CONSERVATION TILLAGE BOOST FROM PERENNIAL GRASSES

David Wright, James Marois, Tawainga Katsvairo, Duli Zhao, Kris Balkcom, Dallas Hartzog, Cheryl Mackowiak, and Ann Blount

155 Research Road, Quincy, FL

wright@ufl.edu

INTRODUCTION

U.S. farms were diversified and livestock was a necessary part of life for transportation and cultivation of crops in the first half of the 20th century. Perennial grasses were used for livestock feed and grain was grown to supply feed for animals. Mechanization brought concentrated areas of grain production and a two crop system for the mid west. Along with mechanization came improvements in plant breeding, fertilizer and pesticide technology and rapid expansion of annual crops and intensive tillage. Extensive areas of tillage resulted in water and wind erosion with loss of productivity. However, recent systems research utilizing conservation tillage has shown that economics, and the decline in soil and water quality, and the environment can be reversed by reintroducing perennial grasses back into cropping systems (Katsvairo et al., 2006). Currently, over 2/3rds of the worlds food supply is produced by crops that have to be planted annually and most of these are produced using tillage (http://www.landinstitute.org/). The recent increase in corn and soybean prices may result in a slow movement back to perennial grasses in rotations unless a large economic advantage or risk management can be shown. While conservation tillage has resulted in many benefits, farmers are still struggling with relatively small yield increases even using new technology. A tri-state research project with bahiagrass in rotation with cotton and peanut has shown higher yields (30% higher peanut yields as compared to cotton/peanut rotations using conservation tillage with annual cover crops), increased infiltration rates (more than 5 times faster), less soil compaction, and a more economically viable cropping system (2 to 7 times higher). Penetrometer measurements have shown less compaction in April from fall kill vs. spring kill perennial grass in the compaction layer. The system needs further refining for different areas of the country, different perennial grasses and different cropping systems as well as to determine cattle impacts on subsequent crops, soil, and water quality. However, all parameters measured over the course of the study have shown measurable improvements over the conventional rotations using conservation tillage.

Reeves (1997) and others have noted the positive benefits of perennial grasses in rotation with row crops and have reported on the advantages shown by Brazilian farmers using perennial grasses. Conservation tillage techniques are still being slowly adopted by peanut farmers in the SE for peanuts while cotton has had a high adoption rate for conservation tillage. If proper management is worked out for peanuts, yields are just as high as or higher than under conventional tillage procedures. Conservation tillage alone may not increase peanut yields where it may have a more beneficial impact on other row crops. Wright et al. (2006) have shown that time of kill of cover crops can have a major impact on the subsequent crops and the problems observed from dry soil, soil insects, and seedling diseases, and that time of kill of perennial grass can also impact certain soil factors at planting.

It has long been known that Coastal Plain soils have a natural compaction layer that limit root growth starting at 15-20 cm depth and continuing to 30-35 cm (Kashirad et al., 1967). Roots limited to the top 15 cm of soil have a very limited water and nutrient supply in sandy Coastal

Plain soils and impacts summer as well as winter annuals. Annual crops fail to develop deep root systems under these conditions, and are often susceptible to periods of moisture stress. It has been shown that perennial grasses develop a deep root system which can penetrate through the compaction layer (Elkins et al., 1977; Katsvairo, et al., 2006) and therefore can have a major impact on soil quality. When roots die, they decay and leave root channels which impacts soil structure, water infiltration and available water for the following crops (Elkins et al. 1977; Wright et al., 2006, Katsvairo, et al. 2006). Long and Elkins (1983) compared cotton following 3 years of bahiagrass sod with continuous cotton and found a seven fold increase in pore sizes large enough to impact water infiltration rates and allow the subsequent crop roots to follow through the compaction layer.

