PERENNIAL GRASSES - A KEY TO IMPROVING CONSERVATION TILLAGE

David Wright[1*], James Marois[1], Tawainga Katsvairo, Pawel Wiatrak and Dallas Hartzog

[1]University of Florida, North Florida Research and Extension Center, 155 Research Road, Quincy, FL 32351-5677

[*]Corresponding author's e-mail address: wright@ufl.edu

ABSTRACT

Before heavy mechanization and intensive cultivation, perennial grasses and forest land covered the U.S. Farmers were diversified and livestock was a necessary part of life for transportation, tillage and travel. Perennial grasses were used for livestock feed and grain was grown to supply feed for animals and any additional was sold to neighbors. After WWII, farms became mechanized and livestock numbers diminished along with perennial grass pastures. Mechanization brought concentrated areas of grain production and loss of pastures and hay fields. Improvements in plant breeding, fertilizer and pesticide technology resulted in expanded acreages of annual crops using intensive tillage. Extensive areas of tillage resulted in water and wind erosion with loss of productivity which is now being addressed by NRCS, universities and other cooperating agencies and partners through conservation tillage and related management. However, recent systems research utilizing conservation tillage has shown that economics, soil and water quality, and the environment can be further enhanced by introducing perennial grasses back into cropping systems. While conservation tillage has resulted in many benefits, farmers are still struggling with low prices and relatively small yield increases with new technology. A tri-state research project with perennial grasses grown in rotation with crops has shown higher yields (50% higher peanut yields as compared to conservation tillage with annual cover crops), increased infiltration rates (more than 5 times faster), less soil compaction if perennial grass is fall killed vs. spring, and a more economically viable cropping system. Bahiagrass killed in the fall allowed degradation of the root system through the winter resulting in as high of yields as doing tillage in the spring to plant peanut in. Adding nitrogen to help degrade spring killed bahiagrass gave as high of yields as fall killed bahiagrass but at an additional cost. Penetrometer measurements showed less compaction in April from fall kill vs. spring kill in the compaction layer. The system needs further refining for different areas of the country and different cropping systems. However, the concept is sound and is being moved onto farms for demonstration and verification.

INTRODUCTION

New technology in agriculture continues to be introduced and widely adopted by growers. Conservation tillage efforts, likewise, began in the 1960's and were hard to adapt on most farms due to lack of adequate weed control options. However, better equipment and weed control options started to become available in the late 70's and early 80's and the conservation tillage revolution began. Since the mid 90's, Roundup Ready crops became available and conservation tillage became widely accepted across the U.S. Research has shown that conservation tillage may increase soil organic matter, water infiltration, and water holding capacity, while reducing erosion, fuel and labor. The development of precision planters, subsoilers, and varieties resistant to herbicides and insects has enabled widespread adoption of conservation tillage practices in many farming systems. Research from South America began to show the potential to couple perennial grasses in rotation with row crops using conservation tillage for maximum benefit to farms (Reeves, 1997). Conservation tillage techniques are still not widely used for peanut production in the SE and have had a slower adoption rate than for most of the row crops. Reports from various researchers have indicated that yields of peanuts may be lower using conservation tillage techniques. However, lower yields are often the result of not killing out the cover crops soon enough (Wright, et. al, 2005). Many techniques have had to be worked out to make the system work.

In the Southeast, much of the farmland suffers from a natural compaction layer starting at 15-20 cm depth and continuing to 30-35 cm (Kashirad et al., 1967). This results in a shallow root system which confines root development to a small soil volume which is a small reservoir for both water and nutrients and consequently has dramatic effects on crop management and yield. Annual cover crops fail to develop deep root systems, and often are susceptible to short periods of moisture stress under the sandy conditions typical of the southeast. These crops then have no effect on the compaction layer during their life cycle or for on the following crops. Perennial grasses such as bahiagrass and Bermuda grass, which are adapted to the southeast, develop a deep root system which penetrates through the compaction layer (Elkins et al., 1977). When the roots die, they decay and leave root channels which positively impacts soil structure, water infiltration and available water (Elkins et al. 1977; Wright et al., 2004). Long and Elkins (1983) compared cotton following 3 years of bahiagrass sod with continuous cotton and found a seven fold increase in pore sizes greater than 1.0 mm in the dense soil layer below the plow depth. These pores are large enough for roots of the subsequent crop to follow through the compaction layer as well as earth worms.

