



## *Precision Agriculture Newsletter*

Editor: Michael Plumblee

Edisto REC, Blackville, SC

September 2018

### From the Editor:

I hope this newsletter finds you all doing well as we transition from summer into harvest. For those of you who do not know, I began working for Clemson in May of 2018 as the Precision Ag. Extension Specialist, and based out of Edisto REC. With this being said, I wanted to update you on where we stand and where we plan to go from here. We are starting up our Precision Agriculture Newsletter once again and anticipate continuing the newsletter on an every other month basis as of now. Within these newsletters we aim to provide you with an update on what we are currently working on, provide you with one technical article from research we are conducting at Clemson, inform you of any seasonal precision agriculture information, share current and upcoming events, and let you get to know us better.

Additional news that you should be aware of is that we are in the process of building a new website. This website will be housed under the Clemson Extension webpage and will provide us a hub to post bulletins, information, and resources that relate to precision agriculture. We will let you know when it is ready. In the meantime, please keep up to date with us on our Facebook page, [www.facebook.com/cuprecisionag](http://www.facebook.com/cuprecisionag). We plan to include announcements in this newsletter of any new information that is posted to keep you up to date.

Overall, this summer has been productive for the Precision Ag. program at Edisto REC with the trials we have been conducting, as well as, providing extension support to growers. Two weeks ago a few of our student workers returned to school and their help will be missed as we get into harvest. The following is a picture of the 2018 summer Precision Ag. crew.



Left to Right: Dr. Plumblee, Travis Avent, Perry Loftis, Brennan Teddy, Ben Fogle, Dr. Kirk, and Kayla Carroll

Last, as we move into harvest and you need any assistance with collecting or interpreting yield data, calibration, or any other precision agriculture needs do not hesitate to contact your local extension agent or the Clemson Precision Agriculture program. Be on the lookout for our next newsletter which should be coming out at the end of October.

Happy Harvest,  
Michael Plumblee

### In This Issue

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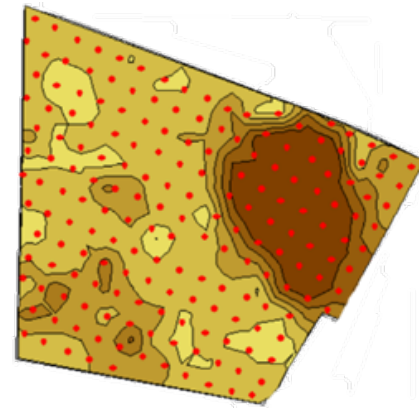
### Evaluating Various Methods for Developing Management Zones and How They Relate to Soil Fertility Levels

Author: Alex Coleman

It's estimated that 260,000 acres of cotton were planted in South Carolina in 2018, an increase of 10,000 acres from 2017 (Attaway, 2018). With commodity prices fluctuating and input costs remaining the same, it is essential for farmers to maximize profit. According to the 2018 Cotton Enterprise Budget (Clemson University, 2018), it costs on average \$670 to produce one acre of cotton. Two of the most significant input costs that cotton producers can manipulate are fertilizer and lime, making up approximately 20% of the total production cost.

Fertilizer recommendations are commonly derived from soil sample analyses that are collected from sampling the field. A soil sample that is representative of the field will aid in determining if fertility levels are sufficient or deficient. Additional nutrients can then be added to meet the crops requirements if needed. Through precision agriculture, inputs are managed on a smaller scale, thus allowing for more precision when it comes to sampling and applying nutrients to a field. Two common methods for collecting soil samples based on smaller management zones are called grid sampling and zone sampling. When grid sampling a field is broken into equal square areas from which soil samples are obtained. Typically large grids (>10 acres) do not provide as much representation of field variability but usually have a lower sampling cost. Additionally, small grid sizes (<10 acres) provide better representation of field variability but typically have higher sampling costs associated with them due to the number of samples. The second sampling method, zone sampling, is where zones are created using data collected from the field to determine areas with similar soil properties (i.e. soil texture; soil organic matter; soil electrical conductivity). Depending on the method used for zone determination and zone size, zones

can vary on how effectively they capture the variability in the field. The objectives of this research are to determine which sampling method provides the greatest economic return when collecting soil samples and managing fertility levels, and ultimately how the sample results effect fertilizer/lime applications.



