The prevailing water crisis in rice growing countries becomes more alarming particularly with the continuous increase in human population and decrease in agricultural land. With the decline in the already limited water available for rice production, there is a need to adopt water-saving measures for rice production in order to meet the challenge faced by billions of people that rely on rice as food and livelihood.

Aerobic Rice Technology (ART) and controlled irrigation are currently promising technologies for rice production in the tropics. ART involves growing drought tolerant rice varieties (e.g., NSIC Rc-192 in the Philippines) in non-flooded and non-puddled soil in water-scarce areas, such as rainfed, upland (Fig. 1) and tail-end portions of irrigated fields, and providing appropriate cultural management practices. Aerobic rice was first introduced in the Philippines by the International Rice Research Institute (IRRI) in 2000. Various research and demonstration farms have shown favorable impacts through 1) low input requirements, 2) ease of production (less labor requirement), 3) competitive yield, 4) higher income for farmers, 5) early establishment which can improve farm productivity, and 6) competition against weeds. In the Philippines, where there are wet and dry growing seasons, ART is adapted in rainfed areas that are generally productive only during the rainy season but left idle during the dry season. Aerobic rice enables the growing of a second crop during the dry season in rainfed areas following harvest of the first crop, which is produced during the wet season. Rice production and cropping intensity is improved even with the limited water resources in the area. When aerobic rice grain yield is compared to other rice cultures, the respective grain yields produced from wet and dry seasons season are 6,180 and 6,740 lb/acre for irrigated rice, 4,831 and 3,820 lb/acre for ART, 5,050 and 0 lb/acre for rainfed rice, and 2,250 and 0 lb/acre for upland rice. During the dry season, rice is not grown in upland and rainfed cultures, while intermittent irrigation (30 to 50%
Welcome to the August issue of Texas Rice. It is with great sadness that I convey Dr. Toni Marchetti’s passing. Toni passed away on September 9, 2011, due to a lengthy bout with cancer. Toni retired in January 2001 from USDA-ARS at Beaumont, after having worked at our Center for 31 years, and after having had a long and rewarding career in plant pathology. I had the pleasure of working with Toni on two plant pathology projects in the late 1990s. Without his expertise, I don’t think we would have gotten these projects off the ground. Toni was an old school plant pathologist. His knowledge of rice blast specifically and rice diseases in general far exceeded that of anyone I have ever met. While others might now know more about which markers and in some cases genes are associated with which symptoms, Toni knew far more about factors affecting disease progression and the inheritance of plant varietal resistance.

A number of traits and events come to mind when thinking of Toni. As a scientist, Toni was extremely hard working and was willing to help any scientist who was willing to work as hard as he was. As an entertainer, Toni and his barbershop quartet made us laugh each year for a number of years at our Christmas luncheon with their oldies but goodies and great one-liners. One event specifically comes to mind involving Toni. Shortly after Toni retired, he was given a nail gun as a present. I remember the profound joy he showed using that nail gun on different woodworking projects. I think the woodworking allowed Toni to move a bit closer to some of his family roots. Toni could have just as easily started a lumber business, which is where he worked for his uncle during his free time as a high school student. Although Toni never gave up his love for woodworking, thank God he decided that working in science was his calling. Please remember with me Toni’s strong support of the Texas and U.S. rice industry and the lasting friendships he made through the years.

This issue of Texas Rice has three articles. The lead article provides an overview of the current status of aerobic rice research being conducted by Dr. Junel Soriano with the Bulacan Agricultural State College in the Philippines. Research by Junel and others in the Philippines strongly suggest aerobic rice production can be economically profitable in the Philippines and allows production during the dry season in areas where water is normally insufficient to allow a dry season flooded rice crop. Although aerobic rice production is currently not economically feasible in the U.S., given rice production costs and the value of rice in our country (Illukpitiya et al. 2009), we might need to rethink this issue if water supplies become any tighter. Junel is currently visiting the Beaumont Center where he is working with Dante Tabien and Fugen Dou. Together they are conducting research on the effects of aerobic and conventional rice production on greenhouse gas emissions, inorganic soil nitrogen, and soil texture.

