Texas Rice

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# Heterosis in Pre-Heading Yield-Related Rice Traits

## *Hybrid Rice Varieties*

Commercial rice varieties are either inbreds or hybrids, the former being homozygotes (having the same alleles for each gene) and the latter being heterozygotes (having different alleles of each gene). An analysis of data contained in the Texas Rice Crop Survey (Wilson et al., 2006) suggests the average yield advantage of hybrid varieties over inbred varieties was around 7% in 2008 and 21% in 2009. In China, where about 37,000,000 acres of hybrid rice is grown (Zhong et al., 2005), there is a 10 to 20% yield advantage over inbred varieties (Cheng et al., 2007). These advantages are attributed to positive heterosis or hybrid vigor. The magnitude of a hybrid's heterosis can be estimated by comparing hybrid trait parameters to the average of its parents (mid-parent heterosis, MPH), or to its better parent (heterobeltiosis), or to a check variety (standard heterosis) (Virmani et al., 1997).

Research have been conducted on the heterosis of various rice traits, including biomass accumulation, harvest index, panicle length, N uptake, radiation use efficiency, whole rice percentage, yield components, and grain yield (Allahgholipour and Ali, 2006; Zhang et al., 2009; Shukla and Pandey, 2008; Yang et al., 2002; Yang et al., 1999; Saghai et al., 1997; Gravois, 1994; Virmani, 1994; Shrivastava and Seshu, 1983). In these studies, the traits measured for heterosis were estimated at or after heading. *What about yield-related traits that are observed prior to heading?*

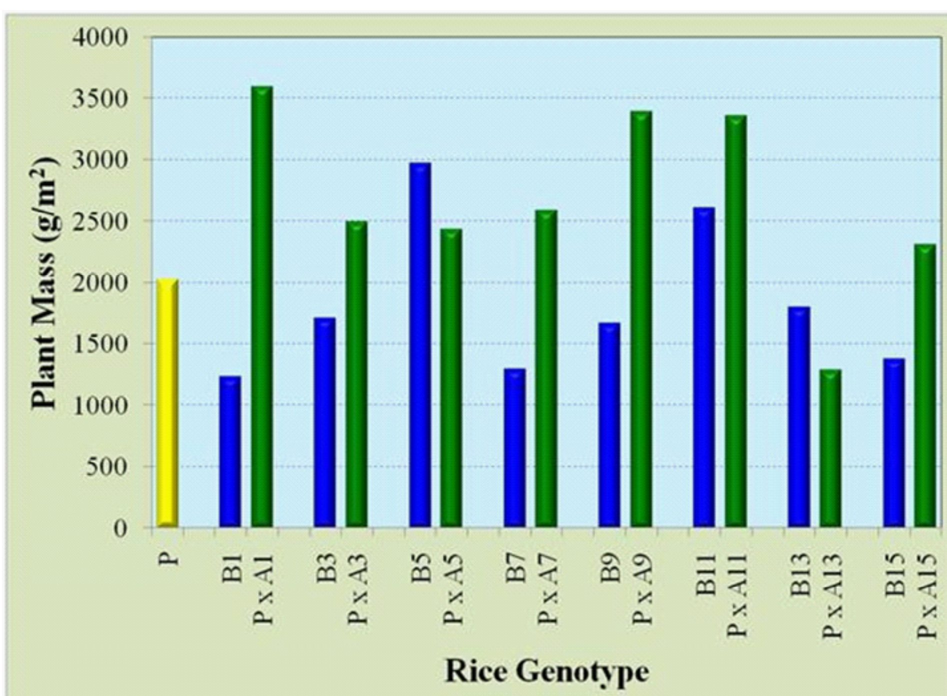


Fig. 1. Plant mass of each hybrid, maintainer or B line (which represented its respective CMS or A line), and male parent (P) at booting stage at Beaumont in 2008.

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# From the Editor ...

## Flowers, Pollen, and Hybrids

Welcome to the first issue of *Texas Rice* for 2010. Our lead article focuses on hybrid rice research that is being conducted by Omar Samonte and others at the Texas A&M University System, AgriLife Research and Extension Center at Beaumont. The focus of this research is to unravel the inheritance of plant traits that result in commercial hybrid rice varieties having on average a greater yield potential than inbred rice. First a bit of explanation on how a hybrid rice variety differs from an inbred rice variety.

In a nutshell, hybrid breeding strives to increase variability across alleles within each pair of genes that affected vigor, yield, resistance, and grain quality, but uniformity across each of the hybrid plants in the plant population. In contrast, inbred breeding strives for uniformity across alleles within each pair of genes that affect these same traits, and uniformity across each of the inbred plants in the plant population

Hybrid rice is developed using one of a number of breeding approaches where two rice varieties are crossed that differ by one or more traits. These traits might involve plant height, tillering rate (rate of production of baby plants through vegetative buds), the rate of production, number, and size of roots, leaves, and stems, resistance to insects and disease, or grain cooking quality. Interestingly, the two parents of a hybrid cross do not necessarily produce higher yields than other potential parents. Each parent is an inbred, with each pair of gene on both sets of chromosomes the same, that is they have the same alleles, for all of the female plants and similarly for the male plants, but differing by one or more genes, and therefore traits, when comparing the female and male plants. The hybrid plants that are produced from a cross share half of their chromosomes from each parent plant, with all of the offspring being genetically identical, and with many of the individual pairs of genes or loci having different alleles, one from each parent. This difference, referred to as heterozygosis, can result in the hybrid plants being superior to both parent plants with respect to one or more traits, such as plant vigor, yield, and disease resistance. When this occurs, some scientists classify this outcome as a positive heterotic effect, also referred to as hybrid vigor.

