Case Study: The Integration of Beef Cattle into a Peanut and Cotton Crop Rotation System that Involves a Perennial Grass

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Preliminary results indicate that beef cattle performance (cow/calf system) is not negatively impacted when they are reared in an integrated beef cattle/peanut and cotton crop rotation scheme that involves 2 years of bahiagrass. Beef cattle grazing also appear not to negatively impact subsequent crop yields of peanut and cotton in the rotation.

Summary

Use of perennial grasses in row crop rotations can enhance crop yields, reduce economic risk, and protect the environment. Integrating beef cattle into the system can make for more efficient use of farm resources, and reduce risk by diversification. A multi-state sod-based rotation project has been on-going since 2000, mainly focusing on the agronomic aspects of the system. Results to date indicate that including bahiagrass (Paspalum notatum) in the rotation improves cotton and peanut yields, and water quality. The present focus now is to demonstrate how best to integrate beef cattle (cow/calf system) into this rotation system, and to evaluate the impact of grazing on subsequent yields of cotton and peanut. To evaluate cattle integration, a farm-size irrigated field (160 acres) was used. The field was divided into four quadrants to accommodate a 4 yr rotation of bahiagrass (bahia1), bahiagrass (bahia2), peanut and cotton. The cows utilized the bahiagrass as well as the winter cover crops (rye and oat blend) planted after the peanut and cotton harvests. The quadrants had non-grazed (exclusion) areas to evaluate the impact of grazing. The cattle grazed bahia2 from May until August, grazed bahia1 from August until frost (Nov.), and fed oat or bahiagrass hay until calving (Jan. thru Mar). After calving, cows and calves grazed winter cover crops until May. Calves were weaned in August. A constant number (45) of mature beef cows were utilized throughout the yr. Put and take cows were used during the winter/spring and summer to utilize excess forage. Hay was harvested from Bahia2 in October and this field was planted into oat or rye/oat (sod-seeded) which was harvested for hay in April. After 2 yr, 84 calves were produced with an average weaning weight of 537 ± 52 lb. No negative impact ($P < 0.05$) on subsequent peanut or cotton yields were noted.

Introduction

Southern farmers know that the yield of crops such as peanut can be improved following a perennial grass such as bahiagrass (*Paspalum notatum*). Yields following bahiagrass are usually greater than that obtained following an annual crop such as cotton or corn (Katsvairo et al., 2006). However, farmers seldom include a perennial grass in a rotation since little information is available showing how these grasses can economically fit into a crop rotation system. A long term multi-state and multi-discipline crop rotation project has been ongoing by the Universities of Florida and Georgia, and Auburn University since 2000. This project examines the impact of short-term (2 yr) inclusion of a perennial grass, such as bahiagrass, in a rotation scheme with peanut and cotton (commonly referred to a sod-based rotation – or SBR). Results to date have been very encouraging in many respects, including improvements in crop yield, water quality, soil health, risk management, and total farm economics (Katsvairo et al, 2006; 2007). More information about the overall SBR project can

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be found on the following website: nfres.ifas.ufl.edu/programs/sod_rotation:shtml.

Since bahiagrass is used in the rotation, it is logical to include beef cattle in the overall rotation as they would be able to utilize the bahiagrass as well as the annual winter cover crops. In much of the previous SBR research, the bahiagrass was harvested as hay. Computer simulations have shown that integrating cattle into the SBR system can increase profit potential, more so than selling bahiagrass (and other forages) as hay (Marois and Wright, 2003; Katsvairo et al., 2006). In addition to increased overall profit potential, adding cattle to the system can buffer against commodity price swings and unfavorable weather. However, there are many questions and concerns about integrating beef cattle into a rotation of perennial grass and row crops. How best to integrate cattle into the rotation and how grazing may influence various aspects of the system have not been studied extensively.

