Cropping systems research changes over time as new questions arise. It is diverse due to the complexity of factors that influence cropping systems decisions.

Rotation trials are continually evaluated. In 2017, a complete cycle of 1, 2, 3, and 4-yr rotations of peanut with different crop combinations with corn, cotton, and grass fallow could be compared. The lowest yields and grades typically occur following shorter rotations, especially continuous peanut. In this cycle, differences among crop sequences within a length of rotation were also observed. Rotations where peanut was immediately preceded by corn were more consistent in providing yield benefit than when peanut was preceded by cotton. Cotton is still considered a good rotation partner with peanut, but is best utilized in longer rotation sequence (three full seasons between peanut) or when immediately following peanut then replacing with corn the year before switching back to peanut.

Two projects that were repeated in 2017 for a second year of data involved a detailed account of how Ca and Mg fertility programs affect soil and plant concentrations of these nutrients. Lime increased soil Ca concentration and pH by the end of the season while gypsum had no direct impact on these factors in the field study. It is anticipated that the water-soluble nature of gypsum coupled with a wet/rainy year caused the gypsum and Ca provided from this source to leach and not be available in the pegging zone or to pods. There was a greater concentration of Ca in leaf tissue when gypsum was applied, likely as it was picked up by the roots after it leached below the pegging zone. Lime and gypsum also both affected Mg availability and uptake by pods. Lime increased Mg availability while gypsum decreased Mg availability, and the application of both balanced each other such that there was no change in Mg concentration compared to the non-treated. If Mg levels are considered low, lime is the preferred method of increasing both Ca and Mg availability for uptake by peanut. However, application of both lime and gypsum may be beneficial in some instances to improve Ca concentration, which may improve germination and vigor for seed peanuts. Tests also proved that Mg is able to compete with Ca when applied in sufficient quantity. All major cations (Ca, K, Mg) need to be considered in peanut production so none become too deficient and impede growth.

In an experiment testing replant methods and gaps in plant stand, results determined that replanting an initial plant stand with supplemental seed next to the original row can be beneficial, regardless of the length of the initial gap. There was also some benefit to replanting segments of row only where the gap occurred compared to not replanting. Gap replanting would reduce input costs compared to full row replanting. However, yield and grade were both improved with full row replanting in this trial. The replanted rows were allowed a longer period of time to mature than the non-replanted or where only the gaps were replanted, which may have contributed to yield and grade gains. If replanting is an option, it is recommended to allow the plants to grow beyond the initial plant stand’s maturity in order for the replanted plants to reach their maximum maturity, as long as the vegetative health of the plant remains in good condition.
NATIONAL PEANUT BOARD / SOUTHEAST PEANUT RESEARCH INITIATIVE

FINAL REPORT - 2017 funding cycle for work done under project agreement entitled: “Agronomic Management and Cropping Systems Research for Peanut”.

Proj ID # 298
NPB Budget ID # 1531
SID # GA-111
UGA Account #2521RF328169

INSTITUTION: University of Georgia

Principle Investigator: Dr. R. Scott Tubbs

EXPIRATION DATE: 31 December 2018

SFRI CONTACT: Joy Purvis, Hannah Jones
NPB CONTACT: Bob Parker

FINAL REPORT:

1) Cropping Systems and Rotations –
a. Lang Farm (Tifton, GA) – A cover crop of ‘Wrens Abruzzi’ rye (90 lb/ac) was planted to all plots except for fallow. Corn, cotton, and peanut were maintained in appropriate plots in the rotation, with peanut (Georgia-06G) being planted on April 25, dug on Sept. 19, and harvested on Sept. 25, 2017.

