CLEMSON
PRECISION AGRICULTURE

Precision Agriculture Newsletter

Editor: Michael Plumblee | **Edisto REC, Blackville, SC** | **February 2019**

From the Editor:

We hope that everyone has had a great holiday season and that 2019 is off to a great start. I am sure that many of you, like myself, are hopeful that the excessive rainfall we have received throughout harvest of 2018 will subside in 2019 to allow fertilizer spreading and planting to begin.

Planning and land preparations for the upcoming growing season have now begun at Edisto REC in addition to equipment servicing, shop renovations, and fabrication on new projects. To recap the last few months our annual Forage Bull Test sale at EREC was held on October 13th and was a great success with 42 bulls sold for an average sale price of $2,795. The class of 2019 bulls have arrived at EREC and appear to be on their way to another successful bull test. Furthermore, the SC Certified Crop Advisers annual meeting was held in Santee from November 13-15 where good information was exchanged between many Clemson specialists, consultants, and industry personnel.

Clemson University in partnership with the South Carolina Soybean Board, South Carolina Department of Agriculture, and the South Carolina Farm Bureau hosted the 2nd annual Corn and Soybean Growers meeting in Santee on December 6th. Researchers from the University of Arkansas, The Scoular Company, and Clemson University made presentations. The State Cotton Meeting on January 22nd and the State Peanut Meeting on January 24th in Santee hosted by the SC Cotton Board, Clemson Extension, the SC Peanut Board, and National Peanut Board, respectively were also successful this year. Several presentations from industry, academia, and Clemson were presented. If you were not able to attend one or more of these meetings and would like more information on topics discussed please let us know.

Over the last several months the Clemson Precision Agriculture group has been redesigning the Clemson Extension – Precision Agriculture website. Upon completion of the new website we hope to provide you with a way to access information regarding precision agriculture, extension bulletins, online calculators, publications, archived newsletters, and other relevant information. You can access our new website at: https://www.clemson.edu/extension/agronomy/PrecisionAgriculture/index.html

Happy New Year from Clemson Precision Ag!

Over the last two months several winter, county and statewide meetings have been held. If we did not get to see you at these meetings we hope to see you in the future. If there is anything we can do precision agriculture related especially as we move into spreading fertilizer and planting please do not hesitate to contact your local extension agent or the Clemson Precision Agriculture program.

Happy Planting,
Michael Plumblee

In This Issue

Determining Soil Moisture Sensor Thresholds in Cotton

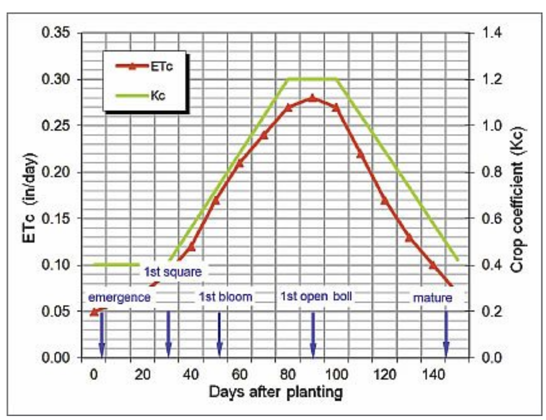
Author: Michael Plumblee

Cotton is one of the major row crops grown in South Carolina, with an average of 233,000 acres of cotton being planted from 2008 to 2018 (USDA-NASS, 2018). Although cotton has historically been associated with being a drought tolerant crop when compared to other crops like corn, cotton can have a positive yield response to irrigation. A survey conducted in 2012, reported that approximately 10% of the cotton acreage in South Carolina was irrigated equating to around 25,000 acres (USDA – NASS, 2018). While 10% may seem minimal compared to other crops such as corn, it is probable that the percentage of irrigated cotton acreage has increased since 2012. Cotton growers within the state are applying on average 6 acre-inches of water to cotton annually, therefore the amount of water used to irrigate cotton each year is something to be aware of but not alarmed by (USDA-NASS, 2018). In South Carolina, approximately 38% of our irrigation water is derived from surface water reservoirs and the remaining 62% is withdrawn from one of the six major underground aquifers present in our state (SC DNR Water Assessment). Typically, surface water is more common as we move into the Piedmont and Upstate regions whereas groundwater wells are more common in the coastal plain.