In contrast, the goal of inbred rice breeding is to produce plants that have the same genes for the majority of gene pairs across the two set of chromosomes. This is typically accomplished by first creating hybrids, rearing out offspring from these hybrids, selecting offspring that are produced by the hybrids of plants that have desirable traits, then repeatedly selecting "selfed" plants, which means self-fertilizing, that increasingly have greater genetic uniformity each generation, until a point is reached where heterozygosity at each loci is almost totally eliminated and the plants are near homogeneous, and a new inbred variety has been developed.

The commercial production of hybrid rice seed would not be economical were it not for the discovery of a freak of nature in China in the early 1970s and subsequent similar discoveries in China and elsewhere of rice plant whose pollen is normally sterile due to an unusual response to photoperiod (daylength), temperature, or male sterile regardless of the temperature and photoperiod condidtions. When one of these male sterile plants is crossed with a normal rice variety, 100% of the resulting seed will have obtained 50% of their chromosomes and genes from the male sterile plant and 50% from the male fertile plant that provided the pollen. Prior to the discovery of male sterile plants, the only way for a normal plant to reliably produce hybrids was by

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### Inside This Issue

**Farming Rice**

A monthly guide for Texas growers

*Providing useful and timely information to Texas rice growers, so they may increase productivity and profitability on their farms.*


# Integrated Agricultural Information and Management System (iAIMS): Cropland Data (http://beaumont.tamu.edu/CroplandData/)

### *Introduction*

One of the many challenges facing researchers who conduct analysis and simulation of biological systems is the ability to dynamically access spatially referenced climatic, soil, and cropland data. Over the past several years, we have developed an Integrated Agricultural Information and Management System (*iAIMS*), which consists of foundation climatic, soil, and cropland databases (Wilson et al. 2007a, Yang et al. 2007, 2010). These databases serve as a foundation to develop applications that address different aspects of cropping systems performance and management. A number of applications have been and are being developed that seamlessly access the foundation databases (Wilson et al. 2004; Yang et al. 2004; Wilson et al. 2007a, b; Yang et al. 2007). Most of these applications also provide several interfaces that expose only features appropriate for specific user levels. Collectively these applications address water conservation, crop production and management, land use suitability analysis, and bioenergy crop productivity and facility site selection optimization. In this article we present an overview of the processes and approaches involved in the development of a cropland data management and display system.

### *Cropland Data Layer Products*

The Cropland Data Layer (CDL) products are developed and maintained by the USDA National Agricultural Statistics Service (NASS, 2010). The CDL contains crop specific coverage maps with each crop represented by a numerical value and color. It is the result of an ongoing cooperative venture among the following USDA Agencies: 1) NASS, 2) Foreign Agriculture Service International Production Assessment group, and 3) Farm Service Agency/Aerial Photography Field Office. In addition, there are in-state agreements between NASS Field Offices and their respective state government or university partners (NASS 2010). The Cropland Data Layer products contain statewide categorization of composite images of cropland distribution. The cropland data include agricultural and non-agricultural land cover categories. The major agricultural land cover includes rice, corn, cotton, alfalfa, sorghum, soybeans, sugarcane, winter wheat, peanuts, sunflowers, potatoes, apples, peaches, and several others. The non-agricultural land cover includes woodland, shrub-land, urban, wetland, water, etc.

The CDL classification process prior to 2006 was based on a maximum likelihood classification approach and relied mainly on data from the Landsat TM/ETM (Thematic Mapper/Enhanced Thematic Mapper) satellite. The only available observational nate was through the NASS June Area Survey (JAS). The JAS data was collected by field enumerators, which was fairly accurate but limited in coverage due to cost and time constraints (NASS 2010). Non-agricultural land cover was based solely on image analyst interpretation.

Beginning in 2006, CDL has been based on imagery from the Advanced Wide Field Sensor (AWiFS) sensor on the Resourcesat-1 satellite. NASS uses USDA Farm Service Agency (FSA)

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Common Land Unit (CLU) data to train the classifier in the agricultural domain and the USGS National Land Cover 2001 data in the non-agricultural domain. Generally, the dominant agricultural crop types have been correctly identified with mid-80% to mid-90% accuracy (NASS 2010).

The most recent CDL products are available for download through the NASS CDL website (NASS 2010). CDL data can also be downloaded from the USDA NRCS Geospatial Data Gateway (NRCS 2010). Data downloaded for a state is typically in the form of a single WinZIP file and contains the CDL imagery in GeoTIFF (.tif) and ERDAS Imagine (.img) file formats, along with the metadata, which includes accuracy assessments. CDL data can also be downloaded from the USDA NRCS Geospatial Data Gateway (NRCS 2010). Currently CDL data is available for 47 of the 48 conterminous US states except for Florida, which will be released in spring 2010 (NASS 2010).

The CDL imagery in GeoTIFF (.tif) and ERDAS imagine (.img) format requires users to have GIS capability to access the data, such as ESRI ArcReader and ENVI software (NASS 2010). This considerably restricts the access and use of cropland data. Furthermore, data in the original GeoTIFF and ERDAS format does not allow easy integration with cropping systems applications that require dynamics access to site-specific crop information. Our objective is to develop a web-based cropland data viewer that allows fast and dynamic data display at a range of spatial scales for a single crop and any combinations of crops, and develop a cropland geodatabase that allows easy and quick access to its underlying crop information.

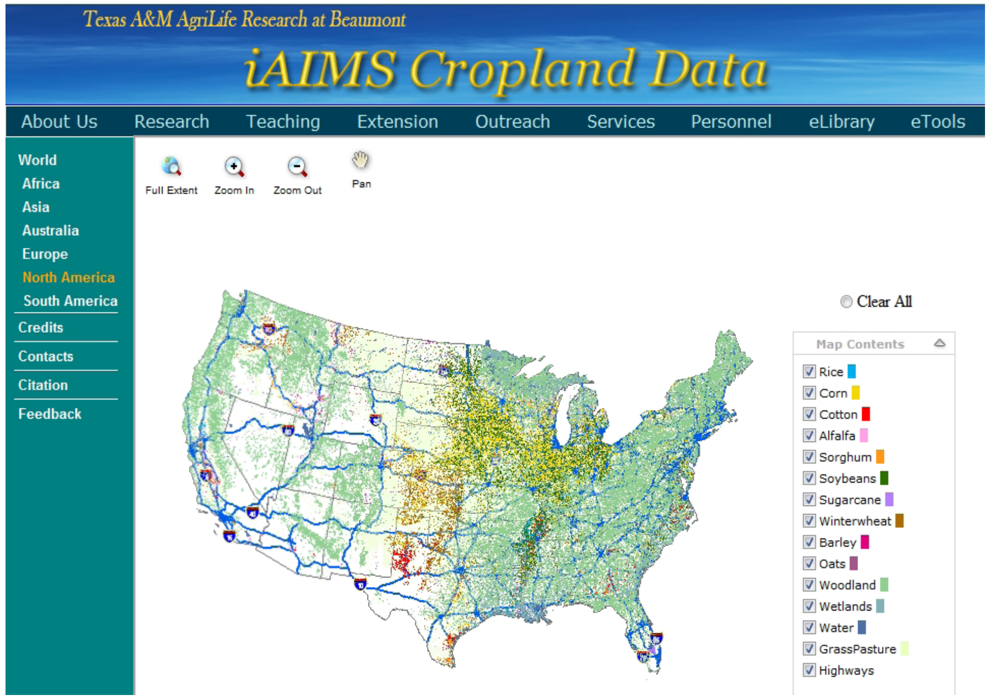


Fig. 1. Screen shot of the major cropland distribution for the conterminous U.S. states, as shown in Cropland Data.

### *Overview of Cropland Data Viewer Development*

Development of the web-based cropland data viewer involves two key technologies: Geographic Information System (GIS) and Web Development Platform. We use the ESRI GIS Products (ESRI 2010) as our GIS integration platform, and Microsoft Visual Studio 2008 and ESRI ArcGIS Web Application Developer Framework (ADF) for the Microsoft .NET Framework as our web development platform.

The major steps in the cropland data viewer development include: 1) download CDL products for each state and each year; 2) use ADF APIs to automatically create a national-scale map document from state-based CDL imagery for each crop type; 3) publish the national-scale cropland imagery for each crop type as a GIS map service; 4) pre-generate map cache in multiple spatial scales for fast data load during map display; 5) develop the web-based cropland data viewer using Visual Studio 2008 and ArcGIS ADF APIs.

### *Web-Based Cropland Data Viewer*

The web-based cropland data viewer is designed

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to shield users from the complexity of accessing map data from GIS programs. It is developed using Microsoft Visual Studio 2008 and the ArcGIS Web Application Developer Framework (ADF) for the Microsoft .NET Framework. The ADF includes a set of web controls, classes, frameworks and APIs that are used to build the web application. The web-based program can be accessed at (http://beaumont.tamu.edu/CroplandData/) (Wilson et al. 2010). Figure 1 shows a screen shot of the major cropland distribution for the conterminous U.S. states. Figure 2 shows an expanded view of the major cropland distribution for the area west of Houston, Texas. Users can navigate through different spatial scales via the main menus on the left side of the viewer. The toolbars on the upper center allow users to view full map extent, zoom in, zoom out, and pan. Users may also hold down the mouse button (left button for PCs) and drag the mouse to specify a rectangular area for display with automatic zooming to the extent as defined by the selected area. The Map Content selector on the right side allows users to selectively display the distribution map of a single crop or any combinations of crops. A highway layer is also added to the display.

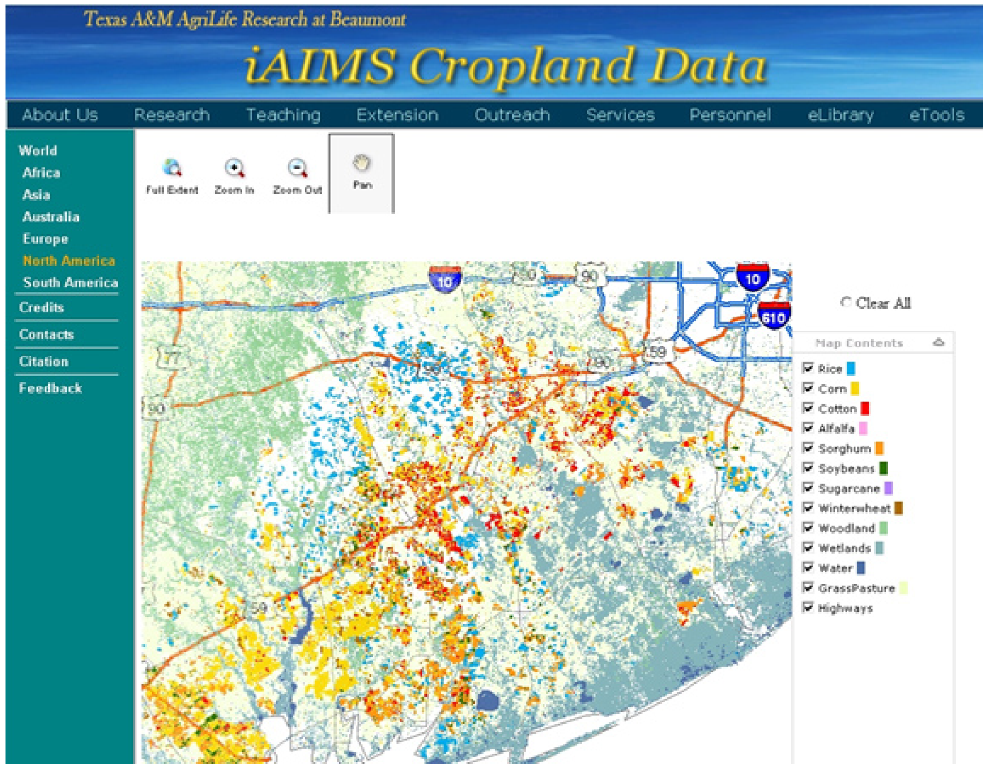


Fig. 2. Expanded view of the major cropland distribution for the area west of Houston, Texas, as shown in Cropland Data.

### *Integration of Cropland Data with Cropping System Applications*

As with the climatic database (http://beaumont.tamu.edu/ClimaticData) and the soil database (http://beaumont.tamu.edu/SoilData), the cropland database is structured to allow dynamics access from cropping systems applications. Applications that currently use the cropland database include rice production decision support system, cotton production decision support system, and bioenergy crop productivity and facility site selection analyzer (under development).

Both the rice and cotton production systems are web-based applications that allow users to specify the spatial scope (specific location, county, state, or area in rectangular grid), crop parameters, and production practices for simulation and analysis, based on site specific weather, soil, and cropland type. The bioenergy crop productivity and facility site selection analyzer is also a web-based application. It identifies the cropland type(s) that can be best used to grow target bioenergy crops (high biomass sorghums and energy canes) and identifies the optimal production footprint, crop mix, rotation schemes, planting and harvesting schedules for a user defined refinery capacity. The climatic and soil databases provide site specific weather and soil information needed to simulate crop biomass potential. The cropland database provides the spatial distribution of potential land parcels available for bioenergy crop production. A road network database is used to identify the possible biomass transportation routes to a biorefinery site.

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# Cropland Data ...

The best biorefinery site is identified as the site that has the optimal production footprint that maximizes year-round feedstock supply while minimizing transportation cost.

The climatic, soil, cropland, and road network databases form the backbone of our cropping systems applications and will play a critical role in furthering our understanding of crop responses to diversified environments, in addressing questions related to production of conventional and bioenergy crops, and climate change impacts at local, county, state, national, and global scales, and in enhancing the competitiveness and economic viability of U.S. agriculture.

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# Heterosis ...

***Pre-Heading Stem Mass and Total Nonstructural Carbohydrates***

In rice, it is at and after heading that most of the yield components (e.g., number of spikelets and grain per panicle, weight of a panicle, and number of panicles per meter square) are determined. It is also after heading when carbohydrates are translocated into the grain, and grain yield is determined. Those carbohydrates that contribute to grain yield come from two major sources: 1) photosynthates produced after heading (during grain filling), and 2) the nonstructural carbohydrates (NSC) that are accumulated in the stems prior to heading.

Several studies have shown the importance of pre-heading traits, including pre-heading stem mass and NSC, in contributing to grain yield. Path coefficients range from -1 to 1 and are an estimate of the direct effect of a predictor variable on a response variable. Stem mass at heading has a positive direct effect on grain yield, having a path coefficient of 0.46 (Samonte et al., 2006). Stem total nonstructural carbohydrate

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(TNC) concentration reaches its maximum around panicle differentiation to heading and decreases afterwards (Samonte et al., 2001). Pre-heading stem NSC have been estimated to contributes 24 to 27% (Cock and Yoshida, 1972) and 20 to 30% (Murthy, 1976) of grain yield. Stem NSC content has a positive direct effect of 0.46 to 0.51 on panicle TNC content (Samonte et al., 2001).

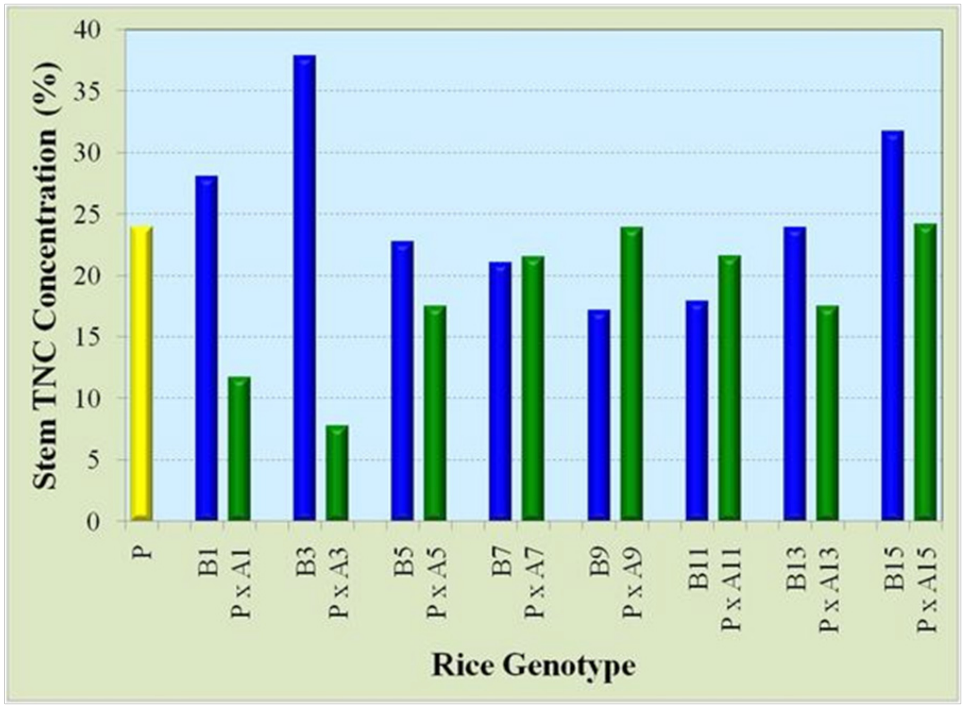


Fig. 2. Stem TNC concentration of each hybrid, maintainer or B line (which represented its respective CMS or A line), and male parent (P) at booting stage at Beaumont in 2008.

### *Hybrid Rice Research at Texas AgriLife*

At the Texas A&M AgriLife Research and Extension Center at Beaumont, field and laboratory experiments were conducted to determine the pre-heading heterotic relationships between rice hybrids and their parents, and to estimate the correlation between the heterosis of stem TNC content and the heterosis of other pre-heading yield-related traits.

The first field experiment that evaluated hybrids produced at the Center was conducted in 2008. The study included 8 hybrids, 8 maintainer lines of the cytoplasmic male sterile (CMS) parents, and the male parent line. Seed of a CMS or A line is produced by crossing an A line with its respective maintainer or B line (that is, an A x B cross), while seed of a B line is produced by allowing the B line to self-pollinate. The repetitive cycle of crossing of an A line to its respective B line to produce or maintain the male-sterile A line makes the A line and its B line near-isogenic (genetically similar except for one of a few genes. A follow-up experiment conducted in 2009 evaluated 8 hybrids, 4 maintainer lines of the 4 CMS parents, and the 2 male parent lines. This study analyzed the following data obtained at the booting stage, prior to heading: light interception, measured at 1-hr intervals from 830 to 1630 hr using an AccuPAR LP-80 Ceptometer; tiller density, leaf area index, and masses of plant structures (leaves, stems, and roots), estimated from samples obtained from the area where light interception was determined; nitrogen concentration of plant structures, using a Leco FP528 N Determinator; nitrogen content of plant structures; nitrogen utilization efficiency (NUE), estimated as the ratio of plant mass over plant N content; and TNC concentration and content. Mid-parent heterosis (MPH) was then estimated for all traits of each hybrid using the equation MPH = [(F1 – mid-parent)/mid-parent] x 100. The mid-parent value was obtained by estimating the average of the parents of a hybrid. NUE is an important varietal parameter because it is a measure of how effective a variety is at producing grain yield as a function of the amount of nitrogen a variety takes up from the soil.

Results from the 2008 experiment showed that prior to heading, at the booting stage, six of the eight hybrids showed positive MPH for **plant mass**, while two hybrids showed negative heterosis (Fig. 1). Negative heterosis occurs when the trait parameter value of the hybrid is less than the average of the mid-parent value. Mean plant mass was significantly

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higher in hybrids than in the mid-parents. It was 2,680 g/m$^2$ for the hybrids and 1,927 g/m$^2$ for the mid-parents. Mean MPH was 42%. This shows that even prior to heading, the hybrids have a biomass advantage over their inbred parents. In general, plant mass is regarded as correlated with grain yield.

Pre-heading **stem and leaf masses**, components of plant mass, were also significantly higher in the hybrids than in the mid-parents. Mean stem mass was 1,948 g/m$^2$ for the hybrids and 1,323 g/m$^2$ for mid-parents, and mean MPH was 52%. Mean leaf mass was 404 g/m$^2$ for the hybrids and 284 g/m$^2$ for the mid-parents, resulting in a mean MPH of 45%. There was also a significant correlation among heterosis for stem mass, plant mass, leaf area index (LAI), leaf mass, and leaf N content.

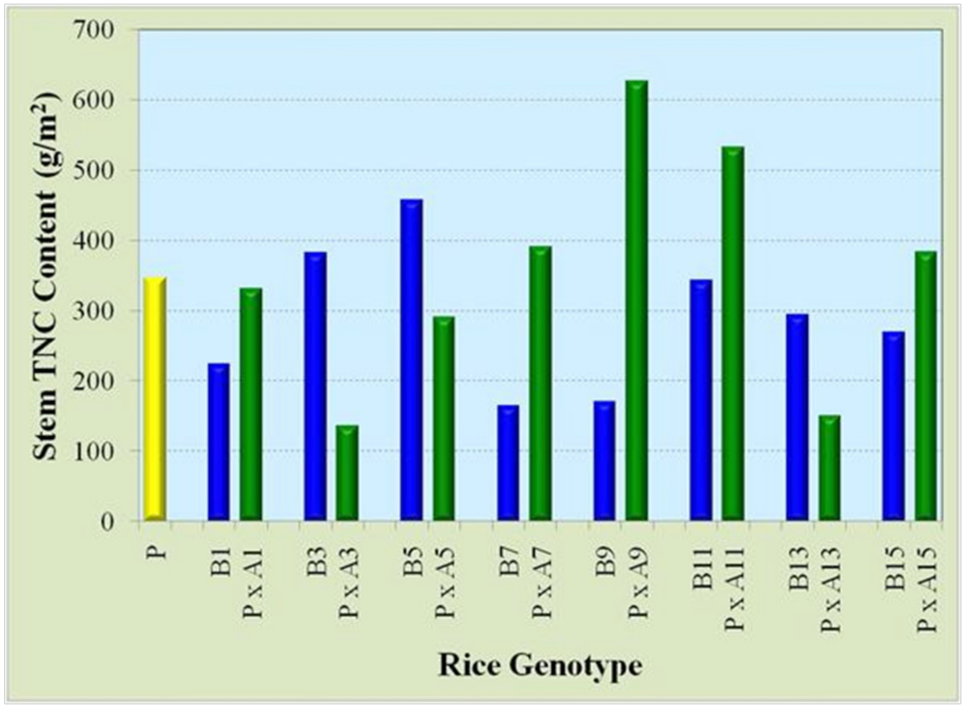


Fig. 3. Stem TNC content of each hybrid, maintainer or B line (which represented its respective CMS or A line), and male parent (P) at booting stage at Beaumont in 2008.

**Stem TNC concentration** prior to heading was significantly higher in mid-parents than in hybrids, with mean concentrations of 24.5 and 18.2%, respectively (Fig. 2). Mean MPH of hybrids was -23%. The lower TNC concentration in the hybrids is possibly due to the higher growth rates and higher demand by the plant structures in the hybrids, thereby reducing the accumulation of TNC in the stem as the TNCs are translocated to the grain. In addition, the lower TNC concentration in hybrids means higher structural carbohydrate concentration, which may be necessary to prevent lodging in the heavier hybrids.

**Stem TNC content** was not significantly different between hybrids and mid-parents, their respective means being 355 g/m$^2$ for the hybrids and 317 g/m$^2$ (Fig. 3). Nevertheless, there was a wide difference between hybrid and mid-parent stem TNC content values, ranging from -229 to 368 g/m$^2$, or an MPH range of -63 to 143%. This suggested the possibility of selecting for hybrids that exhibit positive MPH for stem TNC content. The mean MPH was 18%, which is equivalent to a 38 g/m$^2$ or 375 kg/ha stem TNC content advantage of hybrids over their mid-parents at the booting stage. This implies that at preheading, the hybrids had a non-significant advantage over the inbreds in terms of the TNC accumulated in the stems that can be translocated to the grain after heading.

**Tiller density** was not significantly different between hybrids and mid-parents, with means of 483 and 467 tillers/m$^2$, respectively, and a mean MPH of 8%. Tiller density is one of the yield-related traits that are determined prior to heading. High tillering hybrid varieties are desired to offset the low seeding rates of hybrid seed, which are more expensive than inbred varieties.

**Leaf area index** was significantly higher in hybrids than in mid-parents. Mean LAI was 6.1 m$^2$/m$^2$ for hybrids and 4.6 m$^2$/m$^2$ for the mid-parents, resulting in a mean MPH of 43%. Because of its higher LAI, the hybrids also had slightly but significantly higher **light interception** than the mid-parents. Mean light interception was 90.1% for the

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hybrids and 88.0% for the mid-parents (Fig. 4), resulting in a mean MPH for light interception of 3%. Although a 2 or 3% increase in light interception may seem small, this difference can have a major impact on crop photosynthesis, the rate at which the crop accumulates biomass, and ultimately translate into a 5 to 20% increase in yield by the end of a growing season.

**Leaf N content** was significantly higher in the hybrids (mean of 9.0 g/m$^2$) than in the mid-parents (mean of 5.9 g/m$^2$) (Fig. 5), resulting in a mean MPH of 58%. It was also observed that heterosis for leaf N content had a 0.69 correlation (p-value or 0.059) with heterosis for root biomass. This may imply that the increased root biomass in hybrids relates to the increased N uptake. Yang et al. (1999) proposed that greater root N absorption potential of hybrids is one of the reasons for its greater efficiency. It was observed that leaf N concentration did not differ significantly between the hybrids and mid-parents, with a mean MPH at 8%. These may imply that the increased leaf and root biomass accounted for the increased leaf N content.

**Plant NUE** was not significantly different between hybrids and mid-parents, with the mean of hybrids at 111 g biomass/g N and the mean of mid-parents at 114 g biomass/ g N. Mid-parent heterosis

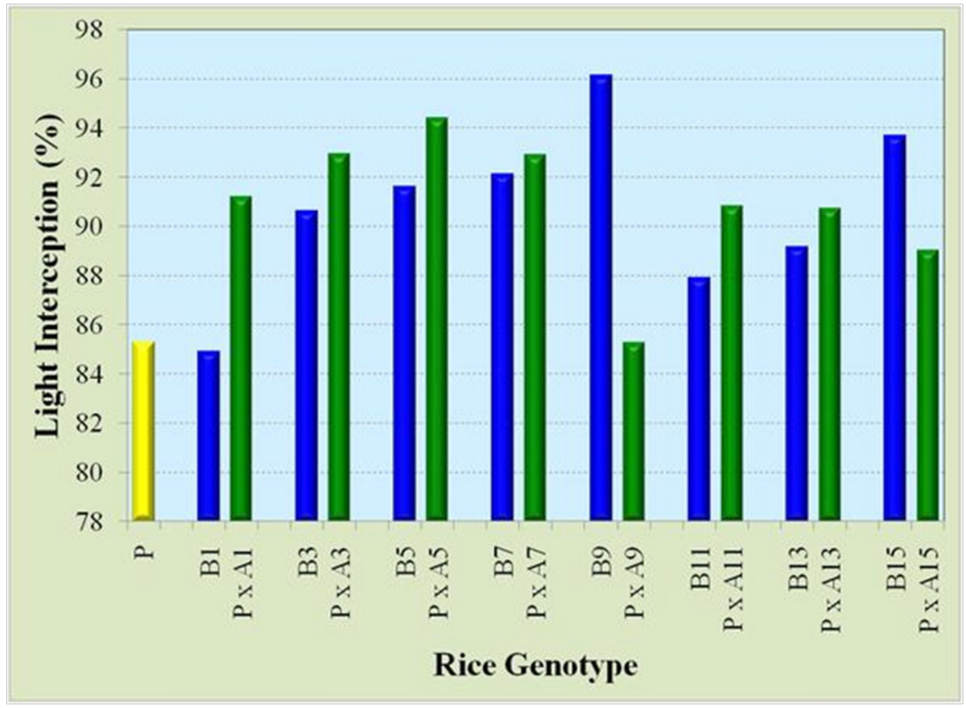


Fig. 4. Light interception of each hybrid, maintainer or B line (which represented its respective CMS or A line), and male parent (P) at booting stage at Beaumont in 2008.

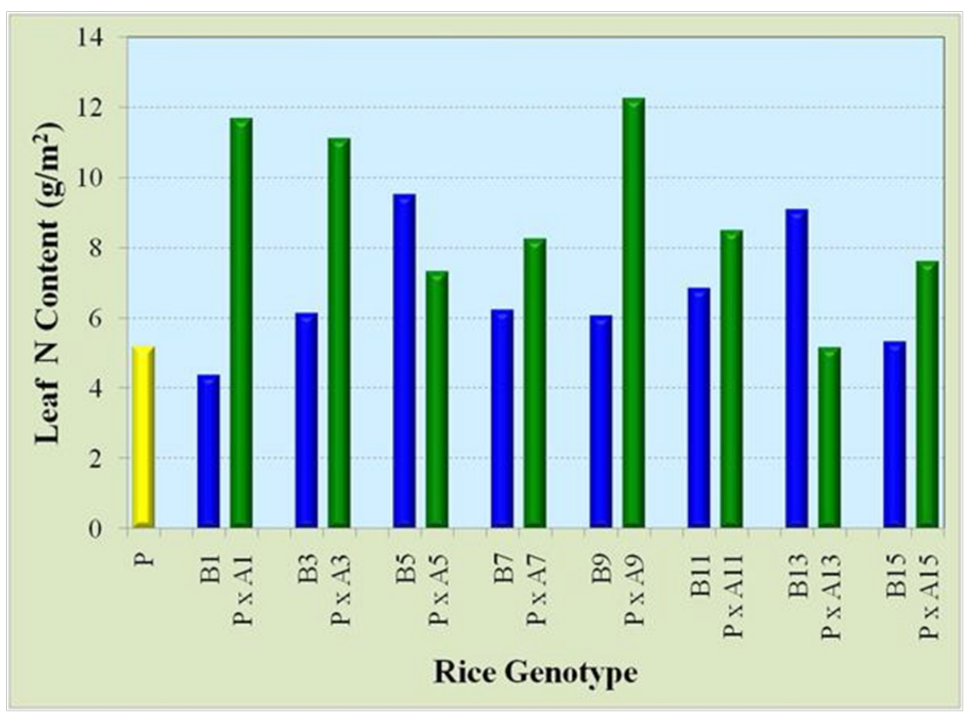


Fig. 5. Leaf nitrogen content of each hybrid, maintainer or B line (which represented its respective CMS or A line), and male parent (P) at booting stage at Beaumont in 2008.

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values of the hybrids ranged from -23 to 15%.

Hybrid rice breeding has been described as one of the strategies for increasing yield potential, the others being conventional hybridization and selection procedures, ideotype breeding (breeding to target an ideal plant type with specific phenotypic traits), wide hybridization (transferring desirable traits from wild rice to cultivated rice varieties, with the initial step of making crosses between wild rice accessions and cultivated rice varieties), and genetic engineering (introducing a non-rice gene[s] into rice using rice transformation or transfer protocols) (Khush, 2005). Continued research on hybrid breeding is being used by our team to improve grain yield, increase water and fertilizer nitrogen use efficiency.

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# From the Editor ...

manually removing the male part of each flower from selected plants using scissors and a small vacuum pump, and then fertilizing the emasculated plant with pollen from normal rice flowers produced by a variety having other desirable traits. While this approach to producing hybrids is commonly used as the starting point for most inbred rice breeding programs, it is prohibitively expensive to use were one to attempt to do so as part of a conventional commercial hybrid-breeding program.

Common wisdom is that hybrid rice out-yields conventional rice. As Dr. Samonte and his colleagues point out in their paper, when averaged across the Texas rice acreage, hybrid rice did indeed out-yielded inbred rice by an average of 7% in 2008 and 21% in 2009. With this yield superiority, then why isn't all of the rice in the world produced through hybrid breeding? The answer to this question has several components.

Hybrid rice production is more expensive than inbred rice production. Chinese researchers have reported that over half of the hybrids that are created from crossing two parents produce lower yields or grain having lower quality, or plants that have other undesirable traits, such as delayed maturity. Hybrid breeding is a long drawn-out process that requires a considerable amount of trial and error until hybrids are created with the desired combination of traits. As a result, hybrid rice seed production is much more tedious and time-consuming compared to inbred seed. For each hybrid line, 2 or 3 other lines must be maintained. For a 3-line breeding program, one line is referred to as the cytoplasmic male sterile line, which contains the gene that results in pollen sterility and therefore prevents successful self-pollination or selfing. A second line, referred to as a maintainer line, is used to re-create the male sterile line, which otherwise would be lost each generation because it can not self-reproduce. A third line, referred to as the restorer line, is required to serve as pollinator (pollen donor) of the male sterile line to create the hybrid seed, which grows as fertile plants. As a result of all of this extra effort, hybrid seed is more expensive to produce. Partially as a result, hybrid rice seed that is sold to growers to produce a crop can be as much as 5 or 6 times as expensive to purchase to plant an acre of rice. As a result, a grower's hybrid rice field has to yield more to pay for the increased cost of seed.

Hybrid rice production has not been adopted by some rice producers who have shown that they can achieve yields with inbred rice similar to the best yielding hybrid rice fields. When this happens, they can make more money growing inbred rice than growing hybrid rice. Also, in some parts of the U.S., including parts of Texas, hybrid rice is penalized at the mills, which reduces its yield advantage thereby eliminating some of the potential profit advantage. Finally, some producers whose fields are located closest to the Gulf Coast plant very early and have through the years shown that they can consistently achieve extremely high yields growing inbred varieties.

Should a rice producer grow hybrid rice? It behooves each of our growers to determine whether inbred or hybrid production best fit within their production system. The answer should be determined by what provides them the greatest net income.

In addition to RiceTec, which commercially produces hybrid rice varieties in the U.S., and Bayer, which is developing hybrid rice varieties, scientists at both Texas A&M University and Louisiana State University are actively pursuing the development of their own hybrid rice varieties. In addition, Arkansas is considering developing a hybrid rice breeding program, while a consortium of states that include

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## From the Editor ...

Arkansas, Louisiana, Mississippi, Missouri, and Texas are formalizing ways to work together to develop hybrid varieties. Who would ever thought that a genetic sport would revolutionize rice breeding around the world?

The second article in this issue is by Yubin Yang and colleagues, and presents a glimpse of part of the more quantitative side of research at the Beaumont Center. In this paper, the authors describe a cropland database and discuss how it is being used. A number of projects at the Beaumont Center are being developed that tie into the cropland database, as well as the soils and climatic databases that have also been developed at the Center.

The goal of all of our Center's research, which spans the spectrum from gene discovery to the development of field-level management tools, is to provide solutions to problems that are more accurate, more timely, that are based on scientific data, and that help to increase the economic and sustainability of our growers.

Please keep on sending us your suggestions.

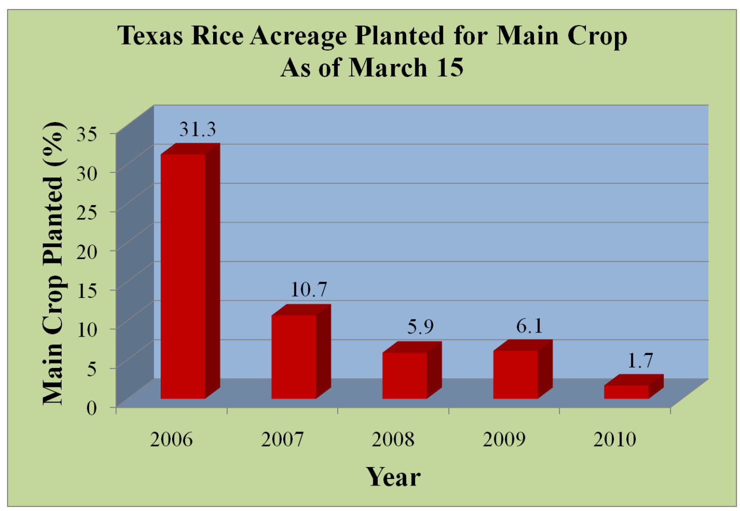
Sincerely,

L.T. Wilson
Professor & Center Director
Jack B. Wendt Endowed
Chair in Rice Research

# Rice Crop Update

As of March 15, 2010, 1.7% of the main crop rice acreage in Texas had been planted. In comparison, 31.3, 10.7, 5.9, and 6.1% had been planted by March 15 in 2006, 2007, 2008, and 2009, respectively.

Weekly updates on the acreage and percentage of rice grown in Texas that are in the various growth stages are available at our website at http://beaumont.tamu.edu/CropSurvey/CropSurveyReport.aspx.

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