

Texas Rice Special Section

Highlighting Research in 2003

Agronomic Management

Variety Selection and Management Options

Soil and Plant Nutrition Project in cooperation with Eagle Lake staff

Texas Rice Foundation provides financial support for evaluating the following four types of varieties for main and ratoon crop production and management practices:

Varieties are tested at two locations (soil types) under recommended and higher N fertilizer rates using two targeted plant populations of 12 and 24 seedlings/ft² for semidwarf varieties and 9 and 18 seedlings/ft² for hybrids. The plant population translates to planting rates of between 22 and 75 lbs seed/acre. Varieties with the highest economic yield index based on main crop yield and milling over the past few years

on clay soil at Beaumont were Cocodrie, Cypress, Jefferson and Wells. The new variety Francis recorded the highest economic main crop yield index in 2002 the first year of its evaluation. Nearly identical economic rankings were obtained at Eagle Lake except Francis did not rank in the top 5 varieties. Francis shows low ratoon potential. Cheniere, based on initial observations, tillers on a par with Cocodrie and exhibits Cypress-type leaf color.

Hybrid varieties get the attention of rice producers because their high yield potential (10,000 lbs/acre main crop plus 3,000 lbs/acre ratoon) frequently surpass yields of conventional semidwarf varieties. Relative to rice 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 costs more and milling

❶ **Semidwarf**

Cocodrie, Cypress, Jefferson, Saber, Cheniere (new Louisiana variety), medium grain Bengal and potential Texas releases TX8181 and TX9092.

❷ **Taller than Semidwarf**

Wells and Francis (new Arkansas release).

❸ **Hybrids from RiceTec**

XL7, XL8, XP710 and XP712.

❹ **Herbicide resistant for red rice control**

CL161 and CL-XL8.

is lower than the best varieties. Each new hybrid tends to improve milling yield. The newest hybrid, XP712, is planted as a long-grain but produces medium grain! Hybrids XL7, XL8 and XP710 offer a range in days from emergence to maturity of approximately 105, 110 and 115, respectfully. The later maturing hybrids tend to produce higher main crop yields while the earlier maturing hybrids excel in ratoon yields. RiceTec funds the hybrid/N fertilizer test.

The four herbicide resistant varieties CL121, CL141, CL161 and CL-XL8 offer an excellent means of red rice control. CL161 and CL-XL8 tiller and yield higher even in red rice infested fields when grown with the "Clearfield" production system utilizing "Newpath" herbicide.



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

Agronomic Management continued...

Reducing Rice Production Cost Through Innovations in Fertilizer and Water Management

Results from one year cooperative research with Dr. Garry McCauley, show that flooding at the 4-leaf stage and the associated N management could reduce production costs by an estimated \$37/acre. The decrease in rice production costs occurred as a result of one less herbicide application, two fewer flushes, 16% less irrigation water, improved N uptake efficiency and only two N applications (preflood and PD). Early flood also provided 3 to 5 days earlier maturity and 2.5% higher whole grain milling at two locations. In addition, flooding clay soils at the 4-leaf stage appears to allow the option of delaying the first N application until preflood without reducing yield. This would allow producers to apply P & K if needed in the fall or early spring and not apply N fertilizer applications until just prior to establishing a flood. However, although early flood reduced production cost by \$37/acre on both clay and sandy soils, early flood tended to suppress early growth and yields on the sandy soil at Eagle Lake while enhancing growth and grain yield on clay soil at Beaumont. These one year results suggest flooding at the 4-leaf stage may be best on clay soil, while flooding at the 6-leaf stage may be best on sandy soil. Another possibility for the sandy soil is to flood early and temporarily drain at mid-season. Dr. McCauley is evaluating potential negative effects of flood duration on sandy soils.



Insight into N Management for Organic and Non-organic Rice Production

Results increasingly suggest that two N applications (60% of N on dry ground just prior to flood and 40% near PD growth stage) will produce rice yields equal to multiple N applications, assuming: a) high tillering varieties, and b) flooding at the 4-5 leaf stage. Preliminary results suggest that banded **fluid fertilizer** produces more rice growth than equivalent amounts of dry, broadcast, preplant fertilizer. The key advantage of banded fluid fertilizer is having the fluid fertilizer applicator knives attached to the rice drill so that an applicator knife is spaced between every other drill row. In addition, early flood (4 to 5-leaf stage) may protect banded N from loss and allow rice roots to reach the fertilizer band more quickly and uniformly.

We are evaluating three **organic N sources** for their benefits (N supply and increasing soil organic matter). Assuming low moisture content, their costs per pound of N are listed in the chart. When applied preplant at 80

- 1 Nature Safe® (12-2-0) \$500/ton = \$2/lb N
- 2 Vital Cycle® (6-2-0) \$35/ton applied = \$0.3/lb N
- 3 Chicken Litter (3-2-2) \$25/ton applied = \$0.4/lb N
- 4 Chicken Litter (4-2-2) \$25/ton applied = \$0.3/lb N

lbs N/acre the order of decreasing N efficiency for rice seedlings based on plant color is Nature Safe® > Vital Cycle® > Chicken Litter. Nature Safe® and Chicken Litter can be used as an N source for organic rice production. Vital Cycle®, derived from municipal sludge, is not allowed in organic rice production.

We are evaluating a **Helena nitrogen foliar spray** product that is applied at 2-10 lbs N/acre during the reproductive stage of rice growth. Its increased efficiency is attributed to its relatively slow and direct transport through rice leaves.



Nitrogen deficiency in rice grown on clay soils.

For more information contact Dr. Fred Turner at 409-752-2741 ext. 2223 or email f-turner@tamu.edu.

Agronomic Management continued...

Rice Cultivar Response to Organic Cultural Management

Sales of organically grown products have been increasing in the U.S. at a rate of 24% per year. The European organic market is also rapidly developing in response to imported transgenic crops and food products. Although only a small amount of the U.S. rice acreage is under organic management, the high value of organically produced rice may offer a new economic opportunity for some growers.