Of the seven sites that contribute to the multi-state SBR project, two sites are set up to evaluate beef cattle integration. One of these is a mid-sized farm-scale field site (160 acres) located at the North Florida Research and Education Center (NFREC) near Marianna in northwest Florida, and the other is a small-sized farm-scale field site (50 acres) located at Auburn University's Wiregrass Sub-station near Headland in southeastern Alabama. Both sites have center pivot irrigation systems. These two sites allow effective study and demonstration of the economic viability of integration of cattle into a SBR system, and determination of impacts of cattle grazing, cattle traffic, and manure on various soil physical and chemical properties, water use efficiency, and subsequent crop growth and yield, greenhouse gas emissions, as well as cattle performance.

The overall objectives of the cattle component in the overall SBR project are as follows:

1). Demonstrate integration into and measure the performance of beef cows/cow calf pairs in a sod- based peanut and cotton rotation (SBR) system.

2). Determine forage available for grazing and for some hay production throughout the year in the SBR system.

3). Identify the impact cattle grazing and traffic has on subsequent crop yields and on various soil parameters.

The focus of this report will be to present information on how the cattle have fit into the farm scale SBR system, present some preliminary cattle performance data, and to present some preliminary results of the impact of cattle on subsequent yield of peanut and cotton. At this time only preliminary results from the Marianna, FL site will be presented representing two yr of cattle and forage yield data (2007-08 and 2008-09). The SBR project at NFREC Marianna will continue for at least four more years.

Site description and procedures

The 160 acre field at NFREC Marianna is divided into four smaller but equal size fields or quadrants (Figure 1). This field has a center pivot irrigation system which covers approximately 85% of the field. The perimeter of the field is fenced with permanent electric fencing. The field is divided into the quadrants using permanent electric fencing with snap back gates across the middle and temporary electric fencing to further divide the main field into the four quadrants. The crop rotation sequence followed for each quadrant was newly planted bahiagrass the first yr (bahia1), one-year old bahiagrass the second yr, (bahia2), peanuts the third yr and cotton the fourth, and the cycle repeats. The rotation was initially stared sequentially such that bahia1, bahia2, peanut and cotton would be represented each yr over the four quadrants. The rotation sequence was started in 2000. The rotation sequence for each

quadrant during summer as well as winter including forage available for grazing and for some hay is summarized in Table 1.

Forty-five mature, spring-calving beef cows from the Marianna NFREC Beef Unit were used (mostly Romosinuano, Brangus, Brangus x Angus, and Romosinuano x Angus) over the 2 yr of this preliminary study. These 'tester' cows were reared in the SBR system field at Marianna year-round. The field is lined with large trees on two sides and with large trees in the opposite corner which provided shade for the cattle. Standard NFREC Marianna Beef Unit procedures were followed for vaccinations, de-worming, breeding, etc. of the cattle. Cattle were provided cattle mineral supplement free choice and fresh water at all times. The cows calved from January to March, bred 60 d after calving, and were pregnancy checked and weighed in June. Body condition score (BCS) was also scored at this time using a 1 to 9 scoring system (1= extremity thin, 9 = extremely obese). Calf weight was taken at weaning which occurred during August; the weights were adjusted to 205 d of age. Cows that were without calf at time of pregnancy check were replaced to ensure that had 45 cow/calf pairs were available.

The cattle grazed bahia2 (second yr bahiagrass) starting in May, continued grazing until September, grazed bahia1 until frost (November), and were then fed hay (oat hay or rye/oat hay and bahiagrass) until calving. After calving, cows and calves grazed winter cover crops (rye/oat mix) until May, and the cycle repeats. Hay was harvested from bahia2 during late October, and this quadrant was planted into oat or rye/oat (sod-seeded) which was harvested for hay in April. Some supplemental feeding of hay was also done during the late spring of each year. Extra cows (cow/calf pairs) grazed excess forage in the late winter/early spring and summer. The above cattle grazing and haying procedure, and the rotation scheme, outlined in Table1, were followed for the second yr. The first yr was slightly different in that bahia2 was sod-seeded with oat only. Bahiagrass hay only was fed during the winter for the first yr. The oat was harvested as hay and was fed along with bahiagrass hay to the cows during the second yr.

