# SOD BASED ROTATION IMPACTS ON COTTON GROWTH AND YIELD

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## Abstract

Recent evidence of short term perennial grass benefits to other crops in rotation with row crops is becoming more widely known. These grasses have tremendous biological and environmental impacts on the farm system. Integrating livestock into row crop operations has the potential to reverse the current trends and change the economic and environmental face of agriculture in the Southeast and the U.S. making farms more sustainable with less financial risk to the operation. Currently, some row crop farmers will use row crop land to contract graze winter stocker cattle. However, short season annual grazing has not shown the promise that integrating perennial grasses into row crop systems has using the same land base. Due to the complex nature of these types of studies, components of the perennial grass/livestock/row crop systems in humid environments are slow to be initiated. Our research integrating perennial grasses with row crops on the same land base is the most viable system that we have found for economical, biological, and environmental stewardship. This study begins to address the integrated system and cattle impacts on cotton and peanuts and related soil properties. Cattle traffic on winter grazing following bahiagrass-peanut resulted in higher soil surface (top 15 cm) compaction and bulk density. No differences were noted in plant height or node number. Cotton yield, boll number, or boll size were not impacted by cattle traffic from winter grazing. Petiole nitrate nitrogen in cotton was higher throughout the bloom-maturity period on grazed areas thought to be due to N cycling with cattle.

## Introduction

Farming has changed dramatically since the early 1950's. This was the period of transition from manual labor and horses to tractors and other mechanized equipment. Farms were more diverse prior to 1950's with cattle, hogs, horses, smaller acreage, and most commodities were sold locally or used on farm (Sulc and Tracy, 2007). Nutrients were often recycled on farms with manure or low rates of low analysis fertilizers being the norm (Dimitri et al., 2005). Since 1950, with a trend toward specialized crops, farm size has increased, the number of farms has declined, agricultural markets have become more international in scope, producers rely more on high analysis mineral fertilizers with no livestock to recycle nutrients, and government payments underpin commodity prices. Dimitri et al., 2005 reported a decrease in the number of commodities produced on farms from an average of five per farm in 1990 to less than two in 2002.

Rise in international commodity markets, high prices, and mechanization resulted in the use of short term rotations, annual cropping systems and the loss of livestock and diversification on farms in many parts of the U.S. The high prices for soybeans in the early 1970's were economically successful but took a lot of livestock out of the Southeast with fences being torn down to make room for larger equipment and larger fields. During this period there was dramatic growth in farm output on U.S. farms. When soybean prices fell in the 1980's about 80% of the row crops land was rented. Growers compensated for lower prices by renting more land and were not interested in building fences on landlord's farms to bring livestock back or diversify in other ways. As prices for soybeans and corn continued to decline growers looked to other row crops to fill in the gap. In the Southeast, corn and soybean were replaced with cotton and peanut based on price and crop insurance potential if crops failed. From the late 1990's to 2006, row crops were only marginally profitable even with high yields. This led to more growers leaving the business and other farmers using larger equipment. This short term rotation of annual crops has led to negative impacts to the environmental including: loss of soil organic matter (Kefyalew, et al., 2007); degradation of soil physical characteristics and increased soil erosion (Bullock, 1992, Karlen, et al., 1994b); surface and groundwater contamination (Karlen, et al., 1994b); an increase of pests, nematodes, diseases, weeds, insects, etc. (Katsvairo, et al., 2006); and an increase in greenhouse gasses (Lal et al., 1999). One method of alleviating many of the problems is integration of perennial grasses and livestock with row crops on the same land base. Pastures and livestock integrated with row crops has had limited attention by researchers in the U.S. In Florida, continuous cropping systems using conservation tillage techniques, has been compared to row crop/pasture rotations and have been shown to be more economically and climatically buffered due to their higher diversity, and were more environmentally sustainable since fuel and pesticide usage was 50% lower. Soil organic matter content has been shown to increase about 0.1% per year with perennial grasses/row crops as compared to simple annual crop rotations using conservation tillage.