Perennial grass value can be determined in long term studies from the Midwest which have shown a loss of ¼ to ¾ of the SOM that was present 100 years ago (Magruder, Sanborn, and Morrow plots) when they were first taken out of perennial grasses and tillage was started. Continuous tillage of soils in the U.S. during the past century degraded these soils, and especially OM, to a level ¼ of what it was originally. Generally, OM decays faster in the Southeast due to higher temperatures than the Midwest. It is known that rotations with perennial grasses will increase soil carbon, improve soil structure, and decrease erosion to a higher level than the winter annual cover crops. Winter annual cover crops have a short duration and degrade fast. Cover crops were used mainly for nitrogen production, erosion control, building OM and nematode suppression during the last century. Many studies with various perennial grasses have shown a major impact on yield of following crops (Katsvairo, et. al, 2006). Even though farmers know about yield improvements following perennial grasses, they seldom use the rotation since little research has been done showing that perennial grasses can be used economically in a row crop system. Rotation is always at the top of the list as an important component of producing crops profitably (Wright et al., 2006). The U.S. Geological Survey has reported that 63% of North America that was previously in native grasslands is now cultivated. Recent research indicates that conservation tillage techniques can be altered to use with perennial grasses to get much better results than with annual cover crops for both environmental as well as economic benefit. The objective of this research was to show impacts of bahiagrass on following crops using conservation tillage in comparison to crops in standard rotations using conservation tillage.

MATERIALS AND METHODS

This long term multi-state (GA, FL, AL) project exams the impact of bahiagrass in rotation with peanut and cotton. This project has completed one full rotation in FL and AL and a new site has been started in GA. Each site has the basic rotation of 2 years of bahiagrass followed by peanut followed by cotton. Winter grazing or cover crops are planted behind each of the row crops and sometimes first year bahiagrass if crop conditions are favorable. The basic design of the study at Marianna, FL is shown below and is under a 140 acre center pivot irrigation system:

Bahiagrass going into the 2nd year	Peanuts after bahiagrass planted May of 2007
Winter grazing with bahiagrass planted no till in May of 2007	Cotton after winter grazing planted May of 2007

Cotton and peanut are planted in one quarter of the pivot each year along with the first year bahiagrass, while the bahiagrass going into the second year continues to grow. Winter grazing is planted within 3 weeks of harvest of cotton and peanut for winter grazing each year and the first year bahiagrass may be over seeded if it is grazed down low enough in the fall.

Data collected has included water infiltration, soil carbon, soil fertility, bulk density, weed population, earthworm numbers, penetrometer measurements, soil moisture measurements, yields and grades of crops, cattle weight gain.

RESULTS AND DISCUSSION

When producers plant peanuts after bahiagrass, they do many tillage passes to tear up the “sod”. Getting good stands of peanut after bahiagrass using conservation tillage methods is an unknown in many people’s minds as well as the digging process. Most growers consider it too hard to plant into bahiagrass and that some tillage needs to be done to obtain good yields. Research from this study compared strip tillage in conventional rotations to strip tillage into bahiagrass without tillage. When perennial grasses are killed, there is a high C: N ratio due to the amount of roots as compared to annual crops (2/3rds of the plant biomass vs. 1/3 for annual crops) which may be detrimental to crops requiring high amounts of N. The bacteria breaking down the plant tissue requires N which is tied up and unavailable for plant growth as the dead tissue decays. Root channels from decayed bahiagrass roots are one of the main passage ways for the subsequent crop roots to get through the compaction layer. We know from previous data that cotton roots exploit the channels and developed a more extensive rooting system in the second year after bahiagrass, which utilize more N across a wider soil profile. Higher root biomass, root area and root length were observed in the bahiagrass rotated cotton following peanut (Katsvairo et. al, 2007).

Peanut land had typically been plowed to reduce diseases until the last 5 years. The idea was that if you turned the land you could bury disease organisms and would have less disease. This concept seemed reasonable until the early 80’s when research showed that strip tilled peanuts actually had less white mold and recent research has shown that tomato spotted wilt virus is less in strip till than conventional fields and even less in bahiagrass rotated fields. This concept took many years to overcome and some growers are still convinced that strip tillage will not work with peanuts. Research in the Virginia/Carolina area (Jordan, et. al., 2004) with annual cover crops has shown that peanut diseases are less with strip tillage. However, while bahiagrass is the favored crop to follow with peanut, there are few areas where bahiagrass is abundant enough to have many acres following it so corn or cotton are the rotation crops of choice.

During the last five years of the study, cotton and peanut yields have been monitored with and without irrigation in both a conventional rotation and the bahiagrass rotation at Quincy. Yields of peanuts averaged almost 600 lbs/A higher without irrigation in the bahiagrass system than the irrigated peanuts in the conventional rotation (Fig. 1). When you consider the cost of the irrigation system or rented irrigated land as compared to non irrigated land this amounted to over $200/A more profit than with irrigated. Likewise, there was no difference in peanut yields over the 5 years with peanuts when comparing the conventional rotation with and without irrigation and the bahiagrass system in the same manner. Conservation tillage techniques were used each year in each system with no problem in either planting, digging, or harvesting or in the grades of the peanuts. Therefore, a bahiagrass rotation should be highly considered for peanut production because of the extra yield, lower disease, and higher grades that can be expected.