To evaluate the impact of grazing; each of the four fields (quadrants) has three 50 ft x 50 ft exclusion areas, marked by GPS coordinates (Figure 1). These areas were fenced when cattle were present in a quadrant. The cattle exclusion areas were paired with grazed areas (50 x 50 ft) that are matched based on topography and soil type. The grazed and un-grazed paired plots within each quadrant allowed for the evaluation of the impact of grazing on subsequent crop yield. These grazed and un-grazed plots will also allow future to evaluations of the impact of grazing on crop growth development, crop nutrient cycling (i.e. N and P), crop water utilization, soil physical properties, carbon sequestration, and greenhouse gas emissions, as well as data for economic analysis of a cattle-SBR system vs. a hay-SBR system. The results of these other evaluations will be the subjects of future reports.

University of Florida IFAS recommendations were followed in regards to seeding rates of winter cover crops and bahiagrass. Bahiagrass was planted in late January. Planting was done using a seed drill and lightly drilling the seed into the rye/oat already present in the quadrant. The cattle then trampled the seed into the soil while they grazed the rye/oat forage. For the first year, the bahiagrass was planted in a similar manner but during March. The bahiagrass seedlings began to appear in in May. Soil test results and IFAS recommendations were followed in regards to liming and fertilization. The peanut and cotton crops each year were planted, managed, and harvested by a local farmer using conservation tillage and BMP's.
Forage sampling was done monthly to estimate forage dry matter available for grazing. Sampling yr started in September, to coincide with weaning of the calves. Sampling was done at three representative locations within each

quadrant when forage was available and the cattle were grazing. Bahiagrass forage was cut and removed from within the fenced exclusion areas (un-grazed areas) about every 6 wk starting mid-June to October to simulate a haying system. Winter crop forage was not removed from within exclusion areas in order to simulate a winter cover crop system.

Cattle data collected included calf weaning weight, and cow body weight and BCS (taken in June of each yr). Cattle data were compared that of cow/calf pairs matched by cow age and genetic background, which were reared in the main herd at the NFREC Marianna Beef Unit. Data were analyzed as complete randomized design within year with the individual animal as the experimental unit. Differences were significant at $P < 0.05$.

Preliminary results

Cattle (cows or cow/calf pairs) have been present on the NFREC Marianna SBR field starting 2004. Starting in 2007, the cattle number has been held constant at 45 tester cows and cattle performance data collected. The tester cows remained on the SBR field year round grazing/occupying one quadrant at a time such as bahia2. From mid-December to early April and again from late June/early July to early October, a second quadrant was available for grazing during each yr. Put and take cattle, extra cows/cow calf pairs from the NFREC Beef Unit, were utilized to graze the excess forage.

The 45 tester cows occupying one quadrant equates to 1.25 head per acre. This stocking density was decided on based on trial and error and experience starting when cattle were introduced on to the Marianna SBR field in 2004. A low to medium UF-IFAS fertilization recommendation was followed in regards to nitrogen top-dressing of the pastures. The bahigrass pastures were top-dressed once or twice a year with 50 lb N/acre each time, and the cool-season forages, twice also with 50lb N/ac each time. Fertilization at planting of the cool-season forages or the bahiagrass was not done as there were sufficient nutrients in the soil from the peanut and cotton crops, and from cattle manure according to soil test. A higher fertilization rate of 100 to 150 lb of N/acre could allow for a higher stocking density.