Cultivation and continuous cropping of some of the best soils in the Midwest has resulted in losing ¼ to ¾ of the SOM that was present 100 years ago (Magruder, Sanborn, and Morrow plots). Many of these long term fertility sites had a rapid decrease in SOM until the 1940's and 50's when fertilizer use started to become a normal practice resulting in more biomass being produced and returned to the soil. Continuous row cropping has continued to degrade these soils. The Southeast has higher temperatures that can degrade organic matter faster than the Midwest. It is known that rotation with perennial sod crops will increase soil carbon, water infiltration, improve soil structure, and decrease erosion to a higher level than the winter annual cover crops which have been shown to be better than summer annuals. Winter annual cover crops do not do much to enhance soil quality because of their short duration and fast degradation. Living roots have a tremendous impact on soil quality with annual crops only having active roots for about 3 to 4 months each year. Much of the research in the 20th century has looked at cover crops as green manure crops to be turned under for nitrogen benefit or nematode suppression. Perennial grasses all over the world have been shown to have a major impact on yield. Florida farmers will testify that peanut, watermelon, and soybean will all yield substantially higher after bahiagrass. With economic conditions of rising labor and fuel costs expected to continue indefinitely, growing continuous annual crops can result in a decrease of SOM as well as a buildup of nematodes and diseases (Dickson and Hewlett, 1989), and compaction of the soil so roots cannot explore large areas for water and nutrients. Rotation is always at the top of the list as an important component of producing crops profitably (Wright et al., 2004). The U.S. Geological Survey has reported that 63% of North America that was previously in native grasslands is now cultivated. The reason for this is that most of these soils were highly productive and high in SOM when initially cultivated. Even though perennial grasses contribute little to the immediately available nitrogen pool, it does add significantly to the organic base and long-term nitrogen pool as well as well as helping reduce pests normally found in annual grass or legume crops (Boman et.al., 1996, Elkins et. al. 1977). Areas with long growing seasons can have two to three crops planted each year adding to the organic matter base of the soil (Wright, et. al., 1998). Benefits of sod prior to row crop production can result in dramatic increases in yield at a lower cost of production with less pesticide use and less negative environmental impact than trying to alter all of these factors with chemicals and tillage tools. Recent research indicates that conservation tillage techniques can be altered to use with perennial grasses as well as annual grasses. The objective of this part of the research was to determine if bahiagrass could be managed in a way to get high yields for the following peanut crop without tillage.

EXPERIMENTAL PROCEDURES

The multi-state project examining bahiagrass in rotation with peanut and cotton has been underway since 2000 in Florida and 2001 in Alabama and Georgia. 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 behind first year bahiagrass at times. The basic design of the study is shown at the site at Marianna, FL under a center pivot irrigation system (Fig. 1). The system rotates each year. Winter grazing is planted after harvest of cotton and peanut each year. 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, and various other measurements.