Rotation of this project was as follows:

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Continuous peanut = 3730 lb/ac  
Average of 2 YR rotations with crops = 5084 lb/ac  
Average of 3 YR rotations with crops = 5564 lb/ac  
Average of 4 YR rotations with crops = 5352 lb/ac

There were consistent statistical differences for yield of peanut in various rotation lengths and among crop variations. Continuous peanut was the lowest yield. There were not as many distinguishable differences among the various crop length and rotation sequences, but some worth noting include the following:

- Both crop sequence and length of rotation can influence peanut yield.
- A three-year rotation of cotton-corn-peanut had the best overall yield, which was a significant improvement over continuous peanut, a two-year cotton-peanut rotation, a three-year cotton-cotton-peanut rotation, a rotation where peanut was grown for a second consecutive year after two years of bahiagrass, as well as ahead of a four-year rotation after corn-corn-cotton-peanut.
- Overall this would suggest that growing peanut immediately after corn in the rotation is better than peanut being immediately preceded by cotton. However, a four-year rotation with three years of cotton between peanut crops was still a successful option. Cotton is a good rotation partner with peanut and is best utilized when grown after peanut and corn is grown prior to peanut.
- A composite average by length of rotation showed a minimum of 1,300 lb/ac increase for not growing continuous peanut, and an additional nearly 500 lb/ac improvement in yield by alternating peanut every third year instead of every other year. There was no additional benefit in this trial going from a 3-year to a 4-year rotation.

b. Gibbs Farm (Tifton, GA) – Corn, soybean, and peanut were maintained in appropriate plots in the rotation, with peanut (Georgia-06G) being planted on April 28, dug on Sept. 21, and harvested on Oct. 2, 2017.

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A full rotation cycle reached completion this year, with the ability to analyze 1, 2, 3, and 4 year rotations compared to each other. However, there were no statistical differences in yield. Because of the field setup, it is not regularly irrigated due to water needs on other parts of the farm (for peanut and cotton breeding research trials) and the inability to irrigate multiple sections of the farm at the same time. Hence, yields were relatively low in comparison to fully irrigated research trials. This area of the farm also deals with consistent deer grazing further complicating management and introducing experimental error. It is noted that any rotation that included soybean within the rotation sequence was among the lowest in each rotation length grouping. Compilation of multiple rotation cycles will be needed to determine if this trend is significant over time with additional replication.

2) **High and Low Calcium, Potassium, and Magnesium in Root vs Pegging Zone** –

   a. **Ca Source x Irrigation** – a greenhouse trial and a field trial were conducted on the UGA Tifton Campus in Tifton, GA. In both experiments, the same treatment structure was used for assessing pod formation and Ca concentration in the pegging zone. Treatments involved inclusion or exclusion of irrigation, inclusion or exclusion of 2000 lb/ac lime around the time of peanut planting, and inclusion or exclusion of 1000 lb/ac gypsum around initial bloom of peanut. This was a factorial arrangement of treatments, so all possible combinations of these three variables were tested.

   The greenhouse trial was planted with Georgia-06G peanut on Feb. 14, 2017. The field trial was planted with a sub-plot effect of two cultivars including Georgia-06G and Georgia-14N on April 19, dug on Sept. 20, and harvested on Sept. 28, 2017.

   In the field experiment, the fertilizer treatments had a significant effect in changing the soil Ca and Mg concentrations, and pH (Figs. 1-3). Addition of lime increased soil Ca concentration over 11 times compared to the non-treated soil Ca. Inclusion of gypsum did not increase Ca over non-treated, and did not have a significant increase when added to lime compared to using lime alone. Lime with gypsum increased Ca seven times greater than gypsum alone, and lime alone (without gypsum) increased soil Ca 5.5 times more gypsum alone (Fig. 1).
With respect to Mg in the soil, application of lime (which contains Mg) increased Mg 3.7 times greater than no fertilizer application. Dolomitic lime is approximately 22% Ca and 11% Mg. However, the application of gypsum (29% Ca and 0% Mg) flushed the soil with Ca and caused a net loss of Mg (-10.8 mg/kg) even greater than the net gain from lime (+6.5 mg/kg). When both lime and gypsum were applied, the presence of both cations balanced the gains and losses, causing no change in soil Mg compared to no fertilizer treatment (Fig. 2).