Our objectives were to determine the impact of cattle traffic on soil properties and the cotton crop when grown in a livestock/perennial grass/row crop system using conservation tillage techniques and winter covers either grazed or not grazed.

## Materials and Methods

A large scale rotation project of 2 years of bahiagrass followed by peanut/winter grazing and then cotton/winter grazing was initiated to determine the impacts of cattle traffic from a cow/calf operation on the following cotton crop. Crops grown in each of the quadrants in the rotation were bahiagrass-bahiagrass-peanut-cotton (B-B-P-C). Winter grazing is planted after both cotton and peanut. The study is under a 139 acre variable rate center pivot irrigation system with dry corners amounting to 40 acres in each quadrant. Three large exclusion areas, 16X16 meters square, were fenced off in the rotation scheme where cattle traffic was never allowed in the areas of bahiagrass, or winter grazing behind cotton or peanut. However, other normal agricultural operations such as cutting hay, winter grazing, or row crop planting were allowed and fences taken down for these operations. All crops were planted with no-till or conservation tillage methods. Areas outside exclusion cages were designated for similar measurements as within the cages. Plots were mapped with GPS coordinates so that fences could be erected in the same location after each crop sequence. Soil resistance measurements were made with a had held recording penetrometer and soil samples taken at different depths from the 3 exclusion cages for bulk density and soil moisture measurements. Likewise, plant height and node numbers, leaf chlorophyll and petiole nitrate nitrogen measurements were taken during the growing season on cotton plants. Final yield, boll number and size, and turnout measurements were taken on the cotton at harvest.

## Results and Discussion

Soil penetrometer measurements were made in April prior to planting cotton. Figure 1 shows that cattle do have an impact on soil compaction in the top 20 cm. Roots of annual crops will not penetrate soil when soil resistance is above 3000 kpa. No differences were detected at 20-30 cm depth, while compaction appears to be higher below 30 cm on grazed areas. This is the reason that in row subsoiling is necessary on Coastal Plain soils.

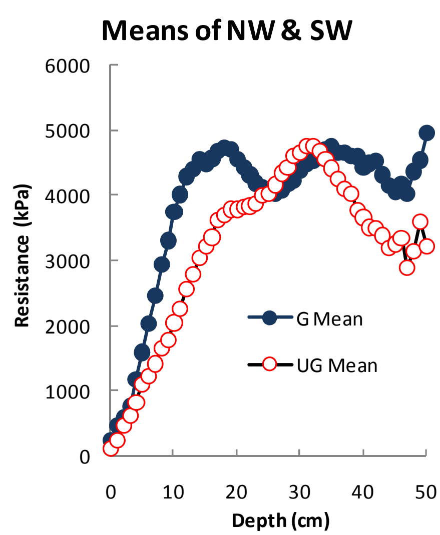


Figure 1. Soil resistance in grazed and un-grazed areas prior to planting cotton.

In 2007, cattle on winter grazing after peanut had increased soil resistance in the top 100-150 mm indicating surface compaction from the cow/calf operation (Fig. 1). However, this made little difference on the winter grazing (oats) since they were well established before cattle were allowed to graze the area. Oats were almost 12 inches tall prior to allowing animals accessing the winter grazing.

Petiole nitrate nitrogen tended to be higher in the non irrigated cotton and where cattle had grazed (Fig. 2). This was thought due to less leaching without irrigation and recycling of nutrients by cattle. Highest levels of nitrate nitrogen occur at squaring to first bloom in cotton plants and decreases thereafter. This is typical for cotton as more nutrients are moved into the boll and reproductive parts of the plant.