We conducted a study in 1999 and 2001 to evaluate the yield potential of U.S. and introduced germplasm under organic and conventional management and determine the influence of cultural management on rice end-use quality. The conventional management methods included nitrogen application that was 100% (200 units N) and 50% of what is normally recommended for fertilizer. The organic management method included a soil activator, poultry litter, and fish emulsion as fertilizer and humic acid and manganese sulfate as a seed treatment. The 1999 study included five cultivars from China, two from the Philippines, and Cypress. In 2001, five of these cultivars were tested along with 15 other conventional and specialty rices. All cultivars produced their highest yield potential using the 100% N conventional management, except for Jasmine 85 which performed best under 50% N. Of all the cultivars tested under conventional management, Tesanai 2 and Zhe 733 produced the highest yields. Under organic management, Tesanai 2 and Jasmine 85 produced the highest field yields, although their milling yields were lower than Cypress. This suggests that these cultivars may be well suited for the brown rice organic market. For the white milled rice market, Cypress and Zhong You Zao 3 produced the highest amount of whole milled rice per hectare (head rice/100 x field yield) under organic management.

Cultural management had a significant effect on grain quality with amylose content decreasing and protein content increasing with greater N application rates. In addition, organic management was associated with decreased translucency and increased whiteness due to greater chalk. All flour pasting (RVA) properties were significantly affected by the cultural management practices with the organic treatment resulting in pasting curves intermediate to those from the 100% and 50% N treatments. However, it is unlikely that the magnitude of these changes in cooking quality could be detected by consumers. Thus, these cultivars, introduced from other countries, are examples of genetic resources that may be directly useful to U.S. organic production or in breeding efforts.

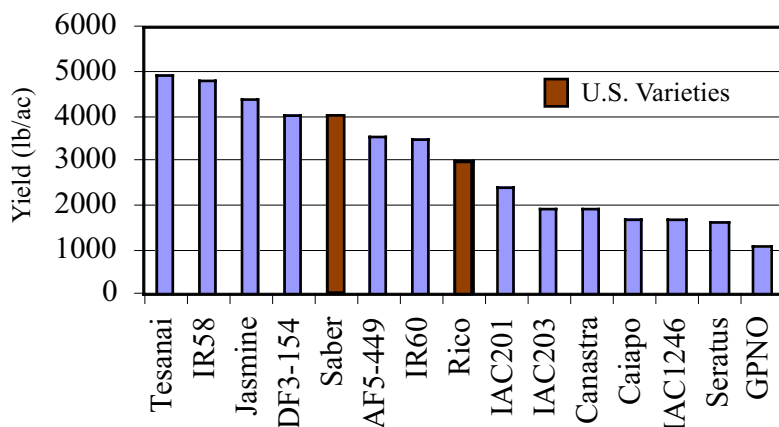
Project Leaders are Anna McClung and Christine Bergman, USDA-ARS.



Dr. Anna McClung

Rice Production Under Upland Conditions In Texas

Figure 1. Yield Under Rain-fed Conditions, 2002 Beaumont



Development of rice cultivars that can produce high yields with less water will help to sustain rice production in areas where there is increasing competition for this natural resource. Sixty rice cultivars representing common U.S. commercial varieties and upland cultivars from other countries were evaluated during 2001 in two separate fields using conventional flood and upland (rain-fed) management. Supplemental irrigation was used in the

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Agronomic Management continued...

upland field through stand establishment, followed by a flushing at panicle differentiation and heading. Of the 60 cultivars tested, six indica cultivars were identified as having good yield potential under upland conditions in Texas. Two of these were Tesanai 2, a cultivar from China that has demonstrated consistent high yield potential in the Texas environment, and Jasmine 85, originally developed in the Philippines.

Twenty rice cultivars that had the most promising performance in 2001 under upland production were evaluated in a replicated trial in 2002 using both conventional flood management and rain-fed management. Of the cultivars tested, three indica cultivars, Tesanai 2, IR58, and Jasmine 85, were identified as having good yield potential under upland conditions (Figure 1). However, several of the cultivars that performed well in 2001 did not yield well in the second year of testing. This is likely due to drought and heat stress occurring at different physiological stages in the two years. Additional upland sources have been identified for testing and breeding populations have been developed using upland and Texas germplasm. These are being evaluated for their adaptation to Texas growing conditions in 2003.

For more information contact Anna McClung at 409-752-5221 ext. 2234, email amclung@ag.tamu.edu.

Entomology/Weed Management

The Entomology Project Continues to Provide Research, Extension and Regulatory Help For Southeast Texas Rice Farmers

Research: This year we have experiments at the Beaumont Center, Eagle Lake, Ganado and commercial rice fields. At the Beaumont Center, we are investigating novel pest management tools applied as seed treatments and pre- and post-flood foliar treatments. These products target rice water weevil and rice stink bug. Also, we are investigating planting date effects (mid-March, first of April, mid-April, first of May and mid-May) on insect populations and yield. We are comparing rice water weevil populations and damage in stale and conventional seedbeds. Our past studies show that rice water weevil populations are higher and more damaging in a conventional seedbed and yields higher in a stale seedbed. We are cooperating with Dr. Don Groth, LSU Plant Pathologist, to determine the relationship between rice water weevil damage and sheath blight damage. We are evaluating currently grown rice varieties for relative resistance to the rice water weevil. We also are determining the best time to apply Mustang Max for rice water weevil control and assessing pre-flood herbicide/Mustang Max tank mixes for potential antagonism. At Eagle Lake, we are evaluating rice water weevil populations and damage in a stale and conventional seedbed on fine sandy loam soil. At Ganado, we are conducting stem borer research to determine the best time to apply Karate Z and to determine varietal resistance to stem borers. This research is in cooperation with Dr. Gene Reagan, LSU Entomologist. In addition, a Ph. D. graduate student, Luis Espino, is developing an easier method than sweep net for sampling rice stink bug.



Dr. M.O. Way

Extension: The Entomology Project makes about 35 on-site inspections yearly. We learn from each visit and redirect our research to answer high priority questions. We also participate in Field Day, winter extension meetings and we publish extension articles in the Rice Production Guidelines, Texas Rice and Rice Production Updates. We contribute to clientele articles in trade journals, judge high school science fairs, give entomology classes to elementary and high school students and conduct the Rice Youth Contest.

Regulatory: This year we have represented Texas in Washington, D.C. to save molinate. We also are working with Syngenta and EPA to gain a stem borer label for Karate Z. In addition, we assisted in gaining a rice label for Mustang Max.

Entomology/Weed Management continued...

Selected data from 2002 Research:

Table 1. Rice Water Weevil (RWW) Insecticide Evaluations, Beaumont, TX. 2002.