The second article in this issue is by Mo Way and focuses on soybean production and management in the Texas Gulf Coast. One of the most important take home messages that Mo provides is his statement that a good soybean producer has to actively manage the crop in order to achieve high yields and strong profits.

Continued on page 10
Current Issues in Soybean Insect Management on the Gulf Coast of Texas

Soybeans can be grown profitably in rotation with rice in Southeast Texas. However, soybean farmers must manage their crop similar to rice farmers. This means proper land selection (i.e., do not plant soybeans on marginal lands) and preparation, selection of the appropriate variety to plant on the optimum planting date, and the management of weeds, diseases and insect pests. Planting soybeans on beds allows for better drainage and helps capture and retain moisture where needed - in the root zone. In addition, timely irrigation using beds and furrows can pay off handsomely. In fact, the average yield of irrigated soybeans grown in Texas is 43 bushels per acre compared to non-irrigated soybeans, which is only 25 bushels per acre (data based on 2005-2008 yields taken from Texas Agricultural Statistics). For Southeast Texas, a soybean farmer may only have to irrigate a few times - a timely irrigation at a critical growth stage can make the difference between a profitable and non-profitable crop. So, if a farmer is considering planting and achieving consistent success in growing soybeans in Southeast Texas, he/she must adopt the mind-set of a risk-aversive rice farmer and be willing to put in the time, effort, and money.

A critical component in successful soybean production is effective insect pest management, which is largely based on the agronomic practices employed by the farmer. Soybeans grown on the Upper Gulf Coast of Texas (Texas Rice Belt) are attacked by a variety of insects that can reduce yield and seed quality, and cause a delay in maturity (Gouge et al., 1999). These insects feed on all plant parts including roots, stems, petioles, leaves, buds, flowers, pods, and seeds (Steffey et al., 1994). Thus,
farmers need to scout soybeans for insect pests from planting to near harvest. Too many soybean farmers in Southeast Texas do not scout often or thoroughly enough which is particularly critical to successful management of the caterpillars and stink bugs that attack the soybean foliage and reproductive organs (flowers, pods and seeds), respectively. Because of our hot humid climate, soybean insect pests in Southeast Texas can build up to damaging levels in a relatively short period of time, and this increases the importance of scouting. A wise soybean farmer once said, “The best thing you can put on your soybean crop is your shadow!”

Most soybeans in Southeast Texas are grown according to the Early Soybean Production System (ESPS), which has important insect management implications (Heatherly and Bowers, 1998). Basically, ESPS involves planting a relatively early maturity group (MG IV) soybean in March or April. The theory behind ESPS is these early-planted and early to mature soybeans reach the critical podfill stage in June or July when soil moisture is still sufficient to provide enough water to completely fill the seeds in the pods. Typically, the Southeast Texas climate in August is very hot and dry leading to lack of soil moisture during podfill, especially with the late-planted and late maturing soybeans. Generally, foliage feeding caterpillars (velvetbean caterpillar, green cloverworm, and soybean looper) infest the crop late in the season (late August to September) when ESPS soybeans are no longer susceptible to defoliation or are harvested. Thus, ESPS soybeans frequently avoid damaging caterpillar defoliation. During this critical podfill stage, late maturing soybeans can tolerate about 20% defoliation (Gouge et al., 1999). Way has observed commercial fields of late maturing soybeans (MG VII/VIII) go from near 0 to virtually 100% defoliation in a matter of a week or less. Again, scouting during this time is crucial to effective management of caterpillars. Sometimes an epizootic of an entomofungus, *Nomuraea rileyi*, will attack these caterpillars and reduce their numbers dramatically, but usually the epizootic begins after significant defoliation has already taken place (Carner, 1980). Many insecticides are very effective against these insects. For further information on the choice of insecticides to apply for defoliator pests, contact Dr. Way at 409-658-2186 or at moway@aesrg.tamu.edu. We are in the process of helping to revise and update Bulletin-1501, which is on Managing Soybean Insects. This extension publication will be available no later than 2012 and will include the latest information on the biology, ecology, and management of all the insects attacking soybeans in Texas.