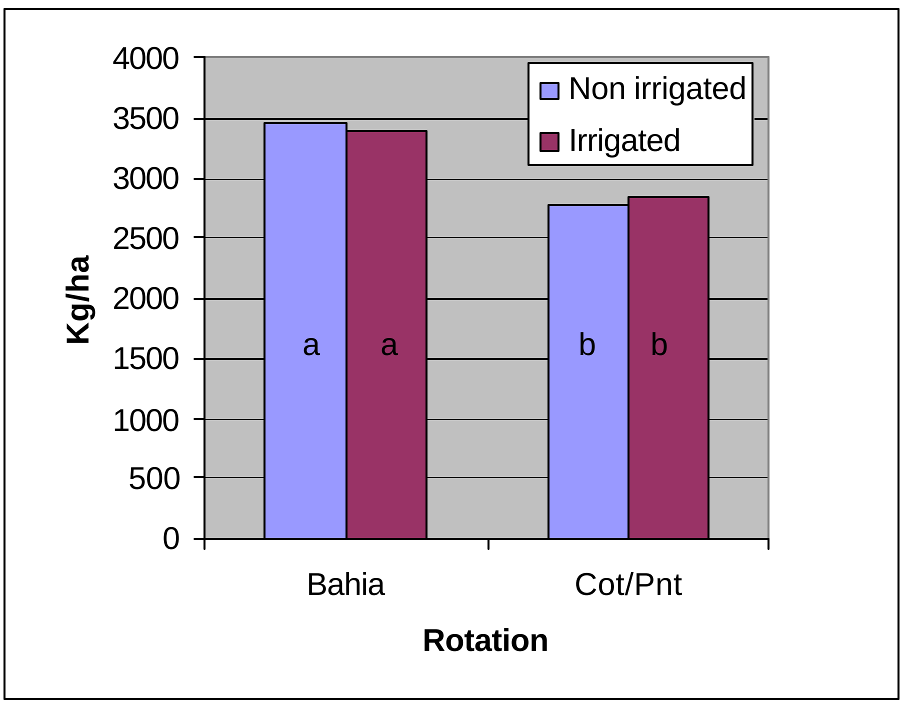

Figure 1. Impacts of bahiagrass and irrigation on peanut yields averaged over a 5 year period (2002-2006) at NFREC, Quincy, FL

Likewise, all of the factors measured such as total plant biomass, LAI, N uptake, and root growth for cotton would indicate that yields would be expected to be higher since all growth parameters were higher in each year (Katsvairo et al., 2007). However, yields are not always higher for cotton in the system. Elkins et al., 1977 reported significantly higher cotton yields when planted after bahiagrass. However, in none of the 4 years at Quincy were cotton yields significantly higher than for the conventional rotation. All of the other crops including the winter cover crops exhibited a significantly higher yield. This includes the peanut crop the year before cotton in the bahiagrass rotation and the winter cover crops both before and after cotton. These enhanced plant growth factors on peanut, cotton, and small grain cover crops resulted in higher yields for all crops except lint yields of cotton. Figure 2 shows that there were no yield differences for cotton over the 4 year period from 2003-2006 in the bahiagrass system. Further research with variable rate irrigation and fertility levels will be used to determine if yield increases can be made to match the increased plant growth that is normally seen in cotton in the bahiagrass rotation.

