Apomixis

Rice is strictly a self-pollinating (inbreeding) crop, and because of this it is easier and more straightforward to produce seed of an inbred line or variety than it is to produce a hybrid. Seeds of an inbred variety are produced from plants of the same variety, that is, they breed true. For example, the rough rice that is harvested from a field can be used as seed of the same variety for planting in the next cropping season. In contrast, the production of seeds of a hybrid variety requires the cross-pollination between the male-sterile parent and the fertility-restoring or restorer parent. A 3-line hybrid breeding approach requires the development and use of a cytoplasmic male-sterile, maintainer (which is crossed to the male-sterile line to produce seed of male-sterile line), and a restorer line to produce the hybrid seed, while the 2-line hybrid approach requires the environment sensitive male-sterile and restorer lines to produce the hybrid seed. As a result, hybrid seed is more expensive because its seed production is more complicated. Furthermore, hybrids do not breed true, as the succeeding generations produced from hybrids show variability and lose their yield advantage. Hence, there is a need to buy F1 hybrid seed to plant in each growing season. This places resource-poor farmers at a disadvantage, as they are not able to buy the costly hybrid seed and utilize this technology in their business (Khush et al., 1994).

There are several papers that suggest that apomixis may be the trait that could remove the need of maintaining and using male-sterile and maintainer lines to produce hybrids, and thus lower the cost of producing hybrid seed (Hanna and Bashaw, 1987; Khush et al., 1994; Miles, 2007). Apomixis is an asexual reproduction in which the seed is produced without the union of the egg and sperm. It bypasses female meiosis and syngamy to produce embryos genetically identical to the maternal parent (Khush et al., 1994). Grossniklaus and van Dijk (2001) and Ozias-Akins and van Dijk (2007) summarized the technical comparisons in seed development through sexual reproduction (or amphimixis) and gametophytic apomixis as follows:

- In sexual reproduction, a megaspore mother cell (MMC or megasporocyte that is a single cell within the ovule that typically is destined for meiosis to generate megaspores) undergoes meiosis (reductional cell division that produces cells having half the chromosome number) and forms a tetrad of four reduced megaspores. One of these divides and develops into the mature embryo sac, which contains the female gametes. Double fertilization then occurs in the embryo sac; the egg cell fuses with one male gamete (sperm) to form the zygote that becomes the embryo, while the binucleate central cell fuses with a second sperm to form the endosperm (a nutritive tissue). In short, female gametogenesis and double fertilization occurs within the ovule.

- In gametophytic apomixis, there is no meiosis (apomeiosis) and unreduced cells initiate embryo sac development. The unreduced cells can originate due to diplospory (aberrant or missing meiosis of the MMC) or apospory (cell within the ovule other than the MMC forms into the unreduced embryo sac). Parthenogenesis then
Welcome to the winter issue of Texas Rice. The lead article provides a glimpse of an interesting area of plant reproduction referred to as apomixis, which is the production of seed asexually without pollination (fertilization). Apomixis has so far been found to exist in 7% of the families of flowering plants. It has also been found in a number of grass species, but so far it has not been discovered for Oryza, which is the genus for rice.

Apomixis is potentially the Holy Grail for rice breeding. If an apomictic rice plant is found, it will very likely revolutionize rice plant breeding by allowing rapid fixing of favorable yield traits found in hybrid varieties, while bypassing current lengthy and expensive hybrid breeding methods. Putting this in context, the discovery of male sterile rice plants led to the development of hybrid rice breeding, which had a profound effect on rice yields both nationally and internationally. In contrast, the discovery of an apomictic rice plant would very likely result in the level of yield increases observed for hybrids but at a much lower cost, which would result in its adoption over most of the world.