Fig. 3. Suhas Vyavhare with cage for redbanded stink bug density/damage study.

Fig. 4. Eggs and newly emerged nymphs of redbanded stink bug.
Although ESPS soybeans usually avoid insect defoliator problems, they are typically susceptible to a complex of stink bugs which have sucking mouthparts. These insects suck the juices from developing soybean reproductive organs and cause yield and quality loss, including decrease in germination of seeds destined for planting the following year (McPherson and McPherson, 2000). In addition, severe damage can result in delayed maturity. Affected soybean plants remain green and pliant which prevents or hampers harvesting operations. Dr. Way has observed commercial fields of soybeans that were abandoned because stink bug damage was too severe, that is, the pods were completely unfilled and plants were not mature enough for harvest (Figs. 1 and 2). The stink bugs primarily responsible for this damage are southern green stink bug, green stink bug, brown stink bugs, and a recent introduction, redbanded stink bug (RBSB). The RBSB is neotropical in origin and has increased in importance in the Southeast United States during this decade (McPherson and McPherson, 2000). No solid information exists regarding treatment thresholds for RBSB, so soybean entomologists are using the treatment thresholds for the other stink bugs, which is about 3 adult stink bugs per 10 consecutive sweeps of a sweepnet (Gouge et al., 1999). Again, many insecticides are effective against stink bugs, but insecticides with residual activity are preferred because stink bugs can re-infest soybean fields after contact insecticides “wear-off”. Multiple applications of insecticides may be required for effective and profitable control of stink bugs. Contact Dr. Way for additional information on insecticidal control options. In summary, ESPS soybeans generally avoid defoliator caterpillar damage, but are prone to stink bug damage. Another advantage of the ESPS is harvest generally occurs before the onset of cool and rainy weather which hampers harvesting operations. However, farmers growing soybeans east of Harris County (Chambers, Jefferson and Liberty Counties) report that ESPS results in relatively low yields and poor seed quality. For this region, MG V/VI soybeans planted in May seem to consistently perform better than ESPS soybeans.

Other insect pests attacking soybeans grown in Southeast Texas are lesser corn stalk borer (larvae feed on roots and crowns of seedlings and young plants), thrips (immatures and adults feed on foliage and leaf and flower buds), three-cornered alfalfa hopper (nymphs and adults girdle stems and petioles); banded cucumber beetle (adults feed on foliage), blister beetles (adults feed on foliage and are often found in high numbers near the margins of fields), grasshoppers (adult and nymphs feed on foliage), garden webworm (larvae feed on foliage of young
Soybean Insect Management ... 

plants), grape colaspis (adults feed on foliage), and bean leaf beetle (adults feed on foliage) (Steffey et al., 1994; Way, 1994). In addition to these pests, soybeans harbor many beneficial insects and spiders (Yeargen, 1994). Some of the more voracious predators are spiders, minute pirate bugs, big-eyed bugs, assassin bugs, adults and larvae of lady bird beetles, lacewing immatures (resemble small alligators with visible hooked mandibles), nabid bugs, ground beetles, dragonflies, damselflies and predaceous stink bugs. Many wasps also can be found parasitizing different selected insect pest stages. In addition, frogs and birds, such as swallows, have been observed feeding on caterpillars and other insects in Southeast Texas soybean fields.