Until recently, water regulation in South Carolina has been localized to areas along the coast with municipalities and industries in larger cities. Since the 1960's and revised in the early 2000's state law in SC requires water users to have a permit for wells that withdraw more than 3 million gallons in one month which is approximately one inch of water per week on 28 acres in a given month (SC DHEC). The majority of our agricultural wells are permitted due to the size and volume of water being pumped annually. These permits define how much water is allowed to be withdrawn from that particular well annually. In November of 2018, South Carolina DHEC unanimously voted to begin to regulate the permits and permitted values associated with groundwater wells in seven counties; Aiken, Allendale, Barnwell, Bamberg, Calhoun, Lexington, and Orangeburg. This area is known as the Western Capacity Use Area. (See link below) https://www.scdhec.gov/environment/water-quality/groundwater-use-reporting/groundwater-management-planning/groundwater.

While they have begun the discussion of how regulation will be structured there are many questions left to be answered, some of which were answered at public meetings held by Clemson University and DHEC throughout the state in January and February, 2019. As we move forward, DHEC has made it clear that they are willing and want to work with SC water users.

When determining how and when to apply water to any crop, several questions often arise. How much water does a particular crop need? When do I need to apply the water? How do I account for rainfall in my irrigation schedule? All of these questions are important. Understanding crop water use will assist with making educated irrigation decisions. When using supplemental irrigation in crop production the goal should be to maximize net returns while using the least amount of water to do so (i.e., increase irrigation water use efficiency). Cotton in particular, has a crop water use curve that follows a bell-shaped curve (See curve below). Water use is relatively low until cotton beings to square and begin reproductive growth. Typically, water use/demand from planting to first bloom is met with rainfall in the southeast.



Cotton - Crop Water Use Curve (*Cotton Inc*.)

As reproductive growth begins, water use in cotton continues to increase until shortly after full bloom; at this point it then begins to decrease through maturity.

After understanding key cotton growth stages where water is important (i.e., square through bloom), utilizing an irrigation schedule to know when to apply water to the crop is essential. Benefits of irrigation scheduling include meeting the crop water demand at the right timing. We can also reduce the likelihood of stressing the plants. Often times when visual drought stress occurs, yield has already been lost. Furthermore, reducing over-watering, maximizing yield, and maximizing profit are all benefits of following an irrigation schedule. In 2012, the USDA conducted a survey known as the Census of Agriculture where 1,046 farms in South Carolina participated. From the farms surveyed it was reported that 6% of these farms used soil moisture sensing devices to decide when to irrigate, 3% reported that they use an evapotranspiration (ET) checkbook method to decide when to irrigate, and the remaining respondents reported that they decide when to irrigate based on the condition of the crop, feel of the soil, or calendar date. While the latter methods could assist irrigators in knowing when to apply water to crops, these methods are rarely repeatable and often do not take into consideration the most economical way to irrigate. Furthermore, some of the benefits in incorporating soil moisture sensors into a production system include monitoring soil moisture in real-time and site-specific to the field, helping determine water sensitive periods throughout the growing season where water use is high. The soil moisture sensors also provide the ability to quantify the amount of rainfall that actually enters the soil and into the rooting zone for any given rainfall event.

There are currently two main categories of soil moisture sensors being utilized to schedule irrigation: 1) soil tension (e.g., Watermark) and 2) volumetric (capacitance) sensors. While both types of sensors can be used to schedule irrigation, differences between the two types can be observed, which include price, accuracy, annual fees, and installation. A comparison of the two main types of soil moisture sensors are displayed in Table 1. After selecting a soil moisture sensor to use, several important decisions need to be made:

- Where to place the sensor within the field?
- How many sensors to place in a field?
- How deep to bury the sensors?
- Do we place the sensor within the row or row middle?
- What threshold value do we use to initiate an irrigation event?

All of these are great questions and common questions that we receive when discussing soil moisture sensors.