Treatment	Rate	0 ^d no. immature RWW / 5 cores		0 ^d yield
	[lb(AI)/acre]	Timing	June 13	(lb/acre @ 12% moisture)
Dimilin 2L	0.188	3 DAF ^a	2.3 de	8323 abc
Dimilin 2L	0.125	3 DAF	2.5 de	7983 bcd
GF-317	0.03	1 DBF ^b	0.3 e	8404 ab
GF-317	0.01	1 DBF	9.5 bc	7845 cde
GF-317	0.003	1 DBF	20.8 a	7457 ef
GF-317	0.03	3 DAF	0.8 e	8388 ab
GF-317	0.01	3 DAF	2.0 de	8303 abc
GF-317	0.003	3 DAF	17.5 b	7537 def
Cruiser 5FS	0.18	ST ^c	0.8 e	8543 a
Icon 6.2FS	0.0375	ST	5.0 cd	7899 cde
Untreated	-	-	41.0 a	7058 f

^a DAF = days after flood, ^b DBF = days before flood, ^c ST = seed treatment

^d Means in a column followed by the same letter(s) are not significantly different at the 5% level (ANOVA and DMRT).

Table 2. Stem Borer Host Plant Resistance Study, Ganado, TX. 2002

Main plot effects:

Variety	No. whiteheads		Yield (lb/acre)		
	M ¹	R ²	M	R	M+R
Priscilla	56.2 a	24.7 ab	7362 d	1674 ab	9036 cd
Lemont	37.9 b	9.2 de	6752 e	1662 ab	8414 e
Saber	30.7 b	27.5 a	7359 d	1336 cd	8696 de
Cocodrie	24.6 bc	28.5 a	8852 a	1141 de	9293 b
Jefferson	20.6 bc	11.3 cde	7890 bc	1443 bc	9333 c
CL121	20.2 cd	18.3 bc	7941 b	949 e	8890 cde
Cypress	17.7 cd	22.7 ab	8075 b	1127 de	9201 cd
Bolivar	14.2 cd	15.8 bcd	7457 cd	1572 abc	9028 cd
XL7	9.9 d	3.0 e	8095 b	1843 a	9937 b
XL8	9.5 d	7.5 de	9237 a	1657 ab	10894 a

Sub plot effects:

T ³ or U	No. whiteheads		Yield (lb/acre)		
	M	R	M	R	M+R
T	1.8 b	12.9 b	8524 a	1508 a	10033 a
U	46.5 a	20.8 a	7269 b	1352 b	8621 b

Interactions:

mp x sp	No. whiteheads		Yield (lb/acre)		
	M	R	M	R	M+R
	sig (P = 0.0001)	ns (P = 0.1178)	sig (P = 0.0022)	ns (P = 0.2467)	sig (P = 0.0029)

¹ M = main crop, ² R = ratoon crop, ³ Karate Z @ 0.03 lb(AI)/acre applied 3 times to treated plots

Technicians in the Entomology Project are Glenn Wallace and Mark Nunez; Graduate Students are Bandara Ratnayake, Luis Espino and Becky Wolff; Summer Student Assistants are Michael Weiss, Josh Moore, Josh Turner, Jeff Lounsbery, Anthony Brown, Ashley Easley and Aaron Baker. For more information contact M.O. Way at 409-752-2741 ext. 2231 or email moway@aesrg.tamu.edu.

Entomology/Weed Management continued...



Dr. Garry McCauley

Weed Control Systems in Rice and Selected Cost

Weed management is a major issue on every acre of rice in Texas. Weed competition can affect rice growth, development, and yield. Herbicides generally account for 15 to 20% of the variable production cost. Field studies supported by Texas Rice Research Foundation are being conducted at Beaumont, Eagle Lake, and Ganado, TX to evaluate weed control systems and relative costs using commercially available herbicides.

Early season treatments include Command applied preemergence, Command, Bolero plus Propanil, Bolero plus Propanil plus Facet applied early postemergence or untreated. The above treatments received sequential late postemergence applications of Arrosolo, Propanil plus Permit, Facet plus Permit, Clincher, Regiment, or were untreated. Herbicides were applied at labeled rates based on soil type. Data being collected includes grass, broadleaf, and sedge control and rice yield. Associated cost for the above weed control systems were determined using data obtained from several local distributors.

All sequential herbicide programs gave adequate weed control (greater than 95%). The only single applications providing adequate control were Bolero plus Propanil and Bolero plus Propanil plus Facet applied early postemergence. Command applied preemergence provided better grass control than Command applied early post emergence, at Eagle Lake and Ganado.

Cost per acre for single applications ranged from \$12.36 for Command up to \$55.86 for Bolero plus Propanil plus Facet. Cost for sequential programs ranged from \$32.29 for Command followed by Arrosolo to \$94.39 for Bolero plus Propanil plus Facet followed by Facet plus Permit. At Eagle Lake, Command, applied either preemergence or early post emergence, followed by Arrosolo and Propanil plus Bolero applied early postemergence cost less than \$36.00. At Beaumont, these treatments cost less than \$37.50. Command followed by Propanil plus Permit, Clincher, or Regiment cost less than \$45 at all locations. Command followed by Facet plus Permit cost about \$55.

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

New Chemistries for Weed Control

Field weed science research in cooperation with several commercial companies continues to be conducted at Eagle Lake, Ganado, Beaumont, and producer fields in the Texas Rice Belt. Our objective is to identify and develop weed control related technology that will assist the rice farmers in producing profitable rice crops.

This growing season we have evaluated DE-638 or penoxsulam a new herbicide from Dow Agro Sciences. It provided excellent control of barnyardgrass at Beaumont. Near Eagle Lake and Rock Island excellent alligatorweed control was obtained when adequate moisture was present but poor control resulted under drought conditions. Late season red rice control with Beyond is being evaluated at Beaumont. Beyond or imazamox is similar to Newpath but has a shorter soil residual. It will also be evaluated for red rice control in the ratoon crop. Newpath rates and timing of applications for tolerance in CL161 and degree of red rice control is also being studied. Hybrid rice varieties XP-710 and XP-712 are being evaluated for tolerance to commercial rice herbicides. XL-8 in systems with Newpath is being evaluated. Plant response has been



Dr. Mike Chandler

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Entomology/Weed Management continued...

similar to commercial varieties now being used.