**Figure 1.** Soil sample points displayed over organic matter map.

A trial was conducted on a 187-acre field in Barnwell County where soil samples were collected on a 1-acre grid in January of 2018. Soil samples were sent to the soil testing lab at Clemson University for determining nutrient levels and soil pH. Soil organic matter and soil texture samples were also collected and analyzed at the Edisto Research & Education Center near Blackville, SC. In order to evaluate various sized grids, grid sizes were created using 4, 9, and 16 acres. These grid sizes were chosen because the range they fall into represent common grid sizes used, as well as, they created square grids from the 1-acre grids that were sampled. In order to evaluate zone sampling, zones were created using elevation, web soil survey (SSURGO maps), Spatial Image Digitizer (SID), soil sand content, and soil organic matter content. For comparison purposes, a uniform rate or “blanket” application was also analyzed. This rate was calculated by determining the average fertilizer and lime recommendations of all of the samples within the field. Additionally, a three-division method was utilized by dividing the whole field into

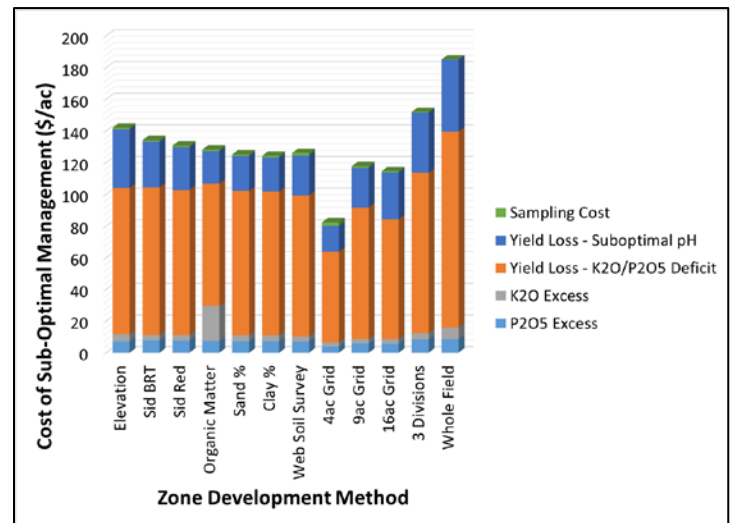


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## PRECISION AGRICULTURE

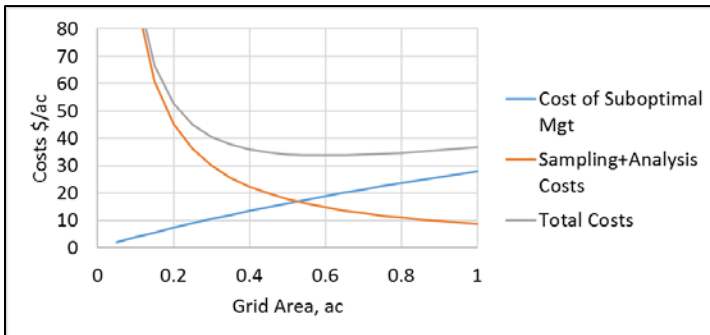


three separate areas and determining the average fertilizer and lime recommendations of each area. In order to obtain the nutrient and lime recommendations from the 1-acre soil samples within each larger grid and zone, sample recommendations were averaged. For example, to obtain the nutrient and lime recommendation for the 9-acre grid method, the nine samples from the 1-acre grids were averaged. This resulted in a theoretical application rate for fertilizer and lime. The application rate that was derived for each zone was then compared to each of the 1-acre samples in that zone where an over or under application of fertilizer/lime was then calculated. For the purpose of this study, input analysis was limited to phosphorous ( $P_2O_5$ ), potassium ( $K_2O$ ), and lime. Costs were acquired from local fertilizer dealers for diammonium phosphate (DAP) at \$533/ton, potash at \$390/ton, and lime at \$50/ton. A cost was associated with excess application of  $P_2O_5$  and  $K_2O$  by simply multiplying the cost of the product by the excess amount applied. In order to estimate a yield loss cost associated with under application of fertilizer the following requirements were assumed;  $P_2O_5$  – 160 lbs and  $K_2O$  – 200 lbs per 1300 lbs of seed cotton. The nutrient with the greatest deficiency was deemed limiting and yield reductions associated with that nutrient were used in calculations. A value of \$0.36 per pound of seed cotton was used to calculate cost associated with yield reduction. Lime application rates and over/under application was determined using a target pH of 6.2. Yield loss from over/under application of lime was determined from cotton yield response to pH models developed from Adams (1968). Costs associated with the over-application of fertilizer, yield reduction, and sampling from each point were averaged within each zone or grid. The total cost for each method was then determined and is referred to as the cost of sub-optimal management. The results of the cost associated with sub-optimal management are displayed in the following figure.