Normally, most plant species reproduce by either producing flowers that contain both female and male parts, and as such are self-pollinating (self-fertilizing), as it is the normal case with rice, or by producing separate female and male flowers, referred to as open pollination, either on the same plants or on separate plants. In the first case, the pollen producing part of the flower is very close to the female part and, as a result, the pollen has a very short distance to travel to fertilize the female part. In the case of open-pollinating plant species, pollination occurs either by the pollen traveling by wind or is transported by insects that fly from flower to flower gathering pollen and/or nectar. As an interesting side issue, self-pollinating plant species tend to have heavier pollen than do plant species that are open-pollinated, providing in each case a pollen dispersal mechanism that is tuned to the fertilization approach that each group of plants has developed.

Currently, 2- and 3-line breeding is the only practical means available to produce commercial volumes of hybrid rice seeds. These approaches are slow and considerably more expensive than conventional inbred rice breeding. Were it not for the ca. 9 to 15% yield advantage that commercial hybrids have over conventional inbreds, hybrid rice breeding would be an interesting oddity and would not have become the major rice seed producing approach that it has become. Even with the yield advantage, the increased cost of producing hybrid seed has greatly slowed its rate of adoption. The negative cost of hybrid production would largely disappear were apomictic based hybrid plant breeding to become a reality.

The second article in this issue focuses on greenhouse gas emissions by rice. This is a controversial topic that has generated considerable political heat, particularly in the U.S., and particularly as it relates to questions about climate change. Research on this topic primarily focuses on increasing our understanding of factors that contribute to greenhouse gas emissions by rice.
Effects of Wetting and Drying on Greenhouse Gas Emissions in Rice Soil

Global climate change is linked to human-induced increase in atmospheric concentrations of three greenhouse gases: carbon dioxide (CO$_2$), methane (CH$_4$), and nitrous oxide (N$_2$O) (Intergovernmental Panel on Climate Change, 2007). Rice soils account for 17% of global agriculture-borne CH$_4$ emissions (Wuebbles and Hayhoe, 2002) and up to 25-35% of the total cropland N$_2$O emissions in heavy rice production regions (e.g., China) (Liu et al., 2010), due to the abundance of organic matter and intensive irrigation that result in high microbial activity. Methane production is favored in flooded rice soils resulting in low oxidation-reduction potentials and an anaerobic environment, while CO$_2$ and N$_2$O are emitted in high amounts in aerobic conditions (Yu and Patrick, 2004). Due to periodic drying followed by rapid rewetting, the rice soil and water regime determines the trade-off relationship between CO$_2$, N$_2$O, and CH$_4$ emissions.

Rice production is the second largest source of CH$_4$ in the agricultural sector, after enteric fermentation by livestock (Fumoto et al., 2010). Methane follows H$_2$O and CO$_2$ in its global warming impact and is a potent greenhouse gas, and its global warming potential is 25 times higher than that of CO$_2$ over a 100-year time period. For additional information refer to http://beaumont.tamu.edu/eLibrary/Newsletter/2005_Winter_Issue.pdf). Since CH$_4$ is produced in an anaerobic environment (without oxygen), the management of soil moisture and irrigation affects the potential for CH$_4$ emission and mitigation. For example, continuous flooding and addition of rice straw and to a lesser extent compost were shown to increase CH$_4$ emissions from rice soils (Fumoto et al., 2010).

Nitrogen fertilization is generally known to increase emissions of CO$_2$ and N$_2$O by soil through increasing microbial activity (Smith et al., 2008). Emissions of CH$_4$ from rice soils, however, vary depending on the fertilizer N source. Research have shown that the fertilization using NH$_4$-N containing fertilizer such as urea results in an inhibition of CH$_4$ oxidation rates and an increase of CH$_4$ emissions, possibly due to the inhibition of methanotrophic bacteria enzymatic activity by NH$_4$-N (Bedard and Knowles, 1989; Kara and Ozdilek, 2010). In contrast, CH$_4$ emissions decreased when NO$_3$-N–containing fertilizers are applied, with the decrease being attributed to the inhibitory effects of NO$_3$-N on methanogenesis (Xu et al., 2007). It has been observed in laboratory soil incubation studies that there is an increase in CO$_2$ emitted from soil following the decrease in CH$_4$ emissions, and this is likely due to CH$_4$ oxidation (Kara and Ozdilek, 2010). At the Texas A&M AgriLife Research and Extension Center at Beaumont, we are conducting studies designed to elucidate the effects of flooding and N fertilization using urea on greenhouse gas emissions, as it is important to determine potential efficiency of irrigation and fertilization management practices for the mitigation of greenhouse gas emissions in Southeast Texas rice soils. We collected representative surface soil samples at Beaumont (fine textured soil) and Eagle Lake (coarse-textured soil) sites in Spring 2010 (Table 1). Samples were air-dried and ground to pass a 2 mm sieve, then 100 g of soil was placed in 1 pt Kerr canning jars. Soil samples