Studies at Beaumont and Eagle Lake with Regiment applied early postemergence followed by a pre-flood or post-flood treatments resulted in substantial reduction in root biomass. The plants recovered very rapidly with proliferation of numerous fine roots. Impact on rice yield will be determined. Aim continues to provide excellent control of hemp sesbania alone or in combination with numerous other herbicides with no antagonistic interactions. Ricestar also continues to give excellent barnyardgrass control when applied early postemergence.

Callisto or mesotrione, a corn herbicide, and Envoke or trifloxysulfuron, a cotton herbicide were evaluated for rice tolerance and red rice control. In CL-161 rice the Callisto did not injure the rice but completely bleached the red rice foliage through the two leaf stage. The red rice was able to recover with no lasting injury. Envoke applied preemergence or early postemergence resulted in substantial stunting of both rice and red rice with little growth occurring for 30 days after application.

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

Genetics

DNA Markers for Rice Quality Measurements

Molecular Genetics Laboratory researchers are developing and analyzing markers for several economically important traits in rice. Considerable progress identifying markers associated with rice quality traits has been made in cooperative work between the Molecular Genetics and Cereal Chemistry Laboratories, supervised by Drs. Bob Fjellstrom and Christine Bergman, respectively.

We recently developed markers associated with grain gelatinization temperature, one of the most common measurements used to classify rice cooking quality. Medium and short grain varieties typically have low gelatinization temperatures and long grain varieties have intermediate gelatinization temperatures. Studies by Japanese researchers previously indicated an enzyme involved in grain starch synthesis called *Soluble Starch Synthase IIa* (*SSSIIa*) probably controls gelatinization temperature. Through DNA sequence analyses, we found that medium and short grain varieties have DNA sequence mutations in the *SSSIIa* gene not found in long grain varieties. Genetic studies performed in collaboration with Dr. Anna McClung showed that inheritance of these DNA mutations is directly associated grain gelatinization temperatures.

Amylose content is another major grain cooking quality characteristic for which we have been analyzing DNA markers. Building on previous work from Dr. Bill Park's lab (Dept. Biochemistry and Biophysics, Texas A&M Univ.) we have analyzed a DNA mutation in another grain starch synthesis gene called *Granule Bound Starch Synthase* (*GBSS*) in a diverse collection of over 250 international cultivars. We have seen that medium and short grain cultivars with low amylose have one characteristic mutation in the *GBSS* gene while long grain cultivars with intermediate or high amylose do not carry this mutation.

We have further developed DNA markers based on the *SSSIIa* and *GBSS* mutations to directly assay the presence of these mutations controlling grain gelatinization temperature and amylose content. With these markers rice breeders could readily select or verify desired cooking quality characteristics at any stage of plant development.

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Project participants include Ming-Hsuan Chen, Janis Delgado, Naomi Gipson, Eric Christensen, Mickey Frank, Anna McClung, Christine Bergman, and Bob Fjellstrom Molecular Genetics and Cereal Chemistry Programs USDA-ARS/TAES, Beaumont, TX. For more information call Dr. Fjellstrom 409-752-5221 ext 2225 or email r-fjellstrom@tamu.edu.



Dr. Bob Fjellstrom

Genetics continued...

Tracking and Taming Rice Genes: how Research Geneticists assist Plant Breeders

Plant breeders produce improved varieties which directly impact the health and wealth of the rice industry. Some varieties, such as Lemont and Gulfmont, were so successful that their names resonate for decades among rice producers and processors, both in the U.S. and around the world. In some instances, a variety becomes so famous for a particular attribute that its name takes on broader meaning, as in the use of the term ‘Rexmont-type rice’ to refer to all rice that is particularly suited for restaurant steam tables and use in canned soups. The beneficial impact of improved varieties, and thus of plant breeders themselves, on the U.S. rice industry is directly felt and much talked about by producers, millers, and processors.



Dr. Shannon Pinson

In contrast, benefits gained from general genetics studies are less direct and more difficult for various members of the rice community to identify and understand. Yet with rice now serving as a model for understanding the genetics of all grass crops, significant U.S. and international research effort is now using rice to answer some very basic genetics questions. The rice genome has been sequenced. Genes are now being identified within the sequenced genetic code, and scientists are seeking knowledge on how those genes direct the development of rice plants and grain. As a USDA Research Geneticist, Dr. Shannon Pinson serves as a bridge between basic genetics research and applied plant breeding. Her mission is to produce germplasm and genetic information that improve the breeder’s ability to create desired varietal improvements.

For example, resistance to a particular race of blast pathogen may be desired but not present among current U.S. rice varieties; or a new chemical attribute of the starch within the rice grain might open a new market for U.S. rice if incorporated into an adapted rice variety. It is Dr. Pinson’s role to evaluate rice varieties from around the world to identify ones containing the desired trait/gene. Sometimes the trait cannot be found within domesticated rice lines, but is found in distant wild relatives of rice - similar to the genetic relationship between wild lions and housecats. Once a rice line containing the desired trait is identified, Dr. Pinson then studies and identifies the genes responsible for that trait by observing how the trait is genetically passed from parents to offspring within a study population. The desired trait might prove to be determined by a single gene, which is often true when studying resistance to specific blast races. More often, however, the pattern of genetic inheritance is complex due to the involvement of multiple genes. The more genes there are involved with a trait’s expression, the more difficult it is for breeders to find and maneuver those genes into improved varieties.

Similar to predicting a wild animal’s location by tracking its food sources and footprints, Dr. Pinson finds genes by observing their genetic environment. Once genes are found, they can be “tagged” with molecular DNA markers, allowing them to be reliably tracked by breeders as they “roam” among breeding lines. With Dr. Fjellstrom’s collaboration, molecular markers are now being used by Dr. McClung to follow some genes for amylose content and blast resistance in her breeding progeny. If, however, the desired genes are located in wild or distant relatives where they are mingled and associated with many undesirable genes/traits, then it is difficult for breeders to incorporate them into improved varieties even if they are molecularly tagged. As a Geneticist, Dr. Pinson also works to



Figure 1: Blast disease lesions on LMNT (L) vs Res TIL D (R).

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Genetics continued...

“tame” genes by separating them from the undesirable genes and incorporating them into genetic backgrounds more similar to U.S. rice varieties. This allows the desired genes to be more easily maneuvered by breeders into new, improved U.S. rice varieties.

