INTEGRATING CATTLE IN A SOUTHERN PIEDMONT CONSERVATION TILLAGE COTTON-COVER CROP SYSTEM

Harry H. Schomberg, D. Wayne Reeves, Dwight S. Fisher, Randy L. Raper, Dinku M. Endale, and Michael B. Jenkins.
USDA-ARS J. Phil Campbell, Sr., Natural Resource Conservation Center in Watkinsville, GA
harry.schomberg@ars.usda.gov

INTRODUCTION

Winter cover crops are often perceived as costly because there are no direct returns from selling the cover crop (Snapp et al., 2005). Additional negative concerns are expressed due to the potential for cover crop induced water stress early in the growth of the main cash crop. Cover crop conservation benefits have been documented for all major crops and growing regions of the US (Dabney, et al., 2001). Beyond the soil conservation benefits, cover crops have been shown to improve water availability by contributing to improvements in soil physical properties that directly influence water infiltration and reduce runoff (Touchton, et al., 1984; Bruce et al., 1995). Payments from government incentive programs, like the Conservation Security Program, can help offset the cost of cover crops (up to \$8 acre^{-1}) (Causarano et al., 2005). Another option for offsetting cover crop costs and increasing farm revenue is grazing of winter cover crops by cattle (*Bos taurus* L.). Grazing stocker cattle in a cotton-peanut rotation in south Alabama produced \$157 gross return and \$75 net return per acre from cattle (Siri-Prieto et al., 2003).

Grazing cover crops may reduce soil productivity due to hoof induced soil compaction during the grazing period (Miller et al., 1997). Cotton yields were reduced an average of 14% in two out of three years on silt loam soil in North Alabama where cover crops were grazed (Mullins and Burmester, 1997). The degree of soil compaction from grazing is influenced by a number of factors (soil texture, soil water content, grazing intensity, vegetation type and climate regime; Taboada and Lavado, 1988). Siri-Prieto et al. (2003) found that paratill or in-row subsoiling was required to alleviate grazing induced compaction and maximize cotton and peanut yields in south Alabama.

In the Southern Piedmont, depth to the Bt layer influences profile soil water content and in turn can influence the degree of compaction from grazing. Depth to the Bt is spatially distributed with erosion class being a surrogate indicator but at a very rough scale (Endale et al., 2006). Other factors influencing soil response to cattle may also be spatially variable but need to be quantified before management strategies can be developed to both reduce compaction initially and apply ameliorative remedies on a spatial basis. By identifying important spatially variable factors, the potential exists to combine new technologies for evaluating spatial variability with GPS technology and in cab GIS maps to identify management zones requiring deep tillage. Performing deep tillage only on areas with a high probability of compaction would therefore reduce producer costs.

Our objectives were to evaluate on a spatial scale the impact of cattle grazing winter annual small grains on (1) cotton and (2) animal production and (3) soil compaction. We measured a number of spatially distributed soil and plant properties to identify those that might easily be combined to define management zones for applying remedies for soil compaction.

MATERIALS AND METHODS

This study started in the fall of 2005 and will continue over three cotton growing seasons (2006-2008). Four fields at the USDA-ARS J. Phil Campbell, Sr., Natural Resource Conservation Center in Watkinsville, GA (33° 59' N, 83° 27' W) historically in no-tillage and instrumented to determine management effects on sediment and nutrient losses from typical fields in the Southern Piedmont are used in the study. Three of the fields are 3.3 acres while the fourth is 6.9 acres.

Winter rye (*Secale cereale* L.) is planted with a no-till grain drill in early October as a cover crop on all fields. Poultry litter is applied in the fall to provide sufficient P for both rye and cotton (*Gossipium hirsutum* L.) and supplemental N is added as needed for cotton and rye. On two fields, rye is grazed with heifer cattle for 10 to 14 days starting in late-March. The other two fields are not grazed and the rye is killed with glyphosate the second week of April. Cattle in the grazing treatment are weighed at the beginning and end of the grazing period. Stocking rate is established based on forage availability and estimated intake so that pastures are defoliated in approximately 10 days. Cover crop biomass is determined prior to and after grazing and just prior to cotton planting. Cover crop residues are analyzed for carbon and N, P, K, Ca, Mg. Cotton is planted the first week of May with a no-till planter. Cotton plants are sampled at first bloom and mid-bloom for biomass, plant height, and nutrient status to determine grazing and landscape effects on growth and nutrient content. Winter grazing effects on plant water stress and soil water availability (0 to 30 cm) are determined from first bloom until cutout by measuring soil water content using TDR probes inserted vertically into the soil. Cotton is harvested in the fall after defoliation using a harvester equipped with a yield monitor and GPS to collect georeferenced yields. Cotton samples from five areas in each field are collected for determination of fiber length, strength, micronair, and uniformity using High Volume Instrument (HVI) classing.