As expected, soil pH was also increased by inclusion of lime while gypsum had no effect (Fig. 3).
Despite the increase in soil Ca by lime application, it did not result in an increase in Ca concentration in the pods on its own, and neither did gypsum alone. However, when both were applied, there was an increase in pod Ca concentration compared to all other fertilizer treatments (Fig. 4).

As for leaf material (Fig. 5), Ca concentrations were impacted more directly by gypsum application, since only treatments including gypsum increased Ca concentration in the leaf compared to the non-treated peanuts.
The amount of Mg in peanut pods was correlated with the amount of soil Mg, as more soil Mg resulted in a higher concentration of Mg in the pods (Fig. 6).

Peanut yield was influenced by all three treatment factors in various interactions. Yield was overall greater in non-irrigated conditions in 2017, suggesting that possible over-irrigation may have occurred. It was a wet growing season. There were no differences in yield among fertilizer treatments in the non-irrigated peanuts, although yield was greatest in the lime only treatment in the irrigated peanuts. When comparing irrigation treatments within a given fertilizer treatment, only the gypsum alone treatment resulted in a yield difference with non-irrigated peanuts having a greater yield than irrigated peanuts. It is possible that the extra water applied during the peak pod fill stages (83% of irrigation was applied in the month of August, between 104-134 days after planting) caused excessive leaching of available Ca.
along with the reduced Mg availability and concentration in the pods resulting in less pod yield, even compared to non-treated which did not experience the same reduction in Mg concentration. The Ca in gypsum is considered a more soluble and readily available form than that provided by lime.

While it was not observed in the field study, the supplemental greenhouse study did demonstrate less seed Ca with gypsum alone than where lime (54% less) or lime + gypsum (53% less) were applied at the 1/3x irrigation rate. There were no differences between seed Ca concentrations at the full irrigation rate. Water is necessary to move Ca from soil solution into the pod/seed. Both soil Ca and soil Mg concentrations were greater at the 1/3x rate irrigation level than at the 1x irrigation level for the two treatments that included lime application. The two treatments including lime application were also greater in soil Ca and soil Mg concentration than the two treatments that did not have a lime application at the 1/3x irrigation rate. Hence, in the greenhouse study as well, lime is supplying substantially more Ca and Mg to the soil than when it is not applied. But in the greenhouse study, those increased concentration levels were not retained at the higher irrigation level. It is possible that over-irrigation was occurring at the “1x” irrigation rate, moving all fertilizer/nutrients out of the pegging zone and further calibration of the irrigation quantities is needed for future greenhouse studies.

Since pod yields were not consistent from year to year in the field study, there was no standardized conclusion of a benefit that either irrigation or fertilization practice provided a universal benefit. Although, addition of lime caused substantial increases in soil Ca and Mg compared to gypsum application. Hence, if Mg concentrations are considered low, lime is the preferred method of increasing both Ca and Mg availability. However, in the case of growing peanut as a seed crop for planting next year, maximizing seed Ca concentration may prove beneficial in increasing germination and vigor, and thus application of both lime and gypsum may provide benefits from that standpoint.

b. MgSO₄ x Gypsum – a greenhouse trial was conducted in Tifton, GA and a field trial was conducted at the UGA Attapulgus Research and Education Center in Attapulgus, GA. In both experiments, the same treatment structure was used for assessing Ca availability in the soil and uptake by the pods. Treatments included 1) a non-treated check (no MgSO₄ and no gypsum, 2) MgSO₄ at 25 lb Mg/ac with no gypsum, 3) MgSO₄ at 25 lb Mg/ac with 1000 lb gypsum/ac, 4) MgSO₄ at 50 lb Mg/ac with no gypsum, 5) MgSO₄ at 50 lb Mg/ac with 1000 lb gypsum/ac, and 6) 1000 lb gypsum/ac with no MgSO₄.