Dr. Pinson has identified genes for several traits including resistance to blast and sheath blight diseases, plant height, heading time, and several traits known to affect yield such as tiller number, panicle size and grain size. She has gone on to “tame” some genes for blast resistance (Fig. 1) and genes for elongated mesocotyls – a trait that improves stand establishment (Fig. 2). Through individual and collaborative research, she is currently tracking genes that impart resistance to grain fissuring (supported by TRRF and the Rice Foundation), improved milling quality, reduced grain chalkiness, improved tillering and vigor during the seedling stage, and resistance to panicle blight disease.



Figure 2: Lemont vs. vigorous rice seedlings

Lemont plants (left in Fig. 1) are very susceptible to blast race IB-49. Dr. Pinson found a gene that imparts resistance to IB-49 in the foreign variety called Teqing. This resistance gene has been “tamed” in the plant on the right – it was separated from the undesirable tall height, late heading, poor grain quality genes also contained in Teqing when it was sexually crossed into a predominantly Lemont genetic background.

Even when treated with vigor-enhancing gibberellic acid, Lemont (left) does not perform as well as LQ:275a (right), a rice line developed by Dr. Pinson. LQ:275a was derived from a cross between Lemont and a foreign variety known as Teqing. Moving the seedling vigor genes from Teqing into a genetic background more similar to U.S. rice varieties is the first step toward incorporating these genes into new U.S. breeding populations and varieties.

For more information contact Shannon Pinson at 409-752-5221 ext 2266, email spinson@ag.tamu.edu.

Plant Physiology

Characterization of Rice Plant Growth and Tiller Production

Rice Plant growth and tiller production are affected by its genetic composition and by the biotic and abiotic environments during its life cycle. This study is intended to determine the physiological basis for (1) the birth and growth of each individual tillers, including the main tillers and all subtillers, and (2) the growth and aging of each individual structures, including individual leaf blade, leaf sheath, culm, and panicle spikelets and branches. The knowledge derived from this study will help us understand the mechanism(s); which controls tiller birth, the allocation of carbohydrate and nutrients between tillers originated from the same mother tiller, the allocation of carbohydrate and nutrients within structures of individual tillers, and the remobilization of non-structure carbohydrate within structures of individual tillers.

Our ultimate goal is to incorporate the detailed physiological processes into our rice plant growth simulated model to help us further our understanding of the interactions between the genetic composition of rice plants and its environments, and to develop a system which can help rice crop management and production.

This study is part of the on-going effort by Dr. Ted Wilson and Dr. Yubin Yang to develop an integrated management system for the rice crop. For more information contact Dr. Yang at 409-752-2741 ext. 2247 or email yyang@aesrg.tamu.edu.

Plant Physiology continued...

Enhancing Ratoon Tiller Earliness and Number

Plant growth regulators (PGRs), which are defined as commercially available compounds with plant hormonal activities, are being used to improve the consistency of ratoon stand establishment of Texas rice. Lee Tarpley, in cooperation with Fred Turner and Mike Jund, is proposing the use of Gibberellin (Gibb) applied as the equivalent of 2 to 4 ounces Release® per acre at 3 to 7 days after peak flowering of the main crop. Two years of small-plot results have shown an increase of 400-500 lbs/A in Cocodrie ratoon yield without effect on main-crop yield or grain quality. The increase in ratoon yield is probably due to enhanced ratoon tiller earliness. During this season we are examining the efficacy of the Gibb treatment on other varieties (Cocodrie, Cheniere, CL-161, Jefferson, Saber, and Sierra) that have ratooning potential and are likely to benefit from this treatment. Several producers are testing the treatment with large field applications, often in combination with a stink-bug treatment. We are also continuing research with PGRs called cytokinins (such as benzyl adenine), that have the potential to increase ratoon tiller number, and might work well in combination with Gibb. In addition, we are examining environmental factors that can affect ratoon tiller initiation and growth through specific physiological mechanisms. These include: a) light quality, which can be impacted by shading from the plants and by organic matter in the water; and b) water quality, which can be diminished by accumulation of decaying plant material, such as fallen leaves. The 2003 small-plot sites are in Beaumont and Eagle Lake. Mr. Tesfamichael (Tesfa) Kebrom, a TAMU Ph.D. student, is focusing on this project. This study is sponsored by the Texas Rice Research Foundation.



Dr. Lee Tarpley

Physiology or Reproductive Stage Tolerance to High Temperatures and of Seedling Tolerance to Cool Temperatures

Research has been initiated in two new projects. Mr. A.R. (Abdul) Mohammed, a new TAMU Ph.D. student, will be working on one of these two areas. One seeks to unravel the physiology of the effects of excess night-time heat during the interval around flowering. The information will be used in cooperation with R. Tabien to establish a selection process for tolerance of this heat, which can cause dramatic losses in Texas rice in some years. In addition, the information will be used to seek preventive or remediative management treatments. At the same time, a study of the effect of the heat at a slightly later stage upon cereal quality will be initiated with the anticipated cooperation of other scientists at the Beaumont Center. The other new project seeks to identify management treatments, such as specific PGRs or selected nutrients, to increase seedling vigor in cool planting conditions. We would like to plant early to increase the amount of season left for the ratoon crop and to avoid main crop heat stress at flowering. Planting early, however, is associated with cool planting conditions. We will simultaneously develop a seedling screening procedure for respiration, which has been shown in another crop to be related to plant vigor expressed as grain number. The methods development will be done in cooperation with R. Tabien and S. Pinson. The screening procedure will then be used in cooperation with R. Tabien as one method to rapidly select for high grain potential. This study is sponsored by the Texas Rice Research Foundation.

Physiology of Lodging Resistance and Vegetative Reserve Storage of Rice Hybrids

Lee Tarpley, in cooperation with RiceTec, is completing a study to identify physiology-based characteristics of lodging resistance. These characteristics will be used by RiceTec to further the incorporation of lodging resistance in their hybrid development program. In addition, Lee Tarpley is studying how the various parts of the hybrid plants are temporarily storing and using carbohydrates (sugars and starch) and nitrogen-containing

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Plant Physiology continued...

compounds (such as protein). The timing and extent of use of these reserves differ between the hybrids and the Texas cultivars. These differences present some unique opportunities for hybrid improvement and management. The 2003 field sites are in Beaumont and Eagle Lake. This study is supported by RiceTec, Inc.