Prior to planting in the fall of 2006, we sampled the fields using standard soil survey characterization techniques on a 12-m by 12-m grid (~ 10 points acre^{-1}) using a trailer mounted hydraulic sampler equipped with Differential Global Positioning System (DGPS) to determine soil characteristics. Soil cores were 5 cm diameter by 60 cm depth and are being characterized for soil texture, soil C, soil N, depth to the Bt layer, and plant nutrients by depth. Soil electrical conductivity (EC) was determined with a Veris Technologies 3100 Soil Electrical Conductivity Mapping system equipped with DGPS. Soil penetration resistance was measured using a tractor mounted penetrometer with DGPS. Soil type, EC data, depth to Bt, and soil penetrometer data are being combined in a Geographic Information System (GIS) for developing plant sampling zones for the second cotton growing season.

To determine the cumulative grazing effects on soil compaction, soil penetration resistance measurements are repeated each year at the same locations in the spring following cotton planting. Geostatistical methods will be used to analyze soil, water, and plant data to determine landscape and grazing effects on cotton productivity. At the end of the study, soil samples will be collected from the 0 to 5 and 5 to 10 cm depths to evaluate changes in soil C and soil quality parameters (particulate soil carbon and nitrogen, soil microbial biomass, aggregate stability).

The data will also be used to develop guidelines for decisions on subsoiling after cattle grazing. Economic costs of grazing winter rye in a cotton system will be determined. Grazing effects on runoff characteristics (water loss, sediment, nutrients and microorganisms) of the watersheds will be determined and evaluated against historic runoff and soil loss characteristics of the fields.

RESULTS AND DISCUSSION

Identification of management areas

Management zones were developed for future guidance in the development of sampling schemes and to test for relationships between management zone designations associated with grazed versus ungrazed fields. Thus far management zones were developed in 2 ways. First we utilized the spatially referenced variables of;

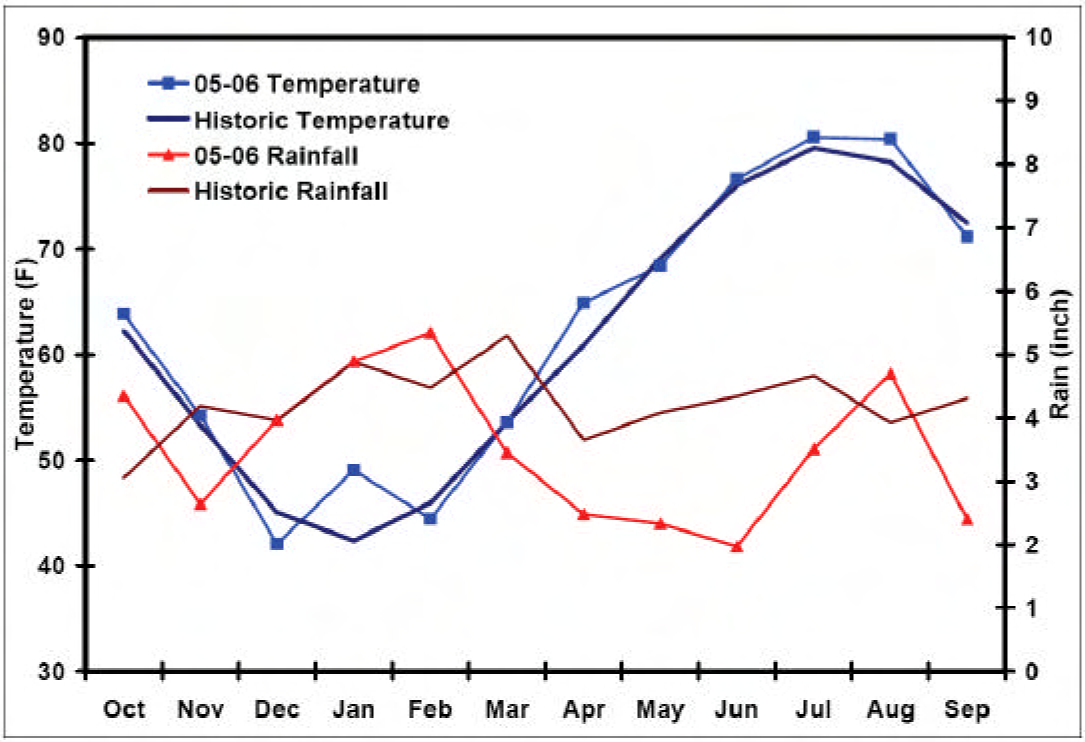
1) Elevation,
2) Slope,
3) Plan curvature,
4) Profile curvature,
5) Compound topographic index,
6) Soil electrical conductivity at two depths (0 to 30 cm and 0 to 90 cm),
7) Depth to the Bt soil horizon,
8) Normalized Difference Vegetation Index collected during early growth of fall planted small grains in 2006, and
9) Cotton yield from 2006.