**Figure 2.** Cost of Sub-optimal Management by Zone Development Method

In this research, the average size of the various management zones was equal to 26 acres. These data demonstrate that a 26-acre zone provides similar representation of the field variability as the 9-acre grid. Sampling costs associated with grid sampling is often considered one of the major drawbacks. However, these data demonstrate that sampling costs are negligible compared to the costs associated with the under application of fertilizer and lime. If only the data from the grid sampling method, including three divisions & whole field, is observed then it can be suggested that as the grid size gets smaller, the losses due to sub-optimal management are reduced. In other words, field variability could be accounted for by using a smaller grid size, although with smaller grid sizes the sampling and lab cost will increase. Estimated sampling costs were obtained from Wollenhaupt (1994), where the lab costs were calculated at \$6 per sample and \$25 per hour labor cost. When comparing the cost of sampling and the cost associated with suboptimal management, an optimum grid size can be determined. The point in which the cost of sampling intersects the cost of suboptimal management results in the optimum grid size for this particular field. The results can be observed in the following graph.



**Figure 3.** Cost per acre of sampling and loss from suboptimal management by size of area sampled.

In conclusion, the data from this research suggests that the optimum grid size for this field is around 0.55 acres. While the sampling cost at this grid size is \$22 per acre, the benefit of applying adequate fertilizer and lime more than paid these costs. Moving forward we anticipate to continue collecting additional data across multiple fields ranging in soil texture and fertility levels. From the continuation of this research, we hope to determine best practices for identifying optimum grid and zone sizes as well as to outline recommendations for creating sampling areas.

Alex Coleman is pursuing a M.S. degree in Plant and Environmental Sciences under Dr. Kendall Kirk. Alex currently works as the Animal Feed Grain technician at Edisto REC. He can be contacted at [amcolem@clermson.edu](mailto:amcolem@clermson.edu).





## Combine Yield Monitor Calibration

Authors: Michael Plumblee, Kendall Kirk, and Jay Crouch

Harvest for South Carolina growers will soon be in full swing. Growers who anticipate on collecting yield data this season should take the time to check yield monitor components to ensure accurate data collection.

Yield monitors are the second most common precision agriculture technology used today. They are, for the most part, standard equipment on new grain combines. Proper calibration is key if management decisions, prescriptions, or profit maps are to be generated from yield data. A few things to consider prior to calibration are to make sure the combine is properly working. If the combine is not working properly during calibration and the problem is fixed during harvest, the yield monitor may need to be recalibrated.

Varying the flow of grain into the machine will provide a range of mass flow rates, helping account for variation in the field, and providing greater confidence in yield data. Imposing different mass flow rates can be accomplished by harvesting loads of irrigated vs. non-irrigated crop, or by simply varying the travel speed between calibration loads; try to maintain a constant mass flow rate within a calibration load and change it between loads. When calibrating a yield monitor, more loads collected and larger load sizes will generally provide a more representative calibration.

Prior to calibrating, a few things to keep in mind are to make sure the combine is setup properly, read the operator's manual for the yield monitor, check and properly setup the GPS offset and header swath width, and ensure the grain tank and off-loading auger is empty. In addition, the following yield monitor components should be inspected and calibrated.

### A short pre-season checklist follows:

**Clean Grain Elevator Chain** – Check the tension of the elevator chain and inspect for excessive wear to paddles, links, and sprockets. Mass flow rate is measured at the clean grain elevator; excessive wear or erratic grain delivery may result in instances of mass flow sensor response not representative of actual mass flow rate.

