every year. In December of 2003, the Beaumont Center Director, Dr. Ted Wilson, started a project to develop a web-based program called Rice Development Advisory (RiceDevA) to replace DD50. RiceDevA is a complete rewrite of the DOS-based program. It provides an improved user interface, and advanced options for creating, running, and displaying multiple field growth forecasts for different rice varieties, planting/emergence dates, and counties.



Dr. Yubin Yang and Peter Lu

RiceDevA can provide growth forecasts and advisories for 21 rice counties in Texas. It can forecast rice growth stages for multiple varieties, different planting dates, and different rice counties. It allows users to create, view, and edit multiple field profiles. It also allows users to run multiple field profiles at the same time and display and print results for multiple field profiles. RiceDevA allows users to choose weather stations in Texas rice producing counties and choose weather data for a specific year or historic averages for the station. RiceDevA also provides interfaces for user to add, view, and edit their own weather data, and allows user to view and download county weather data.



We are currently in the process of developing a web version of our Rice Cultivar Selection program (RicePSM). The RicePSM is a physiologically based program that has been proven to accurately predicate rice crop growth stages and crop yields. It accounts for changes in crop development due to temperatures, rainfall, solar radiation, soil type, fertilizer application, water management, planting density, row spacing, and other factors. The web-based RicePSM, which is scheduled for release in spring 2006, will give more options to users to manage and predict their rice crops.

As we continue to accumulate our knowledge and understanding of the rice cropping system through our research, we are also realizing the increasing importance of extracting and integrating diverse knowledge in agronomy, physiology, ecology, entomology, and economics, into a system that is user friendly and easily accessible. Such an integrated system would greatly help rice producers and consultants in managing their crop production, and help maximize the transfer of knowledge from research to extension, and production.

The Rice Development Advisory Program team includes Dr. Yubin Yang, Dr. Ted Wilson, Peter Lu, Jenny Wang, Jack Vawter, and Dr Jim Stansel.

For more information contact Dr. Yang at 409-752-2741 ext 2500 or email [yyang@acsrg.tamu.edu](mailto:yyang@acsrg.tamu.edu).