The greenhouse trial was planted with Georgia-06G peanut on Feb. 14, 2017. The field trial was planted with Georgia-06G on April 26, dug on Sept. 21 and harvested on Sept. 26, 2017.

Soil Ca concentration was increased with the application of gypsum (Fig. 7).
Applications of either Ca or Mg or both decreased the soil K concentration (Fig. 8). Cations will compete with each other for exchange sites on soil particles.
The application of gypsum reduced Mg concentration in the soil, even when Mg was applied with gypsum. Thus, the sheer volume of Ca flooded the soil and caused an exchange of Mg in favor of Ca where gypsum was applied (Fig. 9).

![Soil Mg concentration graph]

Fig. 9. Soil [Mg] as affected by fertilizer treatment, Atapulgus, GA 2017.

Similarly, the Ca:K+Mg ratio was strongly influenced by the addition of large quantities of Ca through gypsum application, however the ratio was also increased when the high rate of Mg was applied compared to the non-treated. This suggests that when the high rate of Mg is applied, Ca is being supplanted by Mg on soil exchange sites since simple addition of Mg without reduction in Ca would decrease the ratio rather than increase it.

![Ca:K+Mg ratio graph]

Fig. 10. Ratio of Ca:K+Mg in soil at harvest, Atapulgus, GA 2017.
The application of gypsum likewise resulted in an increase in pod Ca concentration compared to when it was not applied (Fig. 11).

![Graph showing Ca concentration in pods]

**Fig. 11. [Ca] in pods at harvest, Attapulgus, GA 2017.**

However, regardless of changes in soil or plant tissue nutrient concentrations, none of the treatments resulted in a change in yield compared to any other treatment, including the non-treated check (Fig. 12). Initial soil concentrations of the nutrients being studied were all above what is considered an adequate level for peanut production. A wide assessment of initial soil test levels (especially for Ca, K, and Mg) were evaluated at numerous UGA field sites and site with inadequate levels of these nutrients could not be identified.

![Graph showing pod yield]

**Fig. 12. Pod yield as affected by fertilizer treatment, Attapulgus, GA 2017.**
In the greenhouse, field data was supported by most of the results. The application of gypsum increased soil Ca regardless of whether Mg was applied or not (Fig. 13).

Fig. 13. Soil [Ca] at harvest, Greenhouse experiment 2017.
(Initial soil [Ca] = 173 mg/kg)

The amount of Ca in vegetative tissue at the completion of plant growth was greatest in the gypsum only treatment (Fig. 14). The addition of the high rate of Mg without gypsum caused a reduction in Ca in vegetative tissue compared to the high rate with gypsum or gypsum alone. This may have been a result of an increase in the soil Mg (Fig. 15) and reduction in the Ca:Mg ratio (Fig. 16) caused by the high rate of Mg.

Fig. 14. [Ca] in vegetative tissue, Greenhouse experiment 2017.
Soil Mg increased with increasing rate of Mg fertilizer, while the addition of gypsum caused a decrease in soil Mg at the higher rate, but did not reduce soil Mg when the low Mg rate was applied (Fig. 15).

![Bar chart showing soil Mg levels across different treatments](chart1)

**Fig. 15. Soil [Mg] at harvest, Greenhouse experiment 2017. (Initial soil [Mg] = 24 mg/kg)**

When gypsum was applied, the Ca:Mg increased compared to where gypsum was not applied (Fig. 16). When Mg was applied, it reduced the Ca:Mg ratio, even in the gypsum treatments. However, the data from the greenhouse trial did not confirm the information from the field trial where the application of Mg caused Mg to supplant Ca on the exchange site, since the ratio decreased with the addition of Mg. A reduction in Ca is possible, although the overall reduction suggests a substantial increase in the denominator by addition of Mg. Since soil levels in the greenhouse study were sufficiently below recommended nutrient concentrations, this may be why the results were different from field to greenhouse.