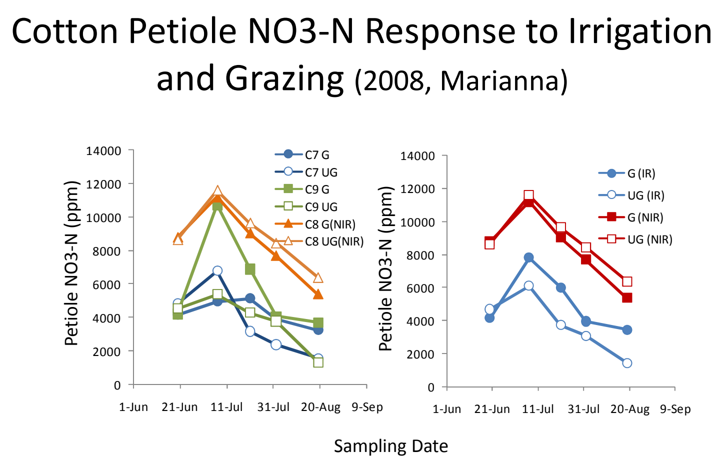


Figure 2. Petiole nitrate nitrogen in grazed and un-grazed areas in response to irrigation

Leaf area index of cotton had a tendency to be higher with grazing and continued to increase until late August or early September when no new vegetative growth occurred (Fig. 3).

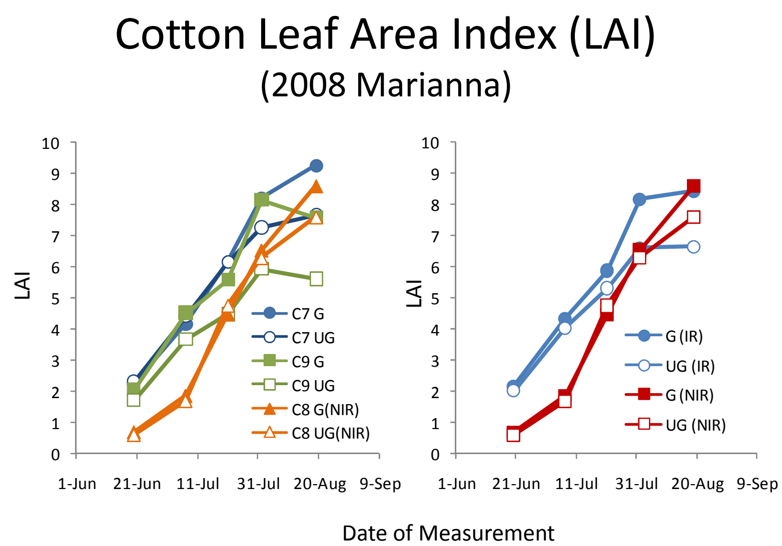


Figure 3. Leaf area index of cotton from grazed and un-grazed and irrigated and un-irrigated areas.

Chlorophyll measurements were made to correlate with nitrate levels in the plant (Fig. 4). However, even though readings continued to increase little difference was found between treatments whether cattle grazed them or whether they were irrigated.

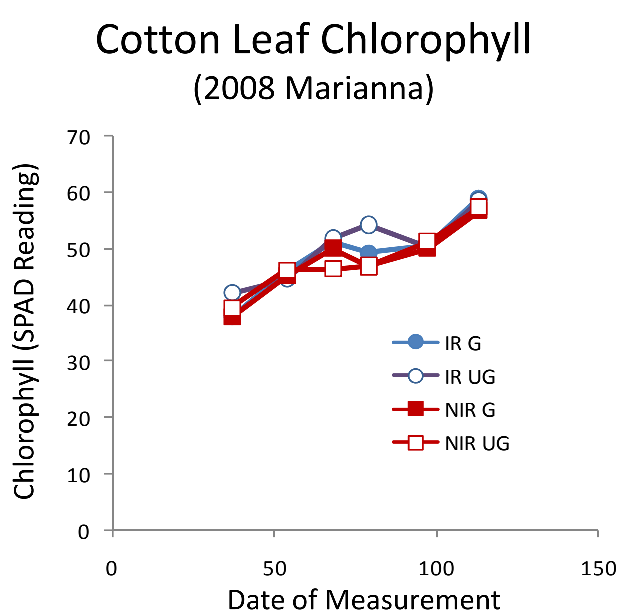


Figure 4. Chlorophyll measurements throughout the bloom and boll set period either grazed or un-grazed or irrigated or un-irrigated.