A summary of the 2 yr of cow/calf performance data from the tester cows in the 160 acre farm-size field, SBR project at Marianna is summarized in Table 2. There was no cattle control treatment in the SBR system at Marianna due to the farm-scale nature of the study. Since the SBR tester cows were managed in a similar manner and by the same herdsman as the NFREC Beef Unit (BU) cows, the SBR cows were matched by age and genetic background to BU cows. Performance of the SBR cows that matched BU cows is summarized in Table 3. Only 8 and 19 matches were obtained for the first and second yr, respectively. For the second yr, average weaning weight of the calves from the SBR cows was actually greater ($P < 0.05$) than average calf weight of the matched BU cows. However, due to the small number of matches, no definitive conclusion can be made other than it appears that cow productivity is not negatively influenced by being reared in the SBR system.

Forage available for grazing in the SBR system at Marianna is summarized in Table 4. As expected, much month to month variation was noted with peak production occurring mid-summer and late winter/early spring of each yr. Put and take cattle were used to graze excess forage during peak forage production. In all, an extra 2,540 and 3,620 animal grazing days during the cool-season for the second and third yr, respectively, and 2,710 and 3,365 days during the warm season were obtained from this excess forage.

The tester cows were offered hay (bahiagrass or bahiagrass amd oat) free choice from mid-November to early February and again from late April to late May of each year when forage

availability was low. In all, 133 and 128 tons of hay were produced on the Marianna SBR field for the 2 yr, respectively. The hay produced was more than enough for the SBR cows. The cows overall maintained good BSC (Table3), thus no supplemental concentrate feeding was needed. The nutrient composition of the hays (analyzed compositions of 8 to 12 % crude protein, and 54 to 58% total digestible nutrients, dry matter basis) should have been sufficient, according to NRC (2000) recommendations, to maintain mature beef cows.

A major concern of integrating cattle into a crop rotation scheme is the effect of grazing and cattle traffic would have on subsequent crop yields. We presently have two yr (2008 and 2009) of crop yield data for the grazed and un-grazed locations within the quadrants from the Marianna SBR field (Anguelov, unpublished data). From these initial yield data, it appears that the presence of cattle does not have a negative impact on subsequent crop yields (Table 5). Increased ($P < 0.05$) cotton lint yield was actually noted for one yr in the grazed vs. the un-grazed locations.

A total of 23,394 and 23,040 lbs of calves were weaned in 2008 and 2009, respectively, years in which we have both animal and crop data from the SBR site at NFREC Marianna. Gross peanut yield averaged 90 ton/yr for the two yr and gross cotton lint yield averaged 55,400 lbs/yr for this 160 acre irrigated SBR field. Yearly gross income for this field averaged cotton ($0.60 per lb), and $23,667 from the sale of the calves ($1.00 per lb) per yr. Value of the excess forage for cattle grazing would average $2,400 per yr (6,120 average animals grazing d/yr x $0.40 per grazing d). Additionally the cattle also add value to the SBR system besides the value of calves and excess forage for grazing. For example, cattle manure has been found to greatly reduce the amount of fertilizer for the subsequent cotton crop. The value of the reduced need for fertilizer has been tentatively estimated to worth $100/acre (Wright and Marosis, unpublished data). The gross value of this savings would be $4,000/yr. Thus the gross value of the cattle component from the SBR field at Marianna averaged $30,667/yr.

The overall rotation scheme shown in Table 1 was followed and will be followed in the future. After several years of experience and trial and error, we feel that this scheme works well at the Marianna farm-size SBR field site. The scheme is by no means absolute, some modifications can be made. For example; supplemental hay could be purchased instead of planting rye/oat into bahia2 for hay or haylage. The bahia2 field could be left alone during the winter or the rye/oat can be planted and then grazed. It is anticipated that some minor modifications will be done in the future as we collect additional data and gain additional experience. We plan to continue the SBR project at Marianna with cattle integration for at least the next three years (2011 to 2014).