Current soybean research at the Beaumont Center and in selected commercial fields in Southeast Texas is concentrating on RBSB and its management. With support from the Texas Soybean Board and selected agrichemical companies, Suhas Vyavhare, a PhD student in the Department of Entomology at Texas A&M University, has embarked on a research program including the following objectives: 1) determine densities and timings of infestation of the RBSB responsible for damage measured in terms of yield, quality and germination reduction, 2) expand the knowledge of the biology/ecology of the RBSB including overwintering and weed host preference, 3) identify a possible agent introduced into the soybean plant by the RBSB, which causes flat pod syndrome (seeds in pods do not fill), 4) evaluate selected germplasm for resistance/tolerance to RBSB and 5) evaluate insecticidal options, including seed treatments, for control of RBSB (Fig. 3 - 6).

For more information, please consult the following references:


Aerobic Rice ...

less than irrigated rice) using shallow tube wells or farm waters reservoir is applied to aerobic rice. In total, the annual rice grain yield produced is 12,920, 8,651, 5,050, and 2,250 lb/acre for irrigated, aerobic, rainfed, and upland rice, respectively.

In 2004, an Aerobic Rice Program was initiated at the Bulacan Agricultural State College (BASC) in the Philippines, with the goal of producing grain yields of 4,500 to 6,700 lb/acre in water scarce areas. ART was implemented in 10 provinces covering 29,640

Continued on the next page
acres with 5,000 rice farmer adoptors as of July 2011, in partnership with 9 state colleges and universities, 10 government organizations, 15 local government units, and 5 non-government organizations. The technology has shown potentials to increase rice production and to use rain and irrigation water efficiently. This production system has the potential of reducing water requirements in the Philippines, compared to an irrigated system, by up to 50% without significant reduction in grain yield. In selected rainfed areas, ART assures the growing of two crops of rice per year. This method saves water by 1) eliminating continuous seepage and percolation, 2) reducing evaporation, and 3) eliminating wetland preparation. BASC, along with stakeholders, is continuously working to further develop and disseminate aerobic rice technology throughout the Philippines. The First Aerobic Rice National Conference, which was held on 23-25 February 2010 at Puerto Princesa City in the Philippines, had as a major objective identifying future directions of and challenges to aerobic rice research, development, and extension. Participants from the Department of Agriculture-Regional Field Offices, higher education institutions, national and international research agencies, private institutions, local government units, farmers, and other government agencies who attended the Conference endorsed a joint resolution sent to concerned government agencies for the nationwide implementation of ART and funding consideration.

Dr. Junel B. Soriano, who is an Associate Professor and Vice President for Research, Extension, and Training of BASC is an ART expert and is currently working at the Beaumont Center through a six-month fellowship supported by the Fulbright – Philippine-American Educational Foundation. Together with Drs. Fugen Dou (soil scientist) and Rodante Tabien (rice breeder), Dr. Soriano is conducting research on greenhouse gas emissions, water use, dissolved organic matter and inorganic nitrogen under different water regimes, soil textures and rice varieties (Fig. 2). In addition to the Fulbright Scholarship Program and the Beaumont Center as the host institution, his research is being supported by the Department of Agriculture-Bureau of Agricultural Research in the Philippines, and the International Rice Research Institute.

The study of ART is very timely as Texas is suffering its worst drought on record. ART can be explored through research and development in the rice growing states of U.S., particularly in areas where water scarcity negatively affects rice production. The rice varieties and management practices used in this system are two of the most important issues since currently used varieties and production practices were originally developed for irrigated and flooded production systems. A variety that can withstand soil moisture levels slightly below field capacity for 3 to 5 days is desirable. Initially, traditional upland rice varieties are grown under aerobic production, but ART-bred varieties would have to be developed, with the goal being to obtain stable yields in water-limited environments. ART technology has potential, and a comprehensive research program is needed to serve the demand for increased rice production in
Wireless sensing networks (WSNs) are used in a variety of applications in diverse fields that include agriculture. They are used to monitor livestock, grazing patterns, and environmental parameters for crop production. Knowledge of environmental parameters, such as temperature and moisture of soil and air, is critical for crop production. In situ (in-the-site or field) data acquisition without WSNs is difficult and laborious, so many producers plan their management practices based on local weather station data. For environmental parameters, such as soil and air temperatures and moistures, the data acquired from a nearby weather station is potentially different from in situ field conditions. The WSN provides an easy and rapidly-deployed, and potentially more accurate way of monitoring and recording environmental parameters affecting crop production in particular fields.