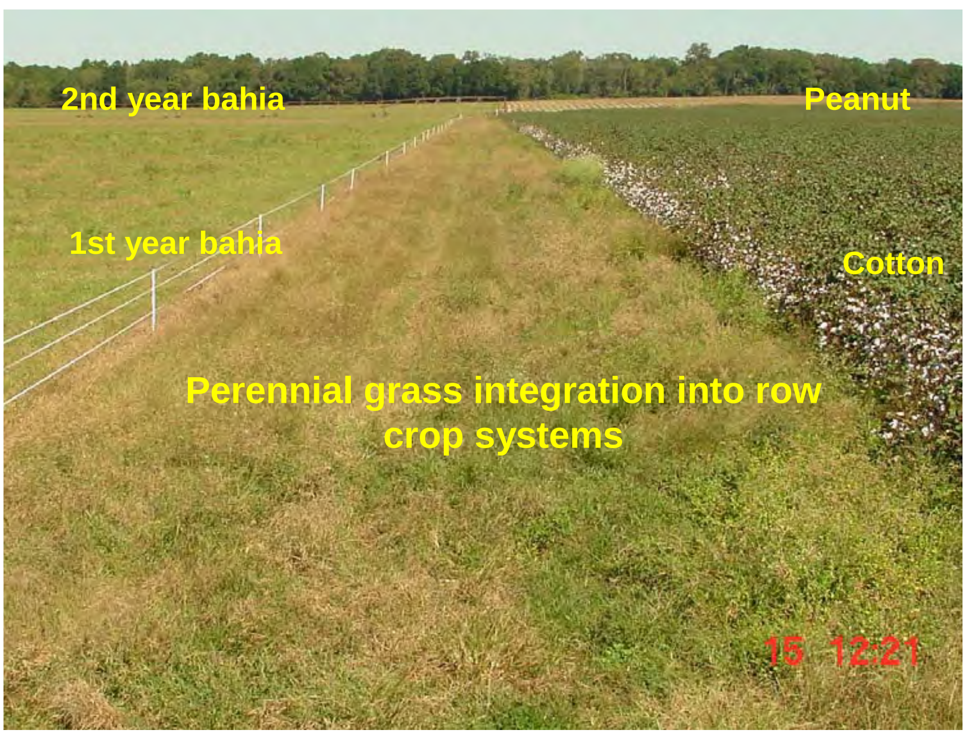

Figure1. Cotton-peanut rotation with bahiagrass with one quarter of the pivot in cotton, peanut, 1 year old bahiagrass, and 2 year old bahiagrass, respectively.

RESULTS

One of the biggest concerns of producers using bahiagrass in rotation with peanut is that of getting good stands using minimum tillage when planting directly into killed bahiagrass sod. When the grass is initially killed, there is a high C:N ratio. This results in nitrogen being tied up and slower decay of the roots and other plant tissue. Decayed root channels from bahiagrass 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.

Peanut land had typically been plowed for the last 50 years. Most of the information was for growers to turn peanut land so that disease organisms would be buried. This concept seemed reasonable until the early 80's when research showed that strip tilled peanuts actually had less white mold and other diseases than where ground was turned. This went against all prevailing recommendations and has taken a long time to overcome in the peanut industry. However, recent research by many researchers (Jordan, et. al., 2004) has continues to show 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 or other perennial grasses are abundant enough to have many acres following it. Most growers consider it too hard to plant into bahiagrass and that some tillage needs to be done to obtain good yields. Tillage and time of kill were compared at Headland, AL and Marianna, FL to determine if peanuts can be planted after bahiagrass with minimum tillage. At Marianna strip till was compared to strip till plus 40 lbs/A of N to help decompose the plant residue, chisel plow, disk, paratill and turned. Table 1 below shows that there was no significant difference between chisel plowed, disked, and turned and strip till with nitrogen added for decomposition. Strip till alone and paratill had lower yields when bahiagrass was killed in the spring and had little time to decompose.

Table 1. Influence of Tillage on Peanuts Planted into Spring Killed Bahiagrass (FL)

Tillage Treatment	Yield lb/A
Chisel plowed	4445 a
Disked	4280 a
Paratilled	3622 b
Striptilled+ 40 lbs. N	3905 ab
Striptilled	3413 b
Turned	4267 a

Table 2 below shows that there was no difference in yield when bahiagrass was fall killed between strip till and turned as was the case with spring kill. The extra time between killing bahiagrass and planting allows the bahiagrass roots to decompose and soil becomes mellower allowing easier root penetration and higher water infiltration through root channels.

Figure 2 below shows the difference killing bahiagrass in the fall vs. spring makes on penetrometer readings in April just prior to planting peanuts. Soils are less compacted from about 6” deep down to almost 18 inches deep where the level comes back together. This has big implications for managing the perennial grass crop in such a way that allows for minimum tillage. Readings will be followed to determine when spring kill meshes with fall kill plots.

Table 2. Tillage influence on peanut yield in fall killed bahiagrass either turned or striptilled (AL)

-	Yield lb/A	TSWV Incidence	White Mold
Turned Bahia	5,950 a	22.2 a	4.6 ab
Striptill Bahia	5,830 a	10.0 b	3.8 b
Turned Cotton	5,320 b	20.4 a	3.2 b
Striptill Cotton	5,160 b	10.2 b	6.6 a
LSD	271	7.7	2.6