References

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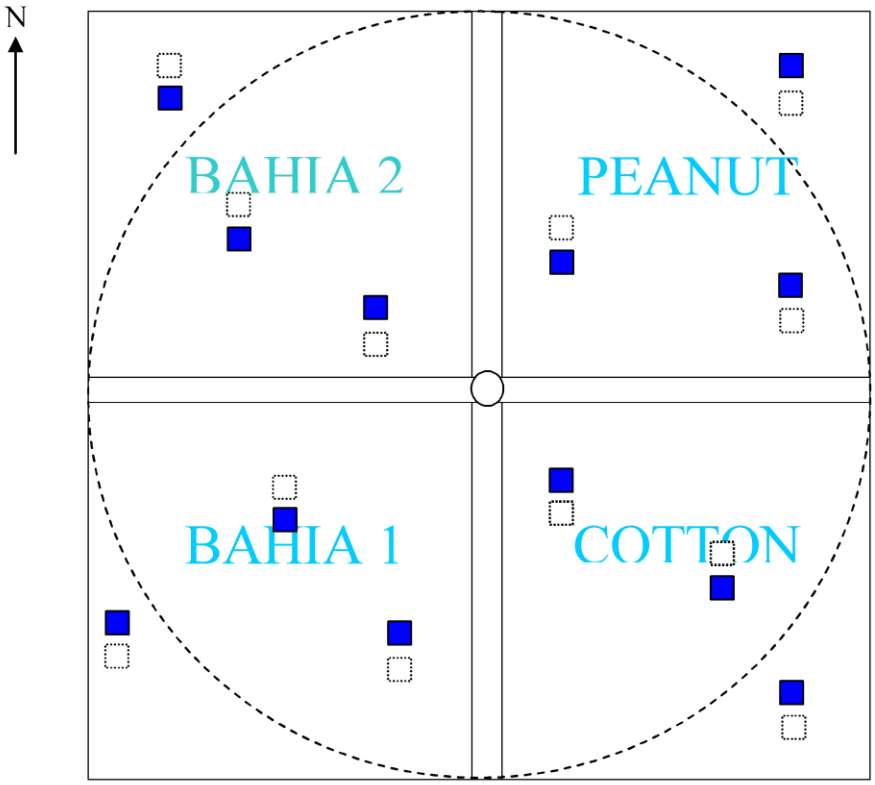
Field Arrangement of Sod-based Rotation Study in Marianna in 2007
(Finalized on 01-22-2007 based on group meeting)



■----- Cage (Un-grazed Plots); □----- Grazed Plots

Plot (exclusive cage) size is 50×50';
The distance between 2 adjacent plots (grazed and un-grazed) is 10 feet;
These plots will be used for soil and plant data collection.

Figure 1. Layout of the farm-size field with center pivot irrigation at Marianna showing locations of the exclusion and check areas (summer 2007 crops)

Table 1. Four year rotation cycle of summer and winter crops in the four quadrants of the farm-size sod-based rotation field at NFREC Marianna

SW Quadrant		NW Quadrant		NE Quadrant		SE Quadrant	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Bahia1[a]	D[c] Bahia1	Bahia2	Oat hay	Peanut	Rye/Oat G	Cotton	Rye /Oat G
Bahia2[b]	Oat hay[d]	Peanut	Rye/Oat G	Cotton	Rye/Oat G	Bahia1	D Bahia1
Peanut	Rye/Oat G[e]	Cotton	Rye/Oat G	Bahia1	D Bahia1	Bahia2	Oat hay
Cotton	Rye/Oat G	Bahia1	D Bahia1	Bahia2	Oat hay	Peanut	Rye/Oat G

[a]Bahia1 = first year bahiagrass that was planted the previous late winter.
[b]Bahia2 = second year bahiagrass
[c]D = dormant
[d]Oat that was sod-seeded in bahia2 and grown for hay only; rye/oat is now in the rotation and is harvested as haylage (forage harvested as round bales at about 40% dry matter and the bales wrapped in plastic)
[e]G = grazing; winter cover crop quadrants available for grazing

Table 2. Performance summary of tester cows in the sod-based rotation study at NFREC Marianna