Continued on the next page
Table 1. Description of original soil samples used in the incubation study that were obtained from the sites at Beaumont and Eagle Lake, Texas, in 2010.

<table>
<thead>
<tr>
<th>Site</th>
<th>Soil Horizon</th>
<th>Depth (ft.)</th>
<th>NO₃⁻-N (mg kg⁻¹)</th>
<th>NH₄⁺-N (mg kg⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beaumont</td>
<td>Ap †</td>
<td>0 – 0.40</td>
<td>1.62 ± 0.02</td>
<td>0.43 ± 0.01</td>
</tr>
<tr>
<td>Eagle Lake</td>
<td>Ap</td>
<td>0 – 0.25</td>
<td>1.30 ± 0.01</td>
<td>0.46 ± 0.01</td>
</tr>
</tbody>
</table>

† Ap – layer of soil that is plowed or cultivated

were incubated over 95 days with the following treatments: with and without urea fertilization at 185 lb/acre of N for Beaumont soil and at 200 lb/acre of N for Eagle Lake soil, and three wetting or soil moisture treatments (Fig. 1). The soil moisture treatments included 1) wetting to attain and maintain field capacity, which is soil moisture after excess water has drained away (field capacity), 2) full water-saturated and submerged conditions, with 1 inch of standing water and continuously maintained under these conditions (flooded), and 3) a treatment where soil was wetted to full saturation with 1 inch of standing water and consequentially dried to field capacity over the period of approximately 1 month (dry-wet). Three dry-wet cycles were applied to the dry–wet treatments, as described above, while the rest of the treatments were maintained at their moisture levels. In total, 36 samples were incubated at 21°C in glass jars sealed with rubber fitted aluminum lids for gas tight design to allow quantification of CO₂. Emission of CO₂ was measured by trapping in a 0.2 M NaOH solution and titration following a 7-day incubation in the beginning and at the end of each dry-wet cycle.

In both Beaumont and Eagle Lake soils, emissions of CO₂ were highest immediately after initial wetting for the treatments maintained at field capacity (Fig. 2 and 3). Emission of CO₂ in the Beaumont treatment maintained at field capacity and amended with urea at 185 lb N/acre was 1.7 times higher than at 0 lb N/acre of urea. In contrast, significant differences were not observed between fertilized and unfertilized Eagle Lake treatments maintained at field capacity. Carbon dioxide emissions decreased in the treatments at field capacity to the level similar to other treatments at the end of the first dry-wet cycle. For Beaumont soil, both fertilized and unfertilized dry-wet cycling treatments, as well as the fertilized permanent flood treatment, had a slight decrease of CO₂ emissions at the end of the first dry-wet cycle compared to their initial level. A significant decrease in CO₂ emissions also occurred in all dry-wet cycling treatments for Beaumont and Eagle Lake soils after rewetting at the third dry-wet cycle. Dry-wet cycling treatments for the Eagle Lake...
Greenhouse Gas Emissions ...

soil (both fertilized and unfertilized) tended to produce higher \( \text{CO}_2 \) emissions compared to permanently flooded treatments (Fig. 3).