Yields follow the same trends as in the dry year of 2007 in that cotton following winter grazing in the Bahia grass rotation had a tendency for higher yields than cotton grown in un-grazed areas (Fig. 5). However, only the cotton grown after grazed winter grazing had significantly higher yields than both the un-grazed areas with or without irrigation. Our speculation is that nitrogen status of the soil is better even though nitrogen does not appear to be a limiting factor.

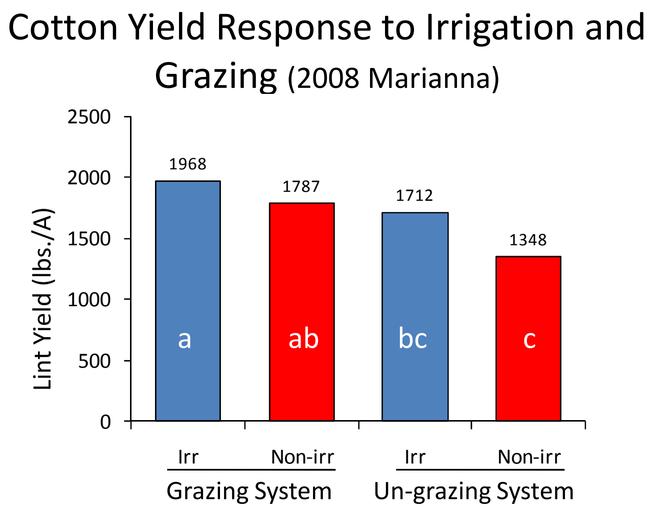


Figure 5. Yields of cotton in grazed and un-grazed and irrigated and un-irrigated areas.

Cotton yield components varied with un-irrigated plots having fewer plants since it was very dry during germination and the first 6 weeks of growth (Fig. 6). This resulted in higher numbers of bolls/m2. Turnout was higher in the un-grazed, irrigated areas. Higher yields from the grazed areas were shown in 2007 as well. This is the second year showing higher yields of cotton can be expected behind winter grazing. Likewise, benefits have been shown to winter grazing yields following Bahia grass as compared to the conventional rotation of two years of cotton followed by peanuts. Therefore, both peanut, cotton, and winter grazing benefit from having Bahia grass in rotation and it appears that cattle can add an extra 175-400 lbs lint/A above not having cattle in the system. Research will continue in this area in 2009.

## Cotton Yield Components

| Treatment | Plants | Open Bolls | | Boll Size | Turnout | Lint Yield |
|---|---|---|---|---|---|---|
| | (No./m2) | (No./pl.) | (No./m2) | (g/boll) | (%) | (lbs/A) |
| G (IR) | 9.17 a | 12.46 b | 111.8 a | 4.76 | 41.4 b | 1968 a |
| G (NIR) | 6.12 b | 15.66 a | 96.0 ab | 5.00 | 41.9 b | 1787 ab |
| UG (IR) | 9.52 a | 9.82 c | 93.3 b | 4.77 | 43.2 a | 1712 bc |
| UG (NIR) | 5.93 b | 12.67 ab | 74.2 b | 4.86 | 41.8 b | 1347 c |

Figure 6. Yield and yield components of cotton in either grazed or un-grazed and irrigated and un-irrigated fields.

## Conclusion

Bahiagrass in rotation with row crops has enhanced the economical, biological and environmental aspects of the conservation farming system as compared to the standard peanut/cotton rotation using cover crops and conservation tillage. When cattle were added to the system, cattle traffic compacted the top 10 cm of the soil surface. We have shown that perennial grass has a positive impact on water infiltration, lowered soil mechanical resistance, increased LAI and plant biomass, and increased deep soil moisture. Cattle often have a positive impact on farm economics by utilizing forages or crop residue during the off season. With this study comparing cotton after peanut after bahiagrass, where the winter cover was grazed or not grazed, we found no difference in cotton height, node numbers, or SPAD meter readings but did find an increase in petiole nitrate nitrogen from bloom until maturity. Increased nitrates were noted throughout the year resulting in significantly higher yields in the irrigated grazed than un-grazed and non irrigated and grazed than un-grazed. Therefore, cattle do have a positive impact on cotton yield. Future research will continue to focus on nitrogen cycling and impacts on other parts of the system.

## Acknowledgement

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