**Moisture Sensor** – Check and clean the moisture sensor. If serviceable, remove any previous crop residues from the moisture sensor channel and plant resin from the sensor itself. The calibration provides a wet yield, which is corrected to a dry yield using the moisture sensor data. Proper moisture sensor operation is critical because assessment of crop performance should generally be conducted on the basis of dry yield.

**Header Height Sensor** – Check that the sensor itself is intact and wiring to the sensor has not been damaged. While it may not seem important, if this sensor is not accurately reading when the header is lowered into the crop, data collection may be incomplete; most yield monitors use header height position as a recording trigger.

**Distance Calibration** – Verify that the distance you are traveling is the distance that is being recorded. It is not a bad idea to re-calibrate to make sure acreage or field capacity recordings are accurate. Field capacity is calculated as speed times width, the speed being determined by distance per unit time. Yield monitors calculate crop yield as a function of mass flow rate and field capacity (lb/hr divided by ac/hr equals lb/ac). Thus, if your distance (i.e. field capacity) is off by 20%, then your yield estimate may also be off by 20%. Accurate distance measurement is just as important on a yield monitor as accurate mass flow measurement.

**Vibration Calibration** – Calibrate for the vibration of the harvester with the header engaged and at engine operating speed, but not harvesting crop. This is done so that the vibration of the machine is not altering the data that is being recorded. Manufacturer recommendations suggest that this calibration be done each time a different header is used on the harvester. Vibration calibration is important because it identifies a threshold impact force caused by machine vibration alone. If more vibration actually occurs than that which was present during calibration, then vibration may be erroneously counted as crop flow.

**Elevator Shaft Speed Sensor** – Verify that the elevator shaft speed sensor on the clean grain elevator is working properly and that it is not damaged. The elevator shaft speed sensor is generally used as a recording trigger in addition to the header height sensor.



### In-field calibration:

**Calibrating the Mass Flow Sensor** – Depending on yield monitor manufacturer, you likely need to flag loads as calibration before they are harvested. Then harvest separate calibration loads with each load containing at least 50 bushels or 3,000 lb. Most manufacturers allow for only one calibration load, but we recommend at least three loads, each at a different mass flow rate. Limited research is available on identifying a specific number of loads required for calibration, but calibration accuracy will generally increase with each additional calibration load. Make sure that the grain tank and off-loading auger is completely empty after each load is harvested. Weigh each individual load with a weigh wagon or truck scale that you know is accurate and record the weight. After each of the calibration loads have been harvested and weighed, the weights can be entered in the yield monitor display. Most yield monitors allow you to enter all load weights at once, following the calibration. If scales are not available, consider contacting your local Extension agent, Clemson Precision Agriculture, or a local weighmaster. The S.C. Department of Agriculture maintains a list of licensed public weighmasters; be sure to call ahead to make arrangements (see link below). S.C. Licensed Public Weighmasters:  
<http://www.kellysolutions.com/sc/weighmaster/showall.asp>

**Calibrating the Moisture Sensor** – While harvesting your loads to calibrate the mass flow sensor, collect a representative sample from each load to determine grain moisture. Grain moisture can either be determined via a trustworthy handheld moisture tester or at most local grain elevators. Depending on the yield monitor, only one moisture reading may be required; however, we would suggest taking one or more readings from each of the five loads harvested and using the average moisture reading. Specific procedures for moisture calibration vary by manufacturer and platform; consult your yield monitor operator’s manual or contact us for details.

After completing these few steps, the yield monitor should be calibrated and ready for harvest. It is also important to note that as harvest continues throughout the remainder of the season, a separate calibration needs to be completed when harvest switches to another crop.