At the Texas A&M AgriLife Research and Extension Center at Beaumont, Texas, a WSN was set up to aid in monitoring soil and air temperature and soil moisture in a flax field in 2011. The objective of this study was to monitor in situ field conditions with assistance from the WSN (in situ WSN data) and compare the data against the local weather station data for possible inaccuracies or differences. The network consisted of HOBOnode™ temperature (soil and air) and soil moisture sensors and aerobic rice in the tropics while utilizing the limited water that is available for irrigation. * 

*Article by Drs. Junel B. Soriano, Fugen Dou, Rodante E. Tabien. Dr. Soriano works for the Bulacan Agricultural State College in the Philippines, while Drs. Dou and Tabien work for the Texas A&M System AgriLife Research and Extension Center at Beaumont, Texas.

### Table 1. Soil and air temperatures recorded using a wireless sensor network (WSN) and a local weather station for March and April in 2011.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Location</th>
<th>March Temperature (°F)</th>
<th>April Temperature (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Day</td>
<td>Night</td>
</tr>
<tr>
<td>Soil temperature</td>
<td>WSN at Flax field</td>
<td>68.56 ± 0.78</td>
<td>68.97 ± 0.71</td>
</tr>
<tr>
<td>Soil temperature</td>
<td>Local weather station</td>
<td>66.02 ± 0.86</td>
<td>65.86 ± 0.87</td>
</tr>
<tr>
<td>Air temperature</td>
<td>WSN at Flax field</td>
<td>68.78 ± 1.12</td>
<td>60.42 ± 1.64</td>
</tr>
<tr>
<td>Air temperature</td>
<td>Local weather station</td>
<td>67.25 ± 1.16</td>
<td>61.12 ± 1.50</td>
</tr>
</tbody>
</table>

*Table 2. Statistical significance of temperature differences between in situ wireless sensor network (WSN) and local weather station recorded for March and April 201. The $p$-values were obtained using the Wilcoxon Matched-Pairs Signed-Ranks Test of daily averages. A $p$-values < 0.05 indicates significant differences between temperatures obtained from the in situ WSN and the local weather station.*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>March Temperature (°F)</th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Day</td>
<td>Night</td>
</tr>
<tr>
<td>Soil temperature</td>
<td>p &lt; 0.001</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td>Air temperature</td>
<td>p &lt; 0.001</td>
<td>p &lt; 0.010</td>
</tr>
</tbody>
</table>
(Onset Computer Corp., Bourne, MA), a HOBOnode™ repeater (Onset Computer Corp.), HOBOnode™ receiver (Onset Computer Corp.) and a computer (Fig. 1). The WSN sensors were tested against standard temperature and humidity sensors (standalone sensor/loggers [HOBOs, Onset Computer Corporation], thermometer, tensiometers) and shown to be accurate in comparison. The network operates on the Industrial, Scientific and Medical (ISM) radio band on a 2.4 GHz frequency, which does not interfere with GPS systems (Do et al., 2004). The sensors periodically transmit the signal wirelessly to the receiver via the repeater. The receiver is directly connected to the computer via a USB cable. Data are recorded and stored and can be retrieved and analyzed when needed. At close range (1,400 ft or less), the sensors can directly communicate with the receiver. However, if the distance between the sensors and the receiver is greater than 1,400 ft, a repeater is needed to transmit the signal from the sensors to the receiver. The repeater can send signals to the receiver up to a distance of one mile.