For the Plant Physiology Project Ronnie Porter is providing technical research assistance and Alicia Delgado, Casey Hall and Marcus McCabe are helping for the summer. For more information contact Project Leader Dr. Lee Tarpley at 409-752-2741 ext. 2235 or email ltarpley@tamu.edu.



Hybrid rice under study for lodging resistance and vegetative reserve storage.

Variety Improvement

Generation and Identification of Herbicide Tolerant Germplasm



Figure 2. Seedlings had normal shoot but the mutagen treated plants had fewer and/or shorter roots.

Weeds, particularly red rice, have been a perennial problem in rice production and the release of herbicide tolerant rice was a big relief to farmers. The use of herbicide tolerant rice was found effective in controlling red rice and most of the weeds. The available herbicide tolerant genes, however, are limited and these were mostly products of genetic engineering and patented. Although these may be available, the use of a few genes in the development of varieties favors genetic uniformity, a narrow genetic base that will greatly affect future rice production, diversity and sustainability. Discovery of new gene(s) has been a continuing effort for important traits, e.g. insect and disease resistance and has to be done for herbicide tolerance. Thus, study

on generation and identification of new genes is underway at the Beaumont Center.

Two approaches were initiated to find herbicide tolerant germplasm. The first is mutation breeding, using two popular chemical mutagens. Seed treatment using ethyl methane sulfonate started late May and seedlings from treated seeds are now growing both in the greenhouse and field. At flowering time, florets of popular varieties will be soaked in another mutagen, methyl nitrosourea, to generate mutagen treated seeds. Chemical treatment affects seedlings and the progenies of these affected plants will have the desirable mutants.

The second approach is the screening of available germplasm. From the US gene bank to rice breeders' collection, thousands of different plant types will be evaluated for tolerance using Roundup and Liberty, the two most popular herbicides found friendly to the environment. Accessions or lines with tolerance will be evaluated in detail and will become donors in the development of new varieties. Ultimately, the project aims to release variety with high grain and milling yield, good grain quality, resistance to relevant pests and pathogens and tolerance to herbicide.

For more information, contact Dr. Rodante E. Tabien at 409-752-2741 ext. 2210 or email retabien@tamu.edu.



Figure 1. Mutagen treated seeds germinated slower and the seedlings had some abnormal features relative to the sturdy normal seedling at the right side.

Rice kernel phenolic content and its relationship with antiradical efficiency

Rice kernels contain several classes of antioxidants (or free radical scavengers), including phenolic compounds, tocols, and gamma-oryzanol. Antioxidants contribute to protective effects against oxidative damage, which have been implicated in a range of diseases, including cancer and cardiovascular disease. They are also able to protect food by preventing oxidative deterioration of lipids. We have begun to study these compounds and preliminary data reported last year indicated that phenolics in rice appear to be related to bran color. We report here the characterization of a rice germplasm collection for total and low- and high-molecular (tannins) weight phenolic compounds and radical scavenging activity (Table 1). The first field experiment was conducted in 1999 and 2000 in Beaumont. ‘Bran color’ was highly statistically significant for both bran phenolic concentration and antiradical efficiency. ‘Year’ and its interaction with bran color were not significant, suggesting that seasonal differences and their interactions may not affect these traits. The accessions ranged from 3.1 to 45.4 mg gallic acid equivalents (GAE) g⁻¹ bran, and from 10.0 to 345.3 μM trolox equivalents g⁻¹ bran for total phenolic content and antiradical efficiency, respectively. The light-brown



Dr. Christine Bergman

bran genotypes exhibited the lowest values for phenolic contents and antiradical efficiency, whereas red bran accessions displayed 10 times higher total phenolic content and more than 50 times higher tannin content than light-brown ones. Antiradical efficiency of rice bran extracts was highly correlated with total phenolic content, suggesting that phenolics are the main compounds responsible for the free radical-scavenging activity of rice bran extracts. From a second field experiment (Little Rock Arkansas, 2001, and Beaumont Texas, 2000), 133 rice accessions were analyzed for total phenolic content in whole grain. Total phenolics ranged from 0.69 to 2.74 GAE g⁻¹. The data confirmed our previous findings that bran color is highly associated with rice kernel phenolic content and growing conditions are not significant.

Project participants include Fernando Goffman, Janis Delgado, Naomi Gipson and Christine Bergman. The authors thank Anna McClung, USDA-ARS and Harold Bockleman, USDA-ARS for providing samples for these studies and Shannon Pinson, USDA-ARS for assisting with a grow-out of the germplasm collection.

For more information contact Christine Bergman at c-bergman@tamu.edu.

TABLE 1

Means over two-years for total extractable phenolic, low-molecular weight phenolic and tannin contents and antiradical activity in the bran of seventeen rice cultivars (Beaumont, 1999 and 2000).

Cultivar	Bran Color	Low-P ^a	Tannin ^b	Total-P ^c	AFE ^d
		(mg GAE g ⁻¹)			(μM TE g ⁻¹)
Dawn	light-brown	2.7	0.4	3.1	11.3
Dicebelte	light-brown	3.0	0.4	3.5	18.0
IARI 6626	light-brown	3.2	0.5	3.8	32.8
Faolin	light-brown	2.7	0.5	3.2	18.2
WIB 685	light-brown	3.0	0.4	3.5	13.1
342	purple	20.6	24.8	45.4	345.3
HB-1	purple	7.5	1.1	8.6	56.3
Athanas	red	9.4	22.4	31.8	223.7
Banjul	red	9.3	29.0	38.2	276.0
Chokoto	red	9.2	30.3	39.5	274.7
Oberingen	red	8.0	29.3	37.3	261.7
IARI 6627	red	14.9	29.0	43.9	312.3
Kaloni 2	red	10.5	22.0	32.5	218.5
Kan Shan Wu Shan	red	13.6	25.2	38.9	267.0
Ngawin	red	9.4	16.6	26.0	197.8
Pokhori	red	9.1	30.8	40.2	285.4
Stev Anker	red	8.9	23.0	31.9	199.0
LSD (α=0.05)		5.8	10.6	13.3	118.8

^a Low-molecular weight phenolic content

^b Tannin content

^c Total extractable phenolic content

^d Antiradical Efficiency

Goal: Increasing the Value of the Rice Bran

Brown rice contains compounds, such as vitamin E and gamma-oryzanol, with unique health beneficial and functional properties. However, these compounds are mainly present in the rice bran, which is removed during the milling process. Vitamin E and gamma-oryzanol are antioxidants that have free-radical scavenger ability in the human diet, where these compounds can effectively protect tissues against free-radical mediated

continued on next page

Rice Quality continued...

diseases (such as cancer and cardiovascular disease). These antioxidants can also prevent lipid oxidation, thus improve shelf life of some foods. In addition, rice bran compounds have been seen to lower serum cholesterol level in humans and have anti-inflammatory and tumor inhibitory effects in animals.