Table 1. Comparisons of Soil Tension and Volumetric Soil Moisture Sensors

	Soil Tension	Volumetric
Price	**>$50 each**	**<$500 each**
Accuracy	**Relative Soil Moisture**	**Absolute Soil Moisture**
Reading Depth / Sensor	**1 Sensor = 1 Depth**	**1 Sensor = Multiple Depths**
Threshold	**One Value to Interpret**	**Multiple Values to Define**
Annual Fees	**Varies**	**Varies**
Installation	**Slurry Needed**	**No Slurry Needed**
Technical Support	**Limited**	**Varies**

General recommendations for installation and placement of soil moisture sensors are as follows. In regard to how many soil moisture sensors do you need, typically at least one sensor or set of sensors per irrigation management zone are needed. By at least incorporating a sensor or sensor set within each irrigation system the irrigator will be able to manage soil moisture and make decisions more consistently and accurately than if no sensors are being utilized. When deciding how many sensors to use it may be worthwhile to consider differences in soil texture. If substantial soil texture changes occur within the field and the option to manage each zone independently (variable rate irrigation) exists then consider incorporating more than one sensor or sensor set. Another consideration would include determining how long it takes to apply irrigation. For example if you have several hundred acres under one center pivot and it takes 3 days to apply 0.75 inches of water then you may want to consider installing a set of sensors at the beginning and end of each irrigation cycle. In theory, by incorporating sensors at the beginning and end of each irrigation cycle you can evaluate soil moisture at the start and stop of each irrigation. By having this data the irrigator can then determine whether they can afford to stop the center pivot or if they need to immediately start another irrigation cycle. An example of sensor placement follows in Figure 1, where the star symbols represent a sensor or sensor set placement.

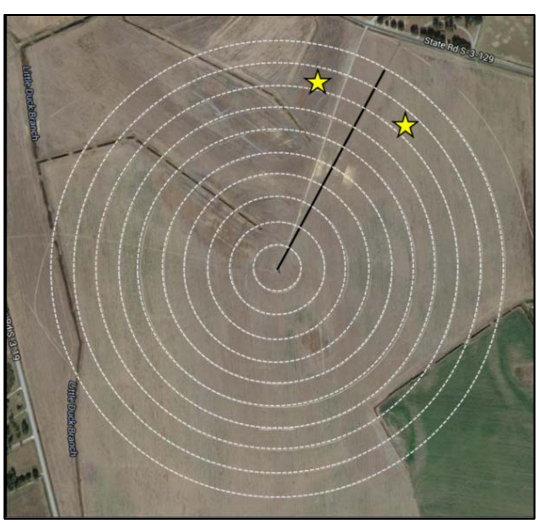


Figure 1. Example of Sensor Placement

Other sensor placement considerations include topography of the field, crop stand, representative yield potential, avoiding traffic rows, and consider placing sensors away from the end gun and center point on center pivots. With regards to sensor depth, crop type usually determines sensor depth due to the differences in rooting depth by crop. However, sensors should be installed deep enough into the rooting zone to effectively manage soil moisture that will be utilized by the crop. For cotton, typical maximum sensor depths range from 24 to 36 inches.

Sensor threshold value determination is essential for maximizing profit and irrigation water use efficiency. A threshold value is defined as the value at which an irrigation event is initiated. Threshold values may vary by crop and by soil texture, thus research to define optimum thresholds are often needed. To determine sensor thresholds three soil-related characteristics must first be defined. ***Field Capacity*** is the amount of water remaining in the soil after being wetted and after free drainage has ceased. ***Permanent Wilting Point*** is the water content of the soil when most plants fail to recover their turgor upon rewetting. ***Plant Available Water*** is the portion of the water that can be absorbed by plant roots. By understanding these terms threshold values can then be understood and determined. Typical manufacturer recommendations for volumetric soil moisture sensors suggest that irrigation be initiated when plant available water has been depleted by 25 to 50%, thus soil texture and water holding capacity are important when using these sensors. An example of plant available water depletion is shown in Figure 2. With soil tension-type soil moisture sensors, a threshold value can be utilized by knowing your soil texture, how much plant available water you wish to deplete, or by utilizing an established threshold recommendation. The Irrometer threshold recommendation chart is shown in Figure 3.

To better understand how to use soil moisture sensors to schedule irrigation in cotton, a research trial was initiated in 2018 at Edisto REC. The objective of this research was to determine a sensor threshold value in cotton that maximized net return and maximized irrigation water use efficiency.