The initial burst of \( \text{CO}_2 \) emission in the treatments maintained at field capacity was likely a result of an increase in dissolved organic carbon concentrations in the soil (Butterly et al., 2009) following wetting (Franzluebbers et al., 1994; Fierer and Schimel, 2002). That resulted in microbial cell lysis due to osmotic shock and release of low molecular weight organic compounds into solution and their further oxidation to \( \text{CO}_2 \) by microbes (Franzluebbers et al., 1994; Lundquist et al., 1999). Initial \( \text{CO}_2 \) level spikes in the fertilized and unfertilized dry-wet cycling and permanent flood treatments were likely a result of the significant amount of oxygen remaining in the soil flooded, which allowed for aerobic decomposition. Increased levels of \( \text{CO}_2 \) in the dry-wet cycling treatments than in permanently flooded treatments appeared to be consistent with the findings by Xu et al. (2007). Oxidation of organic matter to \( \text{CO}_2 \) in aerobic conditions, as well as presence of oxidized Mn (IV) and Fe (III), which are more favorable electron acceptors compared to organic-C in subsequent flooding, contribute to elevated \( \text{CO}_2 \) emissions in rice intermittent flooding (Xu et al., 2007). Thus, intermittent flooding of rice soil also

FIG. 2. Emissions of \( \text{CO}_2 \) in the dry-wet cycling incubation study from the soil obtained from the site in Beaumont, Texas, 2010.

FIG. 3. Emissions of \( \text{CO}_2 \) in the dry-wet cycling incubation study from the soil obtained from the site in Eagle Lake, Texas, 2010.

Continued on the next page
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results in about 30% lower CH$_4$ emissions compared to permanent flooding (Xu et al., 2007).

The results of CO$_2$ emissions in our study demonstrated that irrigation to field capacity results in aerobic conditions, while intermittent flooding treatments go through aerobic phases, and both treatments have a potential to reduce soil CH$_4$ emissions. Further studies will include sampling the soil gas emissions for CH$_4$ and N$_2$O concentration determination, and analyzing the soil for dissolved organic carbon and N forms (e.g., NO$_3$-N, NH$_4$-N, and organic-N). This information would be needed to evaluate each soil moisture level’s mitigation potential for greenhouse gas emissions. This will allow for further improvement of irrigation and fertilization management decisions.

For further information, please consult the following literature cited:


* Article by Drs. Kirill Kostyanovsky and Fugen Dou, Texas A&M AgriLife Research and Extension Center at Beaumont, TX.
Apomixis ... 

occurs, in which the unreduced egg cell initiates embyrogenesis (development of the embryo) in the absence of fertilization. The central cell then initiates development into the endosperm either autonomously or with fertilization (pseudogamy). In short, unreduced embryo sac formation, parthenogenesis, and pseudogamy are the phenotypic elements of apomixis.

Hence, the embryo formed through apomixis does not have paternal contribution, and the apomictic progeny bears the full maternal genetic constitution and is a clone of the mother plant (Grossniklaus and Dijk, 2001).

Apomicts range from being obligate (plants only reproduce through apomixis) to facultative (sexual and apomictic embryos may occur in the same ovule) and there are varying degrees of apomixis both within and between species and genotypes (Hanna and Bashaw, 1987). Between the two, an obligate apomict is more desirable, because a facultative apomict is more difficult to manipulate, it would require intercrossing plants with the highest apomixis levels to increase the frequency of apomixis, and progeny testing would be needed to identify the best apomicts and to evaluate genotypes for genetic stability. Furthermore, an obligately apomictic hybrid would breed true regardless of heterozygosity (Hanna and Bashaw, 1987).