In the effort to improve the value of rice bran, we have studied the vitamin E and gamma-oryzanol contents of US and international rice cultivars. A 2- to 3-fold range of vitamin-E (0.21 - 0.44 grams per kilogram of rice bran) and gamma-oryzanol content (2.78 - 6.59 grams per kilogram of rice bran) was found. In U.S. cultivars, the highest vitamin E content for long grains was found in Dixiebelle and Katy, and for medium-grains in Mars and Rico1. In international rice cultivars, Katakara, from Bangladesh, and Taichung 65, from Taiwan, had the highest vitamin E contents for long and medium grains, respectively (more than 0.4 grams per kilo-



Dr. Ming-Hsuan Chen

gram of rice bran). For gamma-oryzanol content, the US medium-grain cultivars Vista and Rico 1 have among the highest (having 6.3 grams per kilogram of rice bran).

The genetic variation in the amounts of these antioxidants suggests that breeding varieties with high antioxidant contents is possible. Project participants include Ming-Hsuan Chen, Janis Delgado, Naomi Gipson, and Christine Bergman. For more information contact Ming at 409-752-2741 ext. 2267 or email m-chen@tamu.edu.

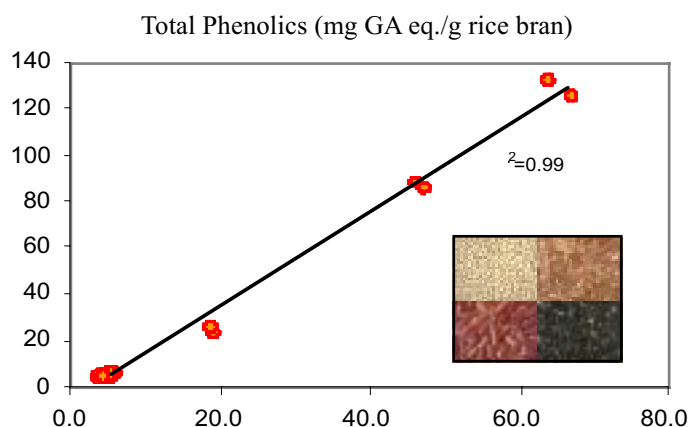


Figure shows the correlation between total phenolic content and antiradical efficiency across U.S. and exotic accessions. Lower insert shows cultivars with different bran colors.

Rice Bran Oil Stability

The rapid enzymatic decomposition of rice bran oils after milling results in its rancidity, which is a serious problem limiting its use. We have studied the intensity of enzymatic decomposition of rice bran oils in three groups of cultivars showing different levels of bran oil content (high-, medium-, and low-oil concentration). Environmental (growing year) effects were not significantly different, while significant differences were seen for hydrolytic enzyme activity among the cultivars tested. The enzymatic hydrolysis of bran oil was strongly related to esterase activity. Red bran cultivars displayed the lowest values for both hydrolytic rancidity and esterase activity, which appears to be related to the inhibitory effect of bran tannin on oil-degrading enzyme activity.

In another study, we looked at the degradation and the quality changes of rice bran oils in rice during storage, using Cypress and Earl as representative long and medium grain cultivars, respectively. The lipids of Cypress degraded faster compared to those of Earl and was related to the higher oil content and lipase (an oil-degrading enzyme) activity of Cypress. The results indicate that lipid content and oil-degrading enzyme activity are both important factors affecting the rate of oil degradation in rice bran. Together, these findings indicate that it is possible to develop rice cultivars with bran that have diminished susceptibility for becoming rancid. Project participants include Fernando Goffman, Naomi Gipson, Janis Delgado, and Christine Bergman.



Dr. Fernando Goffman

Foundation Seed Program

Texas Rice Improvement Association



Robert Weatherton

Texas Rice Improvement Association (TRIA) has provided support in research since 1941. They have produced quality Foundation Seed for the rice industry for over 61 years. The improvement of Foundation Seed has always been our goal. Foundation Seed sales is still our major form of income, while still looking at ways to provide revenues for future projects/research. With new opportunities that have arisen, we now will participate in organic seed production and custom grown seed. As small specialty markets and others become present as viable participants in this rice market we must adapt to new attitudes to survive. We are currently working with Uncle Ben's, Riviana, Doguet's Rice, and Nature Safe.

With organic rice, we are learning and developing new methods and practices to improve production and quality. With new USDA Federal Organic regulations in place producers of organic crops must plant organic seed when available. TRIA will offer the following varieties in organic seed rice in 2004; Sierra, Cypress, Bengal, and Pirogue. At this year's Field Day TRIA will be conducting a field tour, following lunch, that will focus on our findings in organic rice production. We plan to show that timings and amounts of nitrogen are very important in organically grown rice. Yield components as well as quality and milling will be compared to cost of inputs and revenues. Please take a minute to go by the TRIA booth for more information and a tour agenda.

As in the past TRIA will be doing a rice contest. The winner will be awarded 5 cwts. of foundation seed or 200 lbs. of milled rice, so have your calculators handy. The past year has been a busy one with many new challenges. TRIA has/will address these challenges head on for the advancement of research and the improvement of Foundation Seed. Texas Rice Improvement Association is a major component in the survival of the Texas Rice Industry and is always ready to help farmers and producers in anyway possible.



Rogueing is a daily chore in this field of organic Bengal.

For more information contact Robert Weatherton at 409-752-2741 ext. 2230 rweather@ag.tamu.edu.