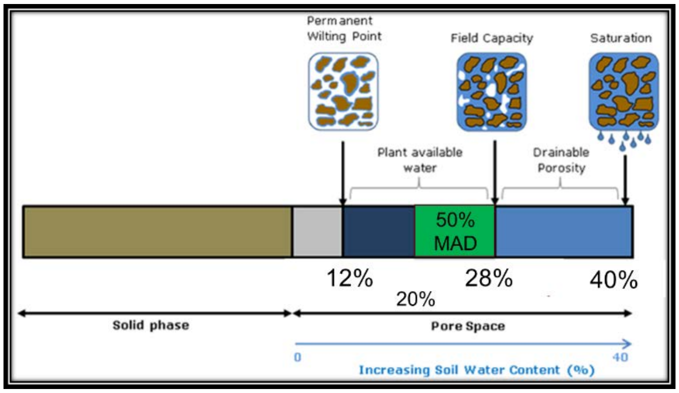


Figure 2. Example of 50% Plant Available Water

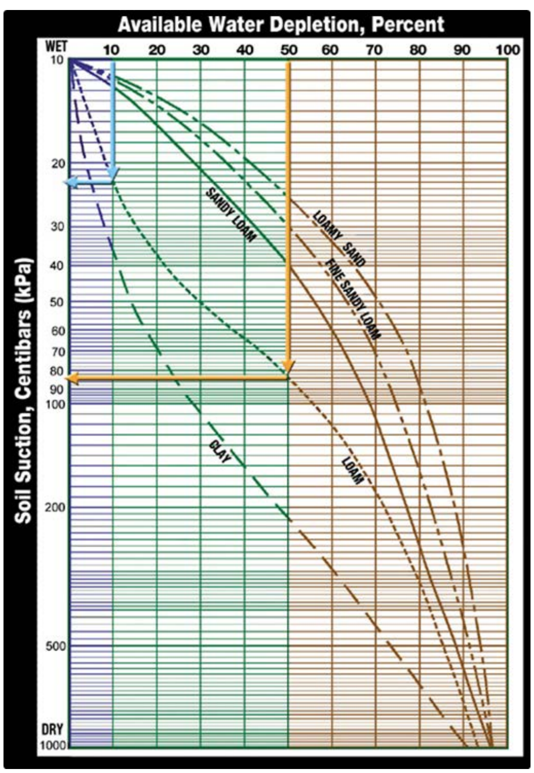


Figure 3. Irrometer Threshold Recommendations

Materials and Methods

This research was conducted at the Edisto Research and Education Center in Blackville, SC. Deltapine 1538 B2XF was planted into a Wagram loamy sand on May 10 and harvested Oct. 4. Plots consisted of 32-row, 38-inch spaced rows that were 200 ft in length and replicated four times. Watermark 200SS soil moisture sensors were installed at depths of 6, 12, and 24 inches within the planted row. Sensors were checked three times each week and irrigation applications were made accordingly. Treatments consisted of season-long threshold values of -15 kPa (25% Maximum Allowable Depletion (MAD)), -30 kPa (50% MAD), and -60 kPa (75% MAD). Non-irrigated plots were included for comparison purposes. Data that were collected throughout the growing season consisted of plant height, total nodes, and nodes above white flower at first bloom; plant heights, total nodes, and nodes above cracked boll at first cracked boll; lint yield, turnout, and fiber quality; and total water applied.

Results

Rainfall in 2018 was above the 108 year average in May, July, September, and October, thus 2018 was considered a wet year (Figure 4). No significant differences in any plant growth measurements that were taken throughout the growing season were observed between irrigation treatments. Overall sensor thresholds of -15 kPa triggered irrigation five times, -30 kPa triggered irrigation two times, and -60 kPa triggered irrigation two times (Table 2). When comparing lint yield across sensor threshold treatments no significant differences in lint yield were observed (Figure 5). These results were likely a product of the ample rainfall we received in the 2018 growing season. Sensor threshold values of -30 and -60 kPa both had greater irrigation water use efficiency (IWUE) than the -15 kPa threshold value (Figure 6). These data suggest that the -15 kPa treatment may have been too aggressive and these plots may have been over-watered since the quantity of lint per unit water (lb-lint/acre-inch water) was lower than both the -30 and -60 kPa thresholds.

When considering net returns above irrigation costs and IWUE, the -30 kPa threshold value appeared to have the greatest value in 2018 (Figure 7). In conclusion, soil moisture sensors appear to effectively schedule irrigation in cotton in soil textures commonly found in South Carolina. In 2018, a weighted average threshold value of -30 kPa resulted in the greatest IWUE and maximized net returns above irrigation costs. Continued research on soil moisture sensor threshold value determination is needed to confirm these results and refine recommendations.