![Bar chart showing Ca:Mg ratio across different treatments](chart2)

**Fig. 16. Ratio of Ca:Mg in soil at harvest, Greenhouse experiment 2017.**
With regards to Ca:K+Mg ratio, this was more consistently driven by the application of gypsum increasing the numerator and causing the ratio to increase. Addition of Mg was not in sufficient quantity to cause a significant reduction in the ratio regardless of whether gypsum was included or not (Fig. 17).

![Graph showing Ca:K+Mg ratio with different fertilizer treatments.]

Fig. 17. Ratio of Ca:K+Mg in soil at harvest, Greenhouse experiment 2017.

Although, the concentration of Ca in the seed was strongly affected by inclusion of gypsum, but a reduction in seed Ca when the high rate of Mg was included is indicative of Mg competing with Ca for uptake (Fig. 18). This is further evidenced in the concentration of Mg in the seed where the high rate of Mg application was sufficiently greater than the non-treated even when gypsum was applied with it (Fig 19).

![Graph showing [Ca] in seed at harvest with different fertilizer treatments.]

Fig. 18. [Ca] in seed at harvest, Greenhouse experiment 2017.
Hence, Mg is able to compete with gypsum when applied in sufficient quantity. Thus, it is important to consider Ca, K, and Mg cations when evaluating soil for sufficiency levels and making applications to increase seed nutrient concentration. The balance of soil nutrient levels are needed to ensure no cation causes another to become too deficient and impede development.

Graduate student Kristen Pegues conducted research pertaining to objectives 2a. and 2b. above as her M.S. thesis project and graduated in May 2018 from UGA. She made oral presentations related to this research at the Southern Branch American Society of Agronomy meeting in Mobile, AL on February 6, 2017 (receiving 3rd place in the student competition) and American Peanut Research and Education Society annual meeting in Albuquerque, NM on July 12, 2017. She also presented a poster at the 2017 Crop Science Society of America annual meeting on October 24, 2017 in Tampa, FL.

3) **Replant Decisions for Peanut** – an experiment was planted at the UGA Lang Farm to assess the length and frequency of skips in the row, and optimum replanting strategies to compensate for lost yield potential because of skips while minimizing seed cost. All plots were initially planted on April 17, 2017. After emergence was complete, all plants in the row were counted and rows were thinned back to specific plant populations. One check plot was kept at 4.0 plants/ft of row with no gaps in the row as the recommended standard. All other plots were thinned to 2.0 plants/ft of row to represent a below optimum plant stand. One treatment remained 2.0 plants/ft with no gaps pulled to represent what would happen if there were no gaps and no replant had occurred. Another treatment kept 2.0 plants/ft with no gaps, but was replanted approximately 3 inches to the side of the original row with a seeding rate of 4.0 seed/ft to attempt to increase production above the sub-optimum plant stand. In the remaining treatments, there were three variables assessed. Plants were removed from random sections of row to establish 2.0 ft, 4.0 ft, or 6.0 ft of consecutive row length where no plants would grow. These lengths would be pulled once per 34 ft row for one treatment, or twice in each row as a
separate treatment. In each of these scenarios, there would be an additional treatment factor involving a replant scenario where either 1) no replant occurred, and the lost yield potential is determined by length and frequency of gaps in the row, 2) a replant occurred with a seeding rate of 4.0 seed/ft of row only in the area where the gap occurred in the row, or 3) a replant occurred with a seeding rate of 4.0 seed/ft of row for the entire length of the row, including next to the initial plant stand and the gap in the row. All replant treatments were planted on May 6, 2017.