Education

<http://beaumont.tamu.edu>

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,

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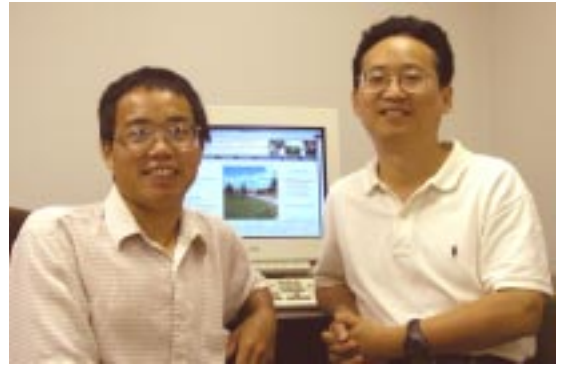
Education continued...

extension and educational communities, and to enhance the dissemination and access of information and knowledge related to rice research and production.

The new 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.

The web project team includes Dr. Ted Wilson, Dr. Yubin Yang, Peter Lu (Web Programmer), Tammy Welch, Jim Medley, and Jay Cockrell.



Dr. Yubin Yang and Peter Lu



Dr. Jim Stansel

The Rice Plant – Its Growth, Development and Yield

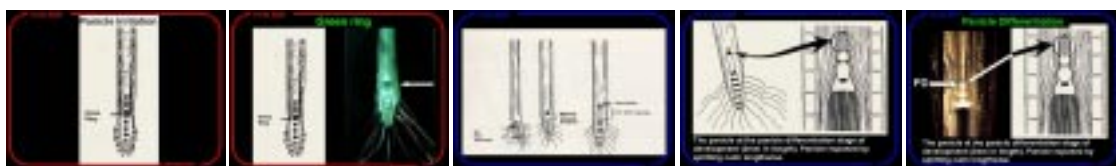
To manage crop stress effectively, farmers need to understand how the crop grows and develops and how stresses can impact the crop. The key to high yields and good quality are to minimize the impact of plant stresses by good timely crop management. To improve sound crop management, a farmer education program about the basics of plant growth was developed and released as a CD.

The CD is a narrated Microsoft PowerPoint presentation divided into three parts. Part 1 discusses and illustrates the vegetative stage of development and how the first yield component (panicles per acre) influences yield very early in the development of the crop. Part 2 covers the reproductive stage and how the grain per panicle (the second yield component) is impacted by management and weather. PD, PI, and Green Ring are discussed and illustrated. The third part looks at grain filling and maturation stage of development during which the third and final yield component, weight of each grain is determined. Factors impacting grain quality are also discussed.

All three parts of the narrated CD takes 1 hour and 37 minutes of playing time and uses 522 Mbytes of space. However, each part can be viewed separately, requiring from 25 to 42 minutes. To play the CD requires Microsoft PowerPoint software and is only PC compatible. CD's are available at no cost at the Beaumont Research and Extension Center and from your County Agricultural Extension Agent.

The program is designed to provide the farmer with a better understanding of how yield and quality are impacted by management, weather, and biotic stresses at each stage of crop development. It is the intent to help the farmer make even better and more timely production management decisions thereby making production even more competitive. This program was funded by the Texas Rice Research Foundation.

Panicle Initiation, Green Ring and Panicle Differentiation



Education continued...

Texas Rice Crop Survey

Variety Performance

Farmers need accurate variety yield and quality field performance data from producers in their region and across the state. Detailed yield and quality information is gathered on up to nine varieties, grown on about 40,000 acres in all regions of the state. This information is published each year in the Rice Production Guidelines.

Acres, Production and Carryover Stocks

Accurate and timely estimates of planted rice acres, production and carryover stocks have been difficult for farmers to find. Inaccurate estimates can and have had negative impacts on rice markets. With funding by the Texas Rice Research Foundation we conduct extensive surveys to determine rice acres by variety for each rice county in Texas. We also accumulate and publish weekly reports by county on crop development and identify crop problems when they occur. Such data is useful in determining crop sensitivity to unfavorable weather, disease, and insect conditions so appropriate alerts and management recommendations can be made.

MAIN CROP YIELD AND QUALITY RESULTS OF VARIETIES PRODUCED IN TEXAS

2002						
Variety	Number of Fields Reported	Reported Acres	Yield lbs./ Acre	Milling Yield %H	Milling Yield %T	Grade
Cocodrie	175	18,880	6,908	60.8	70.4	2.0
Cypress	71	7,690	6,696	61.1	70.4	1.4
Jefferson	14	907	5,796	56.3	69.6	2.1
CL121	20	2,489	5,970	56.5	69.6	2.2
CL161	8	438	7,902	61.5	69.6	
Saber	25	2,399	5,746	60.1	67.3	1.7
Wells	4	374	6,698	58.0	71.8	2.0
Total:	317	33,177				
Weighted Av:			6,685	60.4	70.1	1.8

Compiled by Robin Clements, and Jim Stansel, TAES-Beaumont. Data are compiled from Texas rice belt grower reports, rice dryers and marketing offices. All yields are adjusted to 12 percent moisture.

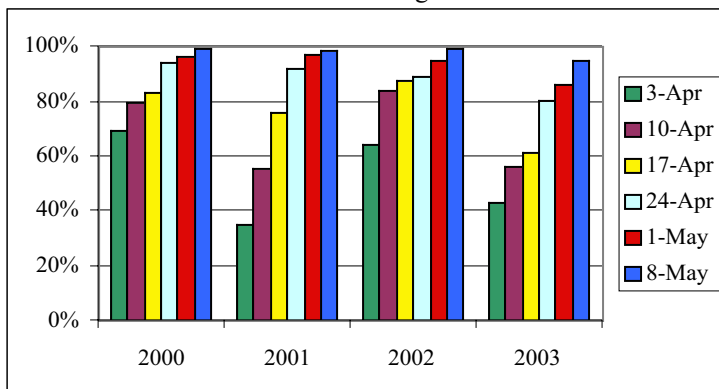
Crop Development Projections

To help farmers and crop advisors plan for management inputs, crop development projections on participating farmer fields are made using a computerized program. The program called DD50 uses accumulative

heat units to predict important stages of development and their associated management inputs. The program uses daily maximum and minimum temperatures above 50°F starting at seedling emergence until the date projections are made. The program then uses average temperature data for future days to predict crop development. DD50 stands for Degree Days above 50°F.

These crop development projections on a field by field basis, help to improve planning and execution of field scouting for timely crop inputs. This program does not take the place of field scouting but it can help users to be more efficient in crop management.

Planted Acreage



For more information contact Dr. Jim Stansel at 409-752-2741 ext. 2258 j-stansel@tamu.edu.