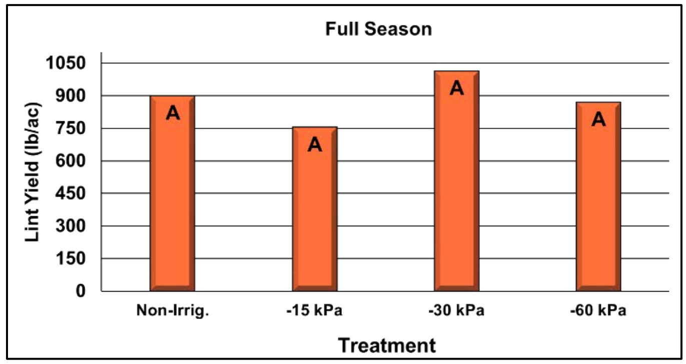


Figure 5. Lint yield by sensor threshold

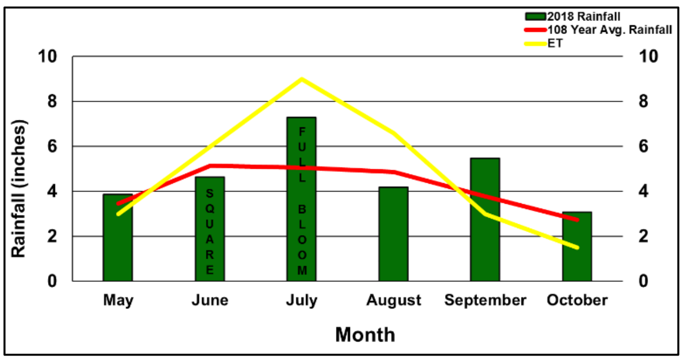


Figure 4. Rainfall in Blackville, SC

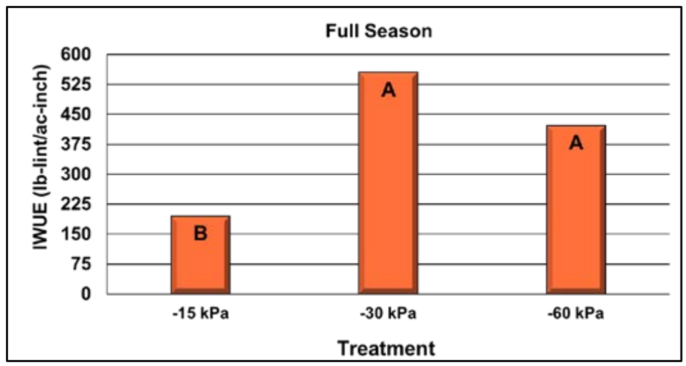


Figure 6. Irrigation water use efficiency by sensor threshold

Treatment	6-22-18	7-3-18	7-9-18	7-12-18	8-22-18	Total Applied
Non-Irrigated	0.00”	0.00”	0.00”	0.00”	0.00”	0.00”
-15 kPa	0.75”	0.75”	0.75”	1.00”	1.00”	4.25”
-30 kPa	0.00”	0.00”	0.75”	1.00”	0.00”	1.75”
-60 kPa	0.00”	0.00”	0.00”	1.00”	1.00”	2.00”

Table 2. Total irrigation applied by treatment

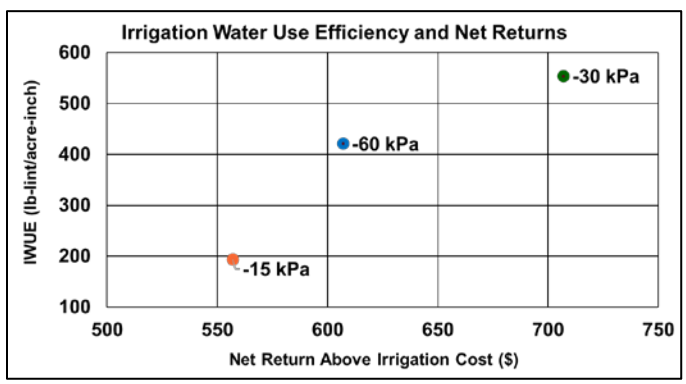


Figure 7. Irrigation water use efficiency by net returns above irrigation costs

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Clemson Precision Ag Online Calculators