Apomicts that produce unreduced parthenogenetic eggs are generally polyploid (having more than twice the haploid [1n] number of chromosomes) and occur in at least 33 of 460 families of angiosperms (Carman, 1997). Poaceae (formerly known as Gamineae), the grass family, is one of the families reportedly having apomicts, but the Oryza species (which belongs to the Poaceae family) was not reported to show apomixis (Carman, 1997). Cultivated rice (Oryza sativa L.) is a diploid (2n or twice the haploid chromosome number). Rutger (1992) did not find apomixis in any of the 547 accessions of closely related wild species of rice having the AA genomes that he screened using the pistil clearing technique. The limited number of Oryza species and accessions that are tested for apomixis could be one of the reasons for not finding apomictic forms (Kaushal et al., 2004). However, it was reported that twin seedlings were found at low frequencies (0.14 to 0.51%) in 8 of the 783 rice accessions screened from the International Rice Germplasm Center at the International Rice Research Institute (Sharma and Virmani, 1990). Consistently high frequency of twin seedlings in the progenies is one of the indications of apomixis (Khush et al., 1994).

Grossniklaus and van Dijk (2001) summarized several papers that studied the inheritance of apomeiosis and parthenogenesis, which are components of gametophytic apomixis. Apomeiosis was reported to be controlled by a single dominant apomeiosis \(A\) allele, and has an inferred genotype of \(Aaa\) or \(Aaaa\). The \(a\) allele (which codes for sexual reproduction) provides the plant with the potential for sexual reproduction. The degree of penetrance of the \(A\) allele explains the occurrence of facultative apomixis, while the presence of several \(a\) alleles explains how a cross between two facultative apomicts generates abundant purely sexual progeny. Parthenogenesis, on the other hand, was reported to have an inferred genotype of \(Ppp\) or \(Pppp\).

Noyes and Rieseberg (2000) reported that diplospory and parthenogenesis are controlled by dominant genes that are unlinked and inherited independently, based on their study of a segregating population of 130 \(F_1\)’s produced from a cross between triploid (3n = 27) agamosperous (or apomictic) \(Erigeron annuus\) and sexual diploid (2n = 18) \(E. strigoss\).

In addition to the number of genes and alleles that control apomixis, some studies that showed environmental conditions, such as photoperiod and low temperatures, affect the degree of apomixis were listed by Nogler (1984). In contrast, Burton (1982) reported that variations in photoperiod from 10 to 16 hours did not make an apomictic bahiagrass clone sexual.

Morphological, cytological, genetic and histochemical techniques are used to identify and screen for apomixis (Bhat et al., 2005). There have
Apomixis has been mutants selected from sexual plants that show apomictic traits, such as meiotic non-reduction (in maize, Arabidopsis, and barley), parthenogenesis (in barley), polyembryony (in maize), embryogenic potential (in maize, carrot, and Arabidopsis), and fertilization-independent endosperm formation (in Arabidopsis) (Spillane et al., 2001).

Apomixis is a complex trait that has been studied since the early 20th century. It has great potential to improve crop breeding and production. Its genetics are being studied, and research techniques, such as comparative mapping, linkage disequilibrium mapping, deletion mapping, and new high-throughput sequencing methods, will help improve our understanding of this trait (Ozias-Akins and van Dijk, 2007).

For more information, please consult the following references:


* Article by Dr. Stanley Omar PB. Samonte, Texas A&M AgriLife Research and Extension Center at Beaumont, TX.
An increase in temperature occurs when greenhouse gases (carbon dioxide, water vapor, nitrous oxide, and methane) trap heat and light from the sun in the earth’s atmosphere. The increase in atmospheric greenhouse gases can increase night temperatures more than the day temperatures. In a report from the International Rice Research Institute (IRRI), researchers found that the annual mean day and night temperatures increased by 0.35°C and 1.13°C, respectively during the 25 year period from 1979 to 2004. Furthermore, the report indicated rice yield declines by 10% for each 1°C increase in night temperature, while the effect of day temperature on crop yield was insignificant (Peng et al., 2004). The major rice-growing region of the United States is the mid-south (or Southern) area consisting of parts of Texas, Arkansas, Louisiana, Mississippi, and Missouri. This area is vulnerable to periods of high night temperatures (HNT) because of its relatively high humidity. High temperatures are considered to be one of the major abiotic stresses affecting mid-south rice productivity. Periods of high temperature often coincide with the reproductive periods of common rice cultivars (Mohammed, 2009).