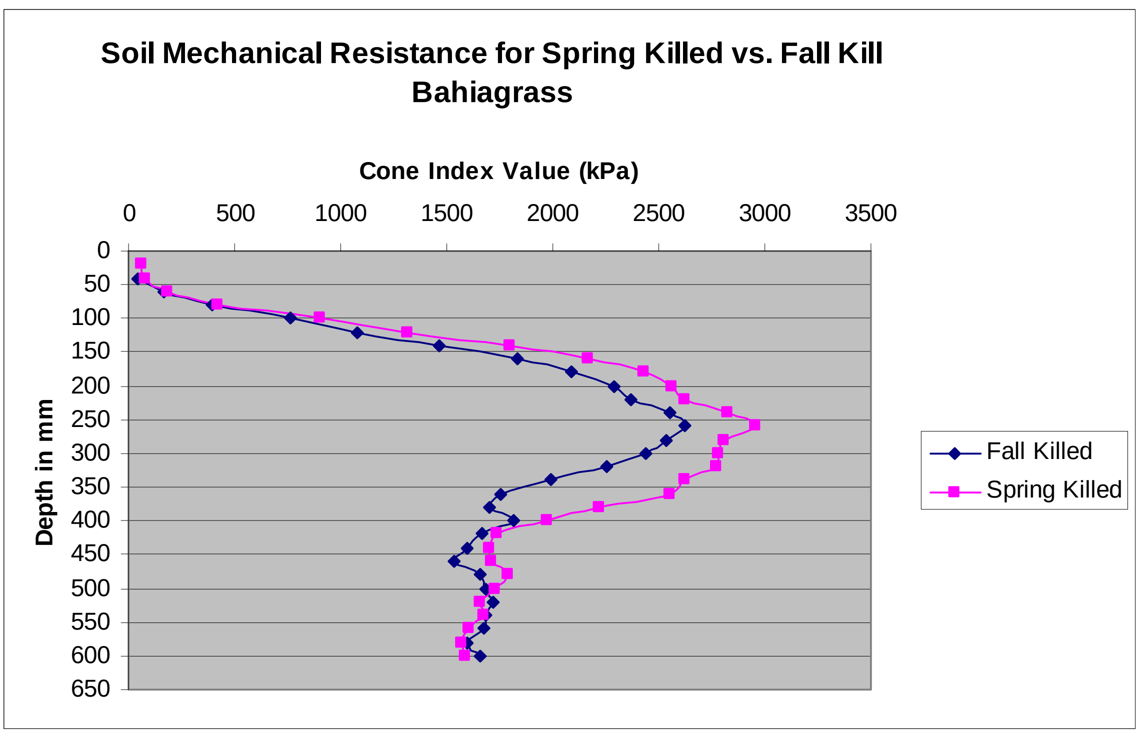

Figure 2. Influence of kill date of bahiagrass on penetrometer readings prior to peanut planting.

The bahiagrass rotated soils had less soil mechanical resistance compared to both cotton and peanuts in the conventional plots. So not only does fall killing help prepare an even better seedbed than with spring kill but it adds and extra dimension over annual cover crops. High mechanical resistance impedes root growth and subsequently reduces yield and retards water movement through the soil profile, thereby increasing the chances of water as runoff.

Fall killing of bahiagrass contributed to the positive aspects of a healthy soil which in turn resulted in healthier and more vigorously growing plants which were better able to withstand stress conditions. Bahiagrass can be managed in such a way to allow strip tillage planting to make it much more economical to grow peanuts. This system is being refined for different areas of the country and different cropping systems and is adding value to conservation tillage planting methods.

REFERENCES

Boman, R.K., S.L. Taylor, W.R. Raun, G. V. Johnson, D.J. Bernardo, and L.L. Singleton. 1996. The Magruder Plots: A century of wheat research in Oklahoma. Div. Of Agri. Sci. and Natural Resources. Pp1- 1-69.

Dickson, D. W. and T. E. Hewlett. 1988. Effects of bahiagrass and nematicides on Meloidogne arenaria on peanut. Supplement of J. Nematology 21 (4S):671-676.

Edwards, J. H., D. L. Thurlow, and J. T. Eason. 1988. Influence of tillage and crop rotation on yields of corn, soybean, and wheat. Agron. J. 80:76-80.

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.

Jordan, D., D. Partridge, J. Barnes, C. Bogle, C. Hurst, R. Brandenburg, S. Bullen, and P. Johnson. 2004. Peanut response to tillage and rotation in North Carolina. Proc. Southern Cons. Till Conf. For Sustainable Agr. 8-9 June, 2004. Raleigh, NC. Pp. 215-219.

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.

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., P. J. Wiatrak, D. Herzog, and J.A. Pudelko. 1998. Comparison of Bt corn to non Bt using strip tillage at four planting dates. Proc. Southern Cons. Till Conf. For Sustainable Agr. July, 1998. Little Rock, AR. Pp. 95-98.

Wright, D. L., T. W. Katsvairo, J.J. Marois, and P. J. Wiatrak. 2004. Introducing bahiagrass in peanut/cotton cropping systems- Effects on soil physical characteristics. ASA. Agron Abstr. 2004. Page 330.

Wright, D.L., J.J. Marois, T. Katsvairo, P. Wiatrak, and J. Rich. 2005. Sod based rotations-the next step after conservation tillage. Proc. Southern Cons. Till. Conf. for Sustainable Agr. June 27-29, 2005. Florence, SC Pp.6-12.