	Calf Adj. WW[a], lbs		Cow Wt., lbs		Cow BCS[b]		
Year	Mean	1 s. d[d].	Mean	1 s. d.	Mean	1 s. d.	N[c]
2008	536	47	1,225	167	5.6	0.6	42,45
2009	538	55	1,220	166	5.6	0.6	42,45

[a] Weaning weight adjusted to 205-d of age.
[b] Body condition score (1 to 9 with 1 = extremely emaciated, 9 = extremely obese); 3 cows below 5.0 (1, 4 and 2, 4.5) for both 2008 and 200.
[c] N = number of calves weaned and number of cows respectively; 2 calves died and one calf was weaned early and bottle fed in 2008, and 1 calf died and 2 were weaned early and bottle-fed in 2009.
[d] One standard deviation.

Table 3. Comparison of performance of the tester cows from the sod-based rotation study (SBR) at NFREC Marianna matched by breed and age to NFREC Marianna Beef Unit cows.

Item	SBR cows		Beef Unit cows	
	Mean	1 std. deviation	Mean	1 std. deviation
2008 (n = 8)				
Cow body weight[a], lb	1,354	127	1,432	128
Cow body condition score[b]	6.1	0.7	6.2	0.8
Calf adjusted weaning weight[c], lb	557	41	566	77
2009 (n = 19)				
Cow body weight, lb	1,308	170	1,321	178
Cow body condition score	6.0	0.6	5.8	0.6
Calf adjusted weaning weight, lb	570[d]	49	517[e]	48

[a] Weight taken at pregnancy testing (June).
[b] Score of 1 to 9 (1= extremely emaciated, 9 = extremely obese).
[c]Calf weaning weight adjusted to 205-d of age at weaning (August).
[d,e]Means differ (*P<0.05*)

Table 4. Estimated amount of forage available for grazing from the sod-based rotation farm-size field at NFREC Marianna (lb dry matter /acre)

	2007-2008			2008-2009		
Month[a]	Forage[b]	Tester[c]	Put & Take[d]	Forage	Tester	Put & Take
Sep	B2, B1	1,690	1,111	B2, B1	872	1,213
Oct	B1	739	0	B1	757	0
Nov	B1	202	0	B1, ROp	91	625
Dec	B1, ROp	0	1,160	B1, ROp	0	408
Jan	ROc, ROp	510	546	ROc, ROp	207	659
Feb	ROc, ROp	719	783	ROc, ROp	708	1,411
Mar	ROc, ROp	1,695	1,988	ROc, ROp	2,909	2,957
Apr	ROc,ROp	1,447	646	ROc, ROp	1,469	431
May	B2	1,188	0	B2	1,430	0
Jun	B2	1,871	0	B2	1,851	0
Jul	B2, B1	2,228	2,128	B2, B1	1,632	3,554
Aug	B2, B1	1,208	1,661	B2, B1	1,347	1,321

[a] Year starts just after weaning of calves from tester cows.
[b] Pasture quadrant available for grazing (B1 = first year bahia, B2 = second year bahia, ROp = rye and oat behind peanut, and ROc = rye and oat behind cotton).
[c] Forage available for grazing by tester cows (hay or haylage offered during low availability – Nov to early Feb, and late Apr to late May). Tester cows on the SBR pastures year round.
[d] Extra forage available for put and take cattle; put and take cattle were extra cattle from the NFREC Beef Unit used to graze excess forage during certain times of the year.

Table 5. Effect of grazing and cattle traffic on subsequent cop yields in the integrated beef cattle/sod-based crop rotation system from the farm size field at NFREC Marianna[a]

Crop	Year	Average yield, lb/acre	
		Un-grazed	Grazed
Peanut	2008	4,843	4,497
Peanut	2009	4,305	4,480
Cotton	2008	1,448[c]	1,736[b]
Cotton	2009	1,104	1,139

[a]From Anguelov, unpunished results.
[b,c]Yields differ ($P<0.05$).