Treatments that did not include any replanting (replant treatment 1) or were replanted only in the gap of missing row (replant treatment 2) were dug on Sept. 7 and harvested on Sept. 18, 2017. All treatments including a replant effect in the entire length of row (replant treatment 3) were dug on Sept. 27 and harvested Oct. 6, 2017. This was to allow the replanted plants an opportunity to achieve maximum maturity since they were planted weeks later and made up a substantial percentage of the surviving plants in the row.

The treatments where the full row was replanted increased plant stand by roughly double the original plant stand (Fig. 20), as seen in all treatments regardless of the length or frequency of the original gap(s) in the row. (Stand counts were not conducted in areas where gaps originally occurred for any replant treatment).

The increased plant stand and the delay in harvest timing to allow the replanted peanuts to gain maturity provided a yield advantage using the “full row” replant strategy (Fig. 21). There was no
yield advantage in the check plots comparing the 4.0 plant/ft to 2.0 plant/ft, although there was also no difference in plant stand by the end of the season for these treatments either. Likewise, there were no differences among the various gap length and gap frequency treatments within the replant method groupings. Therefore, the check plots were removed from the analyses to be able to compare factorial combinations by the three individual treatment components (gap lengths, frequency, and replant method, and all of their possible interactions).

![Pod yield as influenced by gap length, frequency, and replant method, Tifton, GA 2017.](image)

When analyses were performed in this manner, the only treatment variable that influenced yield was the replant method. This analysis made it possible to observe a difference among all three replant methods (Fig. 22). The full row replant method remained the best option for maximizing yield, ahead of both other options. Although, replanting seed only in the gaps also provided a yield advantage over not replanting at all. Since the harvest of the “gap only” replant and non-replanted methods occurred at the same time, the yield improvement was solely from the increase in plant stand in the missing gaps in the row, with no confounding maturity factor. With no interaction involved, this yield improvement is considered uniform regardless of the length or frequency of the gap that occurred.
Figure 22. Pod Yield by replant method averaged over gap length and frequency in row (excluding checks), Tifton, GA 2017

Grade was improved in the 4.0 plant/ft original stand compared to the 2.0 plant/ft original stand (Fig. 23). This was likely caused by each individual plant setting more pods around the taproot with the denser plant stand, while the reduced plant stand relied more on a limb crop of peanuts to compensate, and thus had later pod development that did not catch up in maturity.

Figure 23. Total sound mature kernels (TSMK) as influenced by gap length, frequency, and replant method, Tifton, GA 2017.
Because of the difference in maturity of peanuts for plants planted at different times in the replant scenarios, the extra time to increase maturity permitted the “full row” treatments to have an improved grade over the non-replanted and “gap only” replant treatments (Figs. 23 & 24). There is no explanation of why the grade was reduced drastically at the “2 ft 2x” treatment compared to similar treatments in the “No Replant” scenario. A closer look at plot data on the individual plot basis will need to be made.

![Bar chart showing TSMK (%) for replant methods]

Figure 24. Total sound mature kernels (TSMK) by replant method averaged over gap length and frequency in row (excluding checks), Tifton, GA 2017

With respect to Tomato spotted wilt virus (TSWV) (*Orthotospovirus*), the increased plant stand and proportion of late planted plants likely contributed to the “full row” replant management having the lowest overall incidence of TSWV (Figs. 25 & 26). The relatively early planting date (mid-April) of the original plant stand put the plants at greater risk for TSWV than later planted peanuts.
It is believed that the TSWV incidence was greater in the “gap only” treatment compared to the “non-replanted” treatment simply because there was a larger proportion of row in which plants could become infected since the total length of row with living plants in it was 100% in the treatment where gaps occurred while there were increasingly larger segments of row with no plants that could become infected in the “non-replanted” treatments. An analyses of percentage of viable row (row length with a living plant in it) will be made at a later time to test that effect.
Figure 26. Tomato spotted wilt virus incidence (TSWV) by replant method averaged over gap length and frequency in row (excluding checks), Tifton, GA 2017