THE SAMUEL ROBERTS
NOBLE
FOUNDATION

Conversion Systems of Bermudagrass to Switchgrass or Mixed Nativegrass

J.K. Rogers[1], J.T. Biermacher[2], A. Biedenbach[3]

[1]Assistant Professor and Pasture and Range Specialist, jkrogers@noble.org,
[2]Associate Professor and Agricultural Economist, jtbiermacher@noble.org, [3]Intern, Center for Economic Information and Analysis,
The Samuel Roberts Noble Foundation, 2510 Sam Noble Parkway, Ardmore, OK 73401

Abstract

In the Southern Great Plains, research has demonstrated that switchgrass (*Panicum virgatum*) has excellent forage potential. Switchgrass begins spring growth earlier than many introduced warm-season perennial grasses, i.e. bermudagrass (*Cynodon dactylon*). This enables it to provide abundant, high quality forage with good stocker cattle gains from early to late spring. Nativegrass mixtures can also provide early season forage and contain grasses that vary in seasonal forage distribution providing higher quality forage further into the growing season than switchgrass. Compared to bermudagrass, switchgrass or nativegrass mixtures increase wildlife habitat, lower maintenance cost and can improve land value. These benefits have increased interest in conversion of bermudagrass land areas to switchgrass or nativegrass. Because of its herbicide tolerance and its ability to propagate from stolons, rhizomes and seed, bermudagrass is difficult to control, which makes conversion challenging. To be successful, conversion methods need to be acquired. A two-year, two-location study was developed to determine efficacy of 12 conversion systems for bermudagrass control and establishment of switchgrass ('Alamo') or a nativegrass mixture of little bluestem (*Schizachyrium acoparium* 'Cimarron'), big bluestem (*Andropogon gerardii* 'Kaw'), indiangrass (*Sorghastrum nutans* 'common'), switchgrass ('Alamo') and green sprangletop (*Leptochloa dubia* 'common'). Conversion systems consisted of combinations of preparation time (7, 11, 19 months from treatment initiation to planting), cover crops (0, 1, 2, 3), glyphosate application (13.8, 18.4, 23 L ha^{-1}) and tillage (till, no-till). Switchgrass and nativegrass planting date for all conversion systems was April. Tillage systems were more effective than no-tillage. Mean yields across locations and years for no-till were 963 kg ha^{-1} and 3219 kg ha^{-1} compared to tillage yields of 2517 kg ha^{-1} and 7449 kg ha^{-1} for nativegrass and switchgrass respectively. Tillage systems with cover crops (2 or 3) and preparation time (11 or 19 months) were more successful in establishing nativegrass and switchgrass than other tillage systems.

Conclusions

- Tillage treatments were far more successful than no-till treatments in the establishment of nativegrass or switchgrass as evidenced by the yields. Tillage improved the suppression of the bermudagrass and other weeds and allowed for greater grass establishment. No-till establishment success was disappointing and an area where more research efforts need to be undertaken.
- Increased preparation time had little effect on switchgrass establishment but tended to improve nativegrass establishment.
- Using cover crops in the conversion systems had little effect on nativegrass or switchgrass yields. However, nativegrass yields tended to be improved with increased preparation time. If a cover crop can be used as a revenue generator incorporated into the longer preparation time systems, they could help to reduce the cost of the conversion.
- Switchgrass was much easier to establish than the mixture of nativegrasses. Switchgrass came up quickly and developed a canopy that tended to suppress any residual bermudagrass.
- No-till seed placement, residue management and seed treatment are areas for further research focus in no-till establishment of native warm-season grasses.
- All treatments (no-till and tillage) resulted in increased diversity of the existing bermudagrass stands, which would be an improvement to wildlife habitat.

Methods

- Research design -
  - o 2 X 2 X 3 factorial design arranged into complete blocks with three replications and two planting years of April 2011 and April 2012.
    - 2 – Tillage treatments (No-till (**NT**), Tillage (**T**))
    - 2 – Cover crops (present, absent)
    - 3 – Preparation time (The amount of time that was spent suppressing the bermudagrass prior to the planting date – 7, 11 or 19 months)
  - o Two locations –
    - Location 1 – Headquarters (**HQ**) Carter County, Oklahoma, 34˚ 17' N, 97˚ 08' W, loamy fine sand
      - Soil test 0-15 cm, pH - 5.5, P - 16 kg ha^{-1}, K – 180 kg ha^{-1}
    - Location 2 – Red River Demonstration Farm (**RR**) Love County, Oklahoma, 33˚.9' N, 97˚ 3' W, fine sandy loam
      - Soil test 0-15 cm, pH - 5.6, P - 74 kg ha^{-1}, K – 150 kg ha^{-1}
- Plot size – 3.7m X 6.1m
- Planting rate –
  - o Nativegrass mix – 11.2 kg ha^{-1} bulk
    - Little bluestem (*Schizachyrium acoparium* 'Cimarron')
    - Big bluestem (*Andropogon gerardii* 'Kaw')
    - Indiangrass (*Sorghastrum nutans* 'common')
    - Switchgrass ('Alamo')
    - Green sprangletop (*Leptochloa dubia* 'common')
  - o Alamo switchgrass – 10 kg ha^{-1} bulk
    - Planting depth – .64-1.3 cm
  - o Fall/winter cover crop –
    - Rye (*Secale cereale* 'Maton II'), 112 kg ha^{-1}
    - Planting depth 2.54 cm
  - o Summer cover crop –
    - Sorghum-sudan (*Andropogon bicolor* 'Sweet Sunny Sue') 31 kg ha^{-1}
    - Planting depth 1.3-2.54 cm
- Glyphosate application procedure –
  - o 9.2 L ha^{-1} first application
  - o 4.6 L ha^{-1} each additional application

- Both study locations were in established bermudagrass ('common') in excess of 10 years. Previous management at HQ was unknown while the RR had been managed for hay production. At the start date for all treatments (Table 1) a 9.2 L ha^{-1} application of glyphosate was applied. Additional applications of glyphosate (4.6 L ha^{-1}) were applied prior to planting each cover crop and prior to planting switchgrass or nativegrass. Cover crops were established either no-till or conventionally according to treatment number. Nitrogen, phosphorus and potassium were applied to cover crops according to soil test levels at rates high enough that deficiencies of those elements would be unlikely to limit yield. For the HQ location this was usually 70-70-70 kg ha^{-1} for both rye and sorghum-sudan cover crops while at the RR location, 70-0-0 kg ha^{-1}would be used for both cover crops. Cover crops were harvested and yield and nutritive values determined (data not presented). Tillage was done using a tractor-powered roto- tiller followed by cultipacking and seeding. Conventionally established cover crops were planted with a Hege 500 plot drill while no-till cover crops were planted using a Hege 1000 plot drill. Switchgrass and nativegrass plots were established using a Great Plains 705 drill. All drills were calibrated prior to use. Weed control was not required in the cover crops. In switchgrass and nativegrass plots, broadleaf weeds were controlled using 2.3 L ha^{-1} of 2, 4-D applied as needed but after switchgrass and nativegrass had reached a 3-4 leaf stage.

- All switchgrass and nativegrass plots were planted on a common date in April 2011 and April 2012. All switchgrass and nativegrass plots that were planted following a cover crop were planted behind cereal rye. Planting year 1 (April 2011) plots were harvested in March 2013 and March 2014, and planting year 2 (April 2012) plots were harvested in March 2014 and March 2015. Plots were harvested using a 0.25-m^2 frame that was dropped four times within each plot for a total of 1-m^2 harvest area. Plot harvest samples were hand separated by component (switchgrass or mixed native grasses) and weed (mainly bermudagrass, annual grasses and forbs), then air dried at 60 degrees Celsius to constant weight for dry matter and forage mass determination.

- Switchgrass, nativegrass and other yields were analyzed by location using the PROC MIXED procedure of SAS, Version 9.3 (SAS Institute, Cary, NC). Planting year and replication were treated as random effects and treatment as a fixed effect. LSMEANS with the pdiff option were generated for treatment means and differences between LSMEANS were declared significant at P ≤ 0.05.

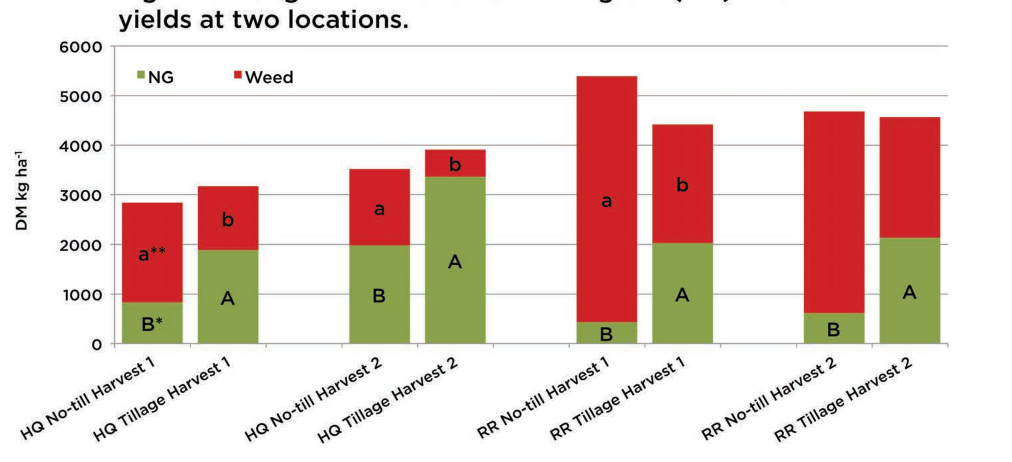
Table 1. Conversion treatments

Trt.	Prep. time	Treatment start date	Planting date	Tillage trips	#Cover crops	Total glyphosate L ha^{-1}	#Glyphosate treatments
1 NT	7 months	Sept., 2010, 2011	April, 2011, 2012	No-till	1 - rye	13.8	2
1 T	7 months	Sept., 2010, 2011	April, 2011, 2012	2	1 - rye	13.8	2
2 NT	7 months	Sept., 2010, 2011	April, 2011, 2012	No-till	0	13.8	2
2 T	7 months	Sept., 2010, 2011	April, 2011, 2012	2	0	13.8	2
3 NT	19 months	Sept., 2009, 2010	April, 2011, 2012	No-till	3 - rye/sorghum-sudan/rye	23.0	4
3 NT	19 months	Sept., 2009, 2010	April, 2011, 2012	4	3 - rye/sorghum-sudan/ rye	23.0	4
4 NT	19 months	Sept., 2009, 2010	April, 2011, 2012	No-till	0	23.0	4
4 T	19 months	Sept., 2009, 2010	April, 2011, 2012	4	0	23.0	4
5 NT	11 months	May, 2010, 2011	April, 2011, 2012	No-till	2 - sorghum sudan/rye	18.4	3
5 T	11 months	May, 2010, 2011	April, 2011, 2012	3	2 - sorghum sudan/rye	18.4	3
6 NT	11 months	May, 2010, 2011	April, 2011, 2012	No-till	0	18.4	3
6 T	11 months	May, 2010, 2011	April, 2011, 2012	3	0	18.4	3

Results

Tillage significantly improved nativegrass (Figure 1) and switchgrass (Figure 2) yields at both HQ and RR locations and for both harvest years. Tillage also had an effect on reducing the weed yield (bermudagrass, annual grasses, forbs) harvested within plots.

Figure 1. Tillage effect on mean nativegrass (NG) and weed yields at two locations.



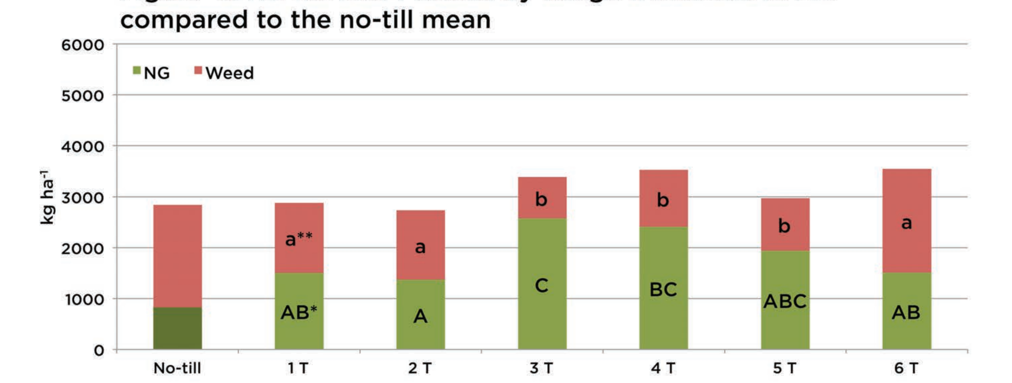
*Different uppercase letters within location and harvest indicate significance at P < 0.05.
**Different lowercase letters within location and harvest indicate significance at P < 0.05.

Figure 2. Tillage effect on mean switchgrass (SG) and weed yields at two locations.

*Different uppercase letters within location and harvest indicate significance at P < 0.05.
**Different lowercase letters within location and harvest indicate significance at P < 0.05.

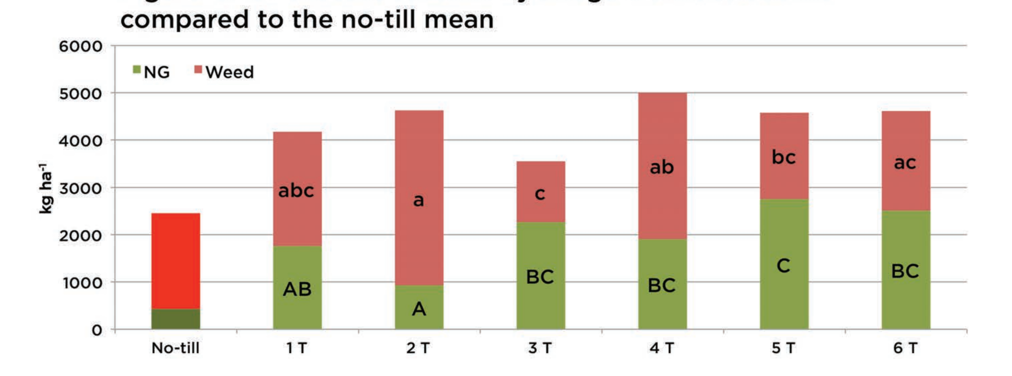
Treatments with the smallest amount of preparation time (1 and 2) tended to produce lower NG harvest 1 yields regardless of cover crop compared to treatments with longer preparation times at both locations (Figures 3 and 4). The use of cover crops in these systems had no effect on NG yields and weed suppression (Figures 3 and 4).

Figure 3. NG harvest 1 means by tillage treatment at HQ compared to the no-till mean



*Different uppercase letters for NG yield between treatments are different at P < 0.05.
**Different lowercase letters for weed yield between treatments are different at P < 0.05.

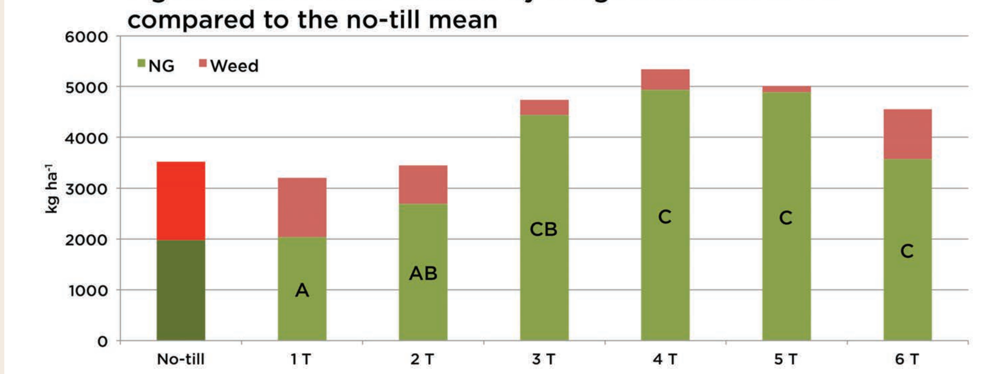
Figure 4. NG harvest 1 means by tillage treatment at RR compared to the no-till mean



*Different uppercase letters for NG yield between treatments are different at P < 0.05.
**Different lowercase letters for weed yield between treatments are different at P < 0.05.

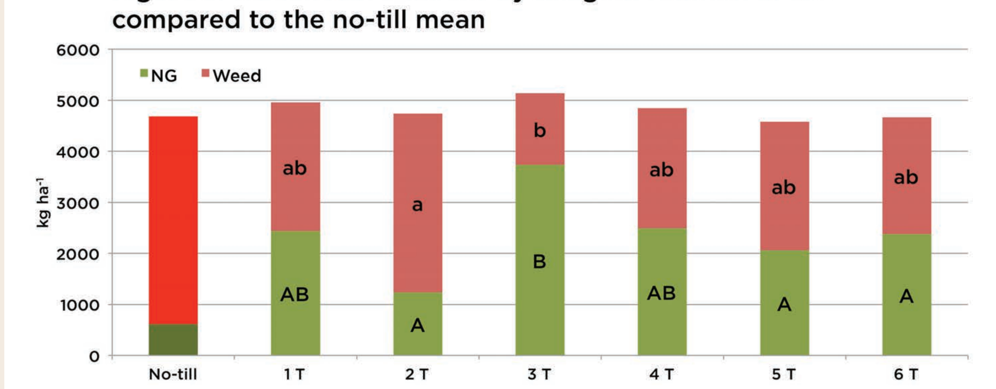
Harvest 2 yields of nativegrass increased compared to harvest 1. At the HQ location (Figure 5) treatments with longer preparation time (3-6) improved NG yields while there was little treatment effect on NG yield at the RR location (Figure 6).

Figure 5. NG harvest 2 means by tillage treatment at HQ compared to the no-till mean



*Different uppercase letters for NG yield between treatments are different at P < 0.05.
**Different lowercase letters for weed yield between treatments are different at P < 0.05.