Author: Kendall Kirk

We have prepared a number of online calculators (web apps) to assist South Carolina growers in crop production and management. Since the release of our first online calculator last fall, our calculators have been visited by 631 users in 9 countries and 32 states! We hope that these calculators prove to be useful tools and we invite you to make suggestions for improvements and new calculators. We plan to release additional calculators as we have time to develop them. In the meantime, please visit the following link to access those discussed below: https://precisionag.sites.clemson.edu/Calculators/

	Lime Rate Calculator The lime rate calculator allows you to input soil test results (soil pH and buffer pH) from the Clemson Ag Service Laboratory. When you provide a target pH, recommended lime rate is calculated in pounds per acre. The app also provides the user with the ability to input CCE and FF, or RNV to calculate lime rates for a specific source.
	Peanut Digger: Conveyor Speed Calculator Many newer model peanut diggers provide digital readouts to indicate conveyor speed in mph. In the absence of such a readout, this tool provides users with the ability to measure conveyor speed with nothing more than a stopwatch, which is built into the app. Clemson tests funded by the SC Peanut Board have demonstrated optimum conveyor speeds for different conditions; more details on this are explained in the app.
	Peanut Yield Estimator This app calculates estimated peanut yields or estimated peanut digging losses in pounds per acre as a function of number of pods observed per unit length along the windrow. The calculator is based on a 2015 Clemson study supported by the SC Peanut Board and the Clemson Creative Inquiry program.
	Soil Acidification Calculator For most South Carolina soils and crops, soil acidification is not necessary. In the event that lowering the pH is desirable, this calculator can be used to determine the rate of elemental sulfur that should be added. Calculations are based on recommendations provided by the Clemson Agricultural Service Laboratory.
	Watermark Calculator If you are using or considering using Watermark sensors for irrigation scheduling, this tool will make your life much easier. When you provide your sensor readings across a range of installation depths, the app automatically interprets rooting depth, calculates a weighted average for your sensor readings, and compares this weighted average to your threshold to make an irrigation recommendation.

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Precision Agriculture Faculty Member Spotlight

Dr. Joe Maja

Dr. Joe Mari Maja, a research sensor engineer at Clemson's Edisto Research and Education Center, has developed different technologies to optimize farm operations (www.iad4sc.com). He currently oversees the Sensor and Automation Laboratory. A major focus of his programmatic effort has been on emerging technologies, small unmanned aircraft systems (sUAS) and robotics. These collective efforts attempt to merge unmanned systems with other appropriate technologies to benefit a variety of agricultural disciplines.

For the past 4 years, Dr. Maja secured external grants as Principal Investigator (PI) or Co-PI in support of sustainable agriculture, unmanned aerial vehicles (UAVs), and water-related projects. He has received significant internal and external recognition for his work in UAV (featured on Clemson's website and most importantly, external news organizations). He is recently a recipient of the Extension Communication award from the American Society for Horticultural Science on Feb. 5, 2019 for their fact sheet related to Drones.

Dr. Maja chaired the IEEE Central Savannah Region Section and is currently a member of the Editorial Board of AIMS – Agriculture and Food Journal. He is an active reviewer for the following journals; Applied Engineering in Agriculture, Agriculture-Open Access Journal (MDPI), Elsevier Computer and Electronics for Agriculture, Biosystems Engineering, NASA Postdoctoral Program, and Journal of Remote Sensing Applications: Society and Environment.

Precision Agriculture Team Member Spotlight

Alex Coleman

Alex is from Saluda, South Carolina and began working for Clemson as the technician for the Corn, Soybean, and Small Grains program in 2016. He received his B.S in Agricultural Mechanization and Business in 2015, and is currently working on a M.S. in Plant and Environmental Sciences with a focus on comparing the suitability of spatial data for the creation of yield management zones. Alex's research project objectives are to determine the most suitable datasets to use in creating yield management zones across major row crops. Additionally, Alex plans to evaluate how the data sets influence management decisions for crop inputs in order to maximize grower profit. In Alex's free time, he enjoys farming at home with his father and spending time family, friends, and fiancé.