In our field study, soil temperature and moisture sensors were placed 6 inches deep in the soil, between rows of flax plants. Air temperature sensors were placed 3 feet above the ground (on PVC stakes) and inside a solar shield to protect them from direct sunlight. This WSN did not include sensors to measure air moisture; however, additional devices were placed in the flax field to measure air moisture. The temperature data (soil and air) obtained through the WSN was compared to the data acquired from the Center’s local weather station (0.6 miles from the flax field) and is presented in Table 1. The statistical significance of temperature differences between the in-field sensors (WSN) and the local weather station sensors were analyzed and the p-values obtained using the Wilcoxon Matched-Pairs Signed-Ranks Test of daily averages. A p-value < 0.05 indicates significant differences between temperatures obtained from the in situ WSN and the local weather station. The possible lag in air temperature at the local weather station was not analyzed.
Ranks Test (Table 2).

Results from our study indicated differences between the field (WSN) and the local weather station with respect to soil temperature (day and night) recorded for March and April 2011. On average, soil temperatures (day and night) recorded by the WSN were 2.5 and 3.0°F higher, respectively, than the temperatures recorded by the local weather station for March and April (Table 1). There were also differences between the field (WSN) and local weather station for air temperature (day and night) for the month of March (Table 2). On average, the day temperature for April recorded by the WSN was 2°F higher, compared to what was recorded by the local weather station (Table 1). In many crops, an increase in air temperature by 2°F can decrease yield. For example, in rice and cowpea, a 2°F increase in air temperature above the optimum temperature can decrease rice yield by 10% (Peng et al., 2004) and cowpea yield by 4.4% (Hall, 1993). In bean, a 2°F decrease in air temperature below the optimum temperature can decrease yield by 6% (CIAT, 1979).

In conclusion, the data monitored and recorded with the assistance of the WSN was different from data recorded by the local weather station. The WSN setup facilitates accurate measurements of environmental parameters at the target locations, thus providing the basis for appropriate management practices for the target location. Although the example presented in Table 1 was provided as a monthly average, more finely resolved time courses, such as diurnal patterns, can be easily extracted from the stored dataset. Figure 2 illustrates the diurnal patterns of soil and air temperatures recorded through WSN and the local weather station.

Please consult the following references for more information:


* Article by Mr. Leon C. Holgate, Dr. Abdul Razack Mohammed, and Dr. Lee Tarpley. Drs. Mohammed and Tarpley work at the Texas A&M AgriLife Research and Extension Center at Beaumont, TX, while Mr. Holgate is a former research associate at the Beaumont Center. For more information, please contact Leon Holgate (leonhlgt@gmail.com) or Dr. Lee Tarpley (ltarpley@tamu.edu).

Editorial ...

A tendency is to plant soybeans on the flat. This works fine when rainfall is adequate. However, when rainfall is scarce supplemental irrigation is needed, and when rainfall comes down in buckets planting on the flat does not provide sufficient drainage and the soybean plants die as a result of the flooding. While soybeans require less time and effort to manage than rice, a properly managed soybean crop still requires major effort. Reiterating the quote from Mo Way’s article, “The best thing you can put on your soybean crop is your shadow”.

The third article provides a summary of research conducted by Lee Tarpley and his lab on the use of wireless sensing networks. Instead of using hardwired sensors that are connected to data-loggers...
As of August 15, 2011, about 70% of the main rice crop acreage in Texas had been harvested (Fig. 1). In comparison, about 67, 33, 54, 49, and 50% were harvested as of August 15 in 2006, 2007, 2008, 2009, and 2010, 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.

I hope you enjoy this issue of Texas Rice. Please come and see us the next time you visit Beaumont, Texas.

Reference:

Sincerely,

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

Rice Crop Update

As of August 15, 2011, about 70% of the main rice crop acreage in Texas had been harvested (Fig. 1). In comparison, about 67, 33, 54, 49, and 50% were harvested as of August 15 in 2006, 2007, 2008, 2009, and 2010, respectively.

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