Abiotic (temperature, drought, UV-B radiation, and nutrient) stresses frequently result in the formation of ethylene, which is a naturally-occurring gaseous plant hormone. Moreover, it has been reported that high temperatures can up-regulate ethylene production and that ethylene is involved in production of reactive oxygen species (ROS), which are compounds that can trigger oxidative stress responses in plants (Christiansen, 1978). Increased production of ROS associated with increased ethylene production decreases membrane stability, thereby disrupting water, ion and organic-solute movement across plant membranes, and thus affecting carbon production (photosynthesis), consumption (respiration), transport and accumulation...
High Night Temperature and Invinsa...

(Hays et al., 2007). The ROS damage to the membranes can be repaired at the cost of plant energy, thereby increasing respiration rates of the plant. In addition, ethylene accelerates premature leaf senescence through enhanced production of ROS and decreased antioxidant enzyme activity, and it also plays an important role in abscission (shedding) of fruits (Kawakami et al., 2010).

Invinsa (1-methylcyclopropene, 1-MCP), is an ethylene perception inhibitor that acts by binding to the ethylene receptor, thereby blocking the ethylene binding sites (Sisler and Serek, 1997) that repress the plant response to ethylene for a period after application. Invinsa is an experimental agrochemical that is being tested to alter plant response to abiotic stresses. Current thought is that the repression of ethylene activity as a result of Invinsa application allows, among other effects, prolonged maintenance of photosynthetic activity relative to the stressed untreated plants. In addition, Invinsa is well-known to inhibit climacteric respiration (ripening stage associated with ethylene production and cell respiration) in some kinds of fruit, and can possibly inhibit a heat stress-triggered ethylene-induced respiration increase in vegetation.

At the Texas A&M AgriLife Research and Extension Center at Beaumont, we hypothesized that Invinsa can prevent the negative effects of HNT by decreasing the respiration rates and ethylene-induced ROS damage to the membrane and by increasing photosynthesis of rice plants. We conducted a study to determine the effects of HNT and Invinsa on rice leaf respiration rates, membrane stability, and photosynthetic parameters. Rice plants (variety Cocodrie) were grown under ambient night temperature (ANT) (77°F) or HNT (86°F) in the greenhouse. They were subjected to HNT through use of continuously controlled (+/- 0.5°F) infrared heaters, starting from 2000 h until 0600 h, 30 days after emergence (DAE). Plants were treated with Invinsa 30 DAE at the rate of 10 g active ingredient per hectare. The Invinsa was supplied courtesy of AgroFresh Inc. Leaf respiration rates, photosynthesis, stomatal conductance, and transpiration were measured using a LI-6400. Respiration was measured

Fig. 2. Effects of high night temperature and Invinsa on leaf photosynthetic parameters of rice plants.
High Night Temperature and Invinsa ...

during the night (from 2300 h to 0200 h) and the photosynthetic parameters during the day (from 1000 h to 1200 h). The leaf membrane stability was also measured and expressed as percent relative injury. All of the parameters were measured 40 DAE.

Our results indicated significant effects of night temperatures and Invinsa on the measured parameters. Increase in night temperatures increased respiration rates (20%), relative membrane injury (28%), internal $\text{CO}_2$ concentration (3%), and transpiration (12%) (Fig. 1 and 2). Invinsa-treated plants grown under HNT showed decreased respiration (5%) and relative membrane injury (9%), compared to untreated plants grown under HNT (Fig. 1). Invinsa-treated plants grown under ANT showed decreased respiration (3%), compared to untreated plants grown under HNT. An increase in respiration under HNT can decrease the availability of photosynthates to the grain. Increased relative membrane injury as a result of HNT can lead to leaky membranes thus affecting properties of the photosynthetic system, enzymes, transport of water, and ion and organic-solute movement across plant membranes, and thereby affect carbon production, consumption, transport and accumulation. Based on our results, we propose that Invinsa can limit heat-induced ROS-damage to the membrane and decrease the respiration rates, thus protecting cellular integrity, including the enzymes involved in the translocation of photosynthates, thereby increasing the availability of photosynthates to the grain.