Industry Spotlight

Precision Planting

Precision Planting, LLC, makes simple technology designed to help growers eliminate agronomic barriers to higher yields and minimize input costs. Their approach to this is very unique in the agriculture industry. Rather than working to make your existing equipment obsolete, Precision Planting's first priority is to work towards solving growers' agronomic and mechanical issues on their existing equipment. This allows growers to invest in technology at a much lower entry costs and maximizes their return on investment.

Precision's planter offerings range from the old stand-by Keeton Seed Firmers to metering improvements, basic monitors to fertilizer placement tools, and row-by-row control of: electric drives, hydraulic downforce, liquid and granular application, and high speed planting. In addition, Precision Planting offers options for multi-hybrid or -variety planting where growers can plant two different hybrids or varieties in the same field with the same planter. They also offer a yield monitor that is designed to provide more accurate maps. These maps assist growers in better identifying productivity zones in their fields.

Precision Planting is also focused on providing growers with new sensors for their existing equipment that help them identify yield robbing issues while they are able to make adjustments in the field. One such technology is SmartFirmer. With this sensor installed on their planter in place of a Keeton Seed Firmer, growers are able to see inside the furrow in real-time on a 20|20 monitor. The SmartFirmer reads:

- Residue levels in the trench that impact seed placement and germination
- Moisture at their current planting depth and the consistency of that moisture
- Temperature in the furrow
- Organic Matter (OM)
- Cation Exchange Capacity (CEC)
  - OM and CEC are displayed in real-time and a map is created that the grower can download and use to better define management zones and share with their trusted advisors to better understand the "horsepower" of the land they farm

Precision will also be testing a new product this year related to SmartFirmer called SmartDepth that will allow growers to set a minimum and maximum planting depth and a desired moisture target. The row unit will then adjust on-the-go to ensure that the planter is always placing seed into moisture.

Precision Planting has a wide and varied product line. The best way to learn more is to contact a knowledgeable dealer that can help you identify the greatest agronomic opportunity for improvement in your operation. For more information, visit www.precisionplanting.com, or contact a Premier Dealer in your area.

Precision Planting's new Gen3 20|20 is able to be configured by the grower to show what is important to them. Maps and data can be arranged to display the information they value most. All of the maps can be downloaded into Climate FieldView and other Ag software for further use by the grower and their advisors.

The above shows Organic Matter (OM) and Cation Exchange Capacity (CEC) maps generated with Precision Planting's SmartFirmer. These maps help growers to add another layer of high definition data and refine management zones. Growers can use as many or as few SmartFirmers as they like. The more they add, the higher definition data they can record and use.

Submitted by: Andy Pace, Precision Planting

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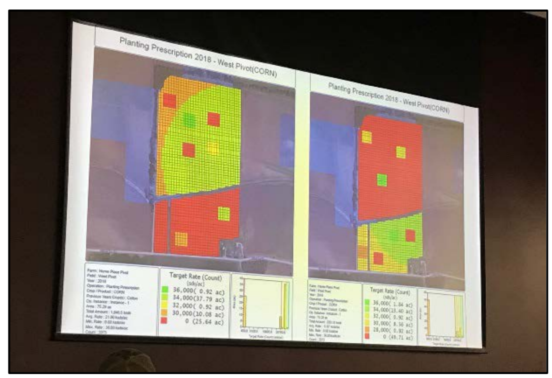
Upcoming Events:

- ~~24 January – SC Peanut Growers Meeting (Santee, SC)~~
- ~~29 January – SC Cotton Growers Meeting (Santee, SC)~~
- ~~February 14 - Valentine's Day~~
- **County Grower Meetings (Statewide)**
- **March (TBD) - Precision Ag. Seminar (Edisto REC)**
- **2019 Planting Season Begins**

Executive Farm Management – Charleston, SC

Precision Planting Meeting – Starkville, MS



State Cotton Growers Meeting – Santee, SC

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<u>Clemson Precision Agriculture Website:</u>
Application, Irrigation, Harvester, and Planter technology information is available online at:
https://www.clemson.edu/extension/agronomy/PrecisionAgriculture/

<u>Need More Information?</u>
For more Clemson University Extension Information: http://www.clemson.edu/extension/

Sincerely,

Michael T. Plumblee

Michael T. Plumblee, Ph.D.
Precision Agriculture Extension Specialist

If you would like more information on a topic discussed in this issue please contact me.

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