If you need assistance with yield monitor calibration, please contact us. For more information, refer to our extension bulletin at:

[http://precisionag.sites.clemson.edu/Extension\\_Guides/Combine\\_Yield\\_Monitor\\_Calibration\\_8\\_2018.pdf](http://precisionag.sites.clemson.edu/Extension_Guides/Combine_Yield_Monitor_Calibration_8_2018.pdf)



Figure 1 and 2. Header Height Sensor – Case IH (Above) John Deere (Below)



Figure 3. Moisture Sensor – Case IH (Below)







Figure 4. Moisture Sensor – John Deere



Figure 6. Shaft Speed Sensor – John Deere



Figure 5. Moisture Sensor – Case IH



Figure 7. Clean Grain Elevator Chain and Sprockets – Case IH



### Precision Agriculture Faculty Member Spotlight

#### Dr. Michael Plumblee

Dr. Plumblee was born and raised in Lexington, SC and began working for Clemson as the Precision Agriculture Extension Specialist in May of 2018. Plumblee received his B.S. in Agricultural Mechanization and Business at Clemson in 2013, M.S. in Agronomy at the University of Georgia in 2015, and Ph.D. in Agronomy at Mississippi State in 2018. His current work focuses on providing growers with recommendations and support on how to utilize new and existing precision ag. technologies in their operations. Some of his current research includes evaluating and developing soil moisture sensor thresholds in various row crops, variable rate prescription development for nitrogen and seeding, chemigation applications, and pesticide product efficacy as a function of droplet size. In his spare time, Dr. Plumblee enjoys hunting, fishing, spending time on a tractor, and being with his wife Allison and family.



### Precision Agriculture Team Member Spotlight

#### Brennan Teddy

Brennan is from Shelby, North Carolina and began attending Clemson in the fall of 2014. He received his B.S in Agricultural Mechanization and Business in May of 2018, and is currently working on a M.S. in Plant and Environmental Science with a focus on image analysis. Brennan's research project objectives are to identify various weed species and soil texture from aerial images taken from consumer-level UAVs, or "drones". In Brennan's free time, he enjoys kayaking and working on vehicles. Brennan hopes that his research will aid in the development of technologies, which are affordable and easy enough to be used by growers in the state.







### Industry Spotlight

#### BMP Logic – Soil Moisture Probes

Sensors, sensors, sensors are everywhere on the farm these days. Sensors measuring weather, sensors in the combine, sensors on the planter, and a plethora of sensors in the tractor makes it easy to get ‘sensory’ overload. So how does BMP Logic help growers get the most for your money when it comes to putting soil moisture sensors in the ground.

First, we think the way you install it is important enough say to start there. Bottom line, is that if you have to dig a hole larger than the sensor itself, you have to wonder if the information you are getting is true. You may have just created an area of preferential root growth around that soil moisture sensor that is no longer representative of the field around it.

Second. All software is not created equal. Most of today’s capacitance based soil moisture sensors work in basically the same way. But it takes software to turn those squiggly lines into a story. Every soil moisture sensor tells a story of what is happening in your field every day. The software you use should make those lines come alive with meaning. So if you have to scratch your head when you pull up your data trying to figure out what it means, maybe you need a different software.

Lastly, customer service from your vendor is critical. Initially you will need a vendor that will “coach” you in the beginning to introduce you to the language the soil moisture probes use to communicate. You have enough to take care of already, the last thing you need is for a vendor to sell you soil moisture sensors, and then walk away. Simple to read, easy to understand graphs, combined with education about the data results in user adoption of the technology.

Soil moisture sensors never replace eyes on the field, but they do have a place in today’s management systems. It doesn’t have to be complicated. The stories sensors tell may just change the way you think about irrigation, because you actually see what happens after the water hits the ground.

Submitted by: Doug Crawford and Justin Jones, BMP Logic

### Upcoming Events:

- ~~23 August – Simpson Station Field Day~~
- **3 September – Labor Day**
- **6 September – Peanut Field Day – Edisto REC (Morning)**
- **6 September - Agronomic Crops Field Day – Edisto REC (Afternoon)**
- **13 September – Pee Dee REC Field Day**
- **20 September – Fall Hay Clinic – Edisto REC**
- **13 October – Forage Bull Test Sale – Edisto REC**



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## PRECISION AGRICULTURE



### **Pest Management Handbook – 2018**

Insect, Weeds, and Disease control recommendations are available online in the 2018 South Carolina Pest Management Handbook at:

<http://www.clemson.edu/extension/agronomy/pest%20managment%20handbook.html>

### **Need More Information?**

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

Sincerely,

*Michael T. Plumblee*

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

### **Contact Us:**

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

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