Secondly, we estimated the principle components of a dataset consisting of these variables and used the orthogonal variables from the principle component analysis to developed management zones. In both cases, the data currently support 2 to 5 management zones and zones do not show a relationship with the grazing treatment. Management zones were defined across all four fields and the analysis indicated only one zone was well represented in all fields while other zones were missing in some fields. Currently we have 5 variables describing the topography, 2 variables related to soil properties, and two plant growth variables. In the future, we will add additional soil and plant variables to the dataset and repeat the statistical analysis testing for changes in the management zones with time as related to treatment variables and to soil variables influenced by management.

Weather data

Cover crop growing period temperature and rainfall were similar to long term averages. Rainfall deficits occurred in November, March, and April of the rye growing period. The rainfall deficit in the spring did not appear to negatively impact rye growth or availability of forage in the first year of the study.

During the cotton growing season, temperatures were near the historic trends. However, there was a period of cool temperatures during the two weeks following cotton planting in mid-May that appeared to prolong germination and stand establishment. Limited rainfall during June reduced cotton growth, whereas rain in July and August coincided with blooming and boll formation. Total rainfall during the cotton growing period from May to September was 14.9 inches; 6.4 inches below the long term average.



Temperature and Rainfall for the cover crop and cotton growing seasons Fall 2005 to Fall 2006 and the long-term averages at Watkinsville, GA.

Grazing Data

In the first year, cereal rye (*Secale cereale* L.) herbage grew from approximately 1000 lbs/acre in February to 8000 lbs/acre in mid April. The area was grazed with 59 Angus heifers for 11 days (in March and April) beginning with an initial herbage mass of approximately 3000 lbs/acre, which ultimately provided approximately 4000 lbs/acre of grazed forage during the grazing period.

In the second year with fewer animals (40 Angus heifers) we began grazing during a period of rapid growth with a herbage mass of only 2000 lbs/acre defoliated over 7 days harvesting an estimated 2300 lbs/acre. However, because of the earlier start the fields were defoliated twice although the second defoliation, only yielding approximately half of the original grazed forage.

We estimated that a stocking rate of 1.4 animals/acre would have kept the area defoliated between February 1st and April 15th if animal management and agronomic management are efficient and climate is adequate.

<u>Yield data</u>

Cotton was planted May 12th and 15th just prior to 10 days of cool weather which delayed germination and growth. Cotton was harvested in the fall of 2006 using a picker with a yield monitor. Seed cotton yields ranged from 2140 lbs/ac to 2950 lb/ac. No significant yield differences were detected between grazed and ungrazed fields (both treatments averaged approximately 2500 lb/ac). After ginning, our yield per acre averaged 1008 lb lint/ac. Conservation tillage, heavy residue from the rye cover crop, late season rain in August and a dry fall were critical for producing yields in this range. Georgia's cotton production for 2006 totaled 2.12 million bales (480 lb lint/bale) on 1.33 million acres and averaged 765 lb/ac or 1.6 bales/ac.

CONCLUSIONS

Preliminary results indicate grazing cover crops can be a viable option for cotton producers in the Southern Piedmont because of the potential to increase revenues from grazing without reducing cotton yields.

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