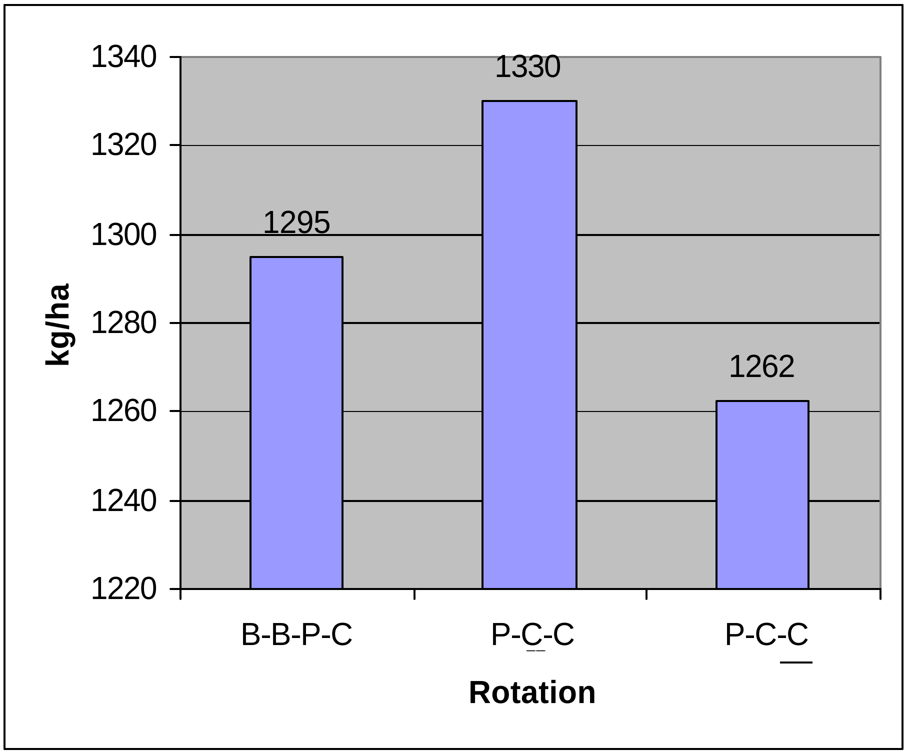

Figure 2. Influence of bahiagrass on cotton yields (2003-2006) in a bahia/peanut/cotton (B-B-P-C) rotation as compared to cotton in a standard cotton/cotton/peanut (P-C-C, or P-C-C) rotation using cover crops and conservation tillage at NFREC, Quincy, FL

Cotton rotated with bahiagrass has been shown to have better top and root growth in every case but it may not translate into yield. However, the benefits that have been shown with peanuts is a big enough economic incentive for most growers to try the system on some part of their farm. The reduction in risks from having half as many acres in “cash crops” is another major factor when you consider that most of the risk from crop production is weather and pest related.

CONCLUSIONS

Bahiagrass can be managed in such a way to allow strip tillage planting to make it more economical to grow peanuts. This system is being refined for different areas of the country, different perennial grasses and different cropping systems and is adding value to conservation tillage planting methods above applied inputs. Perennial grass rotations reduces risks, enhances the environment and offers economic value to producers.

REFERENCES CITED

Elkins, C. B., R. L. Haaland, and C. S. Hoveland.1977. Grass roots as a tool for penetrating soil hardpans and increasing crop yields. Proc. 34th Southern Pasture and Forage Crop Improvement Conf. P. 21-26. April 12-14, 1997, Auburn Univ. Auburn, AL.

Kashirad, A. J., G.A. Fiskell, V.W. Carlisle, and C.E. Hutton. 1967. Tillage pan characterization of selected Coastal Plain soils. Soil Sci. Soc. Am. Proc. 31:534-541.

Katsvairo, T. W., D.L. Wright, J.J. Marois, D.L.Hartzog, J.R. Rich, and P.J. Wiatrak. 2006. Sod-livestock integration into the peanut-cotton rotation: a systems farming approach. Agron. J. 98:1156-1171.

Katsvairo T.W., D.L. Wright, J. J. Marois, D. L. Hartzog, K. B. Balkcom, P. J. Wiatrak and J. R. Rich. 2007. Cotton roots, earthworms, and infiltration characteristics in sod-peanut-cotton cropping systems. Agron J 99:390-398

Long, F. L. and C.B Elkins. 1983. The influence of roots on nutrient leaching and uptake. *In* Lowrance, R., T., Asmussen, L., and Leonard, R. (eds) Nutrient cycling in agricultural ecosystems. Univ. of Ga. College of Agric. Exp. Stations, Spec. Pub. 23, pp. 335-352.

Reeves, D. W. 1997. The role of soil organic matter in maintaining soil quality in continuous cropping systems. Soil and Tillage Res. 43:131-167.

Wright, D.L., J. Marois, T. Katsvairo, Pawel Wiatrak, and D. Hartzog. 2006. Perennial grasses- a key to improving conservation tillage. Proc. Southern Cons. Till. Conf. for Sustainable Agr. June 26-28, 2006. Amarillo, TX
http://www.ag.auburn.edu/auxiliary/nsdl/sctcsa/