For further information, please consult the following literature cited:


* Article by Dr. Abdul Razack Mohammed, Mr. Leon Carl Holgate, and Dr. Lee Tarpley, Texas A&M AgriLife Research and Extension Center at Beaumont. We appreciate the gift of Invinsa for testing purposes, as well as a generous gift in support of Dr. Tarpley’s Plant Physiology project, which were provided by AgroFresh Inc.

From the Editor ...

gas emissions, and identifying methods to control or mitigate emissions. One of the most important areas of research for our scientists is to develop production methods that increase economic profitability while promoting environmental sustainability. As our scientists explore how to further increase profitability, they work to provide an assessment of environmental impacts as well, as represented by this article.

Continued on the next page
The third article in this issue focuses on the evaluation of an experimental compound developed by AgroFresh Inc. to reduce the negative effects of high nighttime temperatures on plant stress. One of the main yield determining factors for rice (and other crops) is the occurrence of high nighttime temperatures, particularly during the reproductive stage of rice crop development. The effect of high nighttime temperature is most apparent by looking at the yields of rice grown in California compared to the other rice producing states (Fig. 1). Previous analyses suggest that the higher nighttime temperatures in Texas, for example, results in a 30% higher plant respiration cost compared to California, which increases spikelet abortion and reduces gulf coast main crop rice yields by 800-1600 lbs/ac (Wilson et al. 2006). Increased stress due to high nighttime temperatures can also compound injury from biotic stresses (insects, weeds, and disease) and further reduce yields. The research by Dr. Tarpley and his team has a goal of reducing the negative effects of nighttime temperatures and thereby increasing the yields of Texas rice growers.

This issue marks the 10th year of producing Texas Rice. The impetus for creating Texas Rice was the identification by the Texas rice industry of the need for a publication that provides access to on-going research by our scientists and access to relevant research by scientists in other states and nations. This represents our 99th issue of Texas Rice, including 10 issues of research highlights.

I would like to thank the Texas rice producers for their continuing support of our research program and for their often overlooked contribution to the research that we do. When I joined the Texas A&M AgriLife Center at Beaumont going on 12 years ago, I very much viewed growers as fitting in an easily defined box as being a recipient and user of research results. It wasn’t until I joined the Beaumont Center that I began to see that many of the best rice producers are experimenters in their own right and have played a major role in encouraging our scientists to explore research topics that contribute to the fundamental understanding of what makes a rice plant grow the way it does and produce a high or low yield in response to abiotic and biotic stresses. Thanks for making me part of the research learning process.

I would also like to acknowledge each of the scientists who have worked so hard to generate articles for Texas Rice. I would particularly like to acknowledge the tremendous work by Dr. Omar Samonte, who as the Texas Rice Technical Editor has played a pivotal role in maintaining the quality of this publication, in many cases by researching and writing key papers, including the one in this issue on Apomixis, and by working with our scientists to encourage them to produce quality papers for Texas Rice.

Best wishes for a Merry Christmas and a happy
From the Editor ...

new year with your family and friends. Also, please continue to send me your suggestions and comments.

Cited References


Sincerely,

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

Rice Crop Update

As of November 15, 2010, about 69.9% of the ratoon rice crop acreage in Texas had been harvested. In comparison, about 72.6, 86.9, 68.1, and 49.4% had been harvested as of November 15 in 2006, 2007, 2008, and 2009, respectively (Fig. 1).

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.

Fig. 1. Comparison in percentage of ratoon rice crop acreage in Texas that had been harvested by November 15 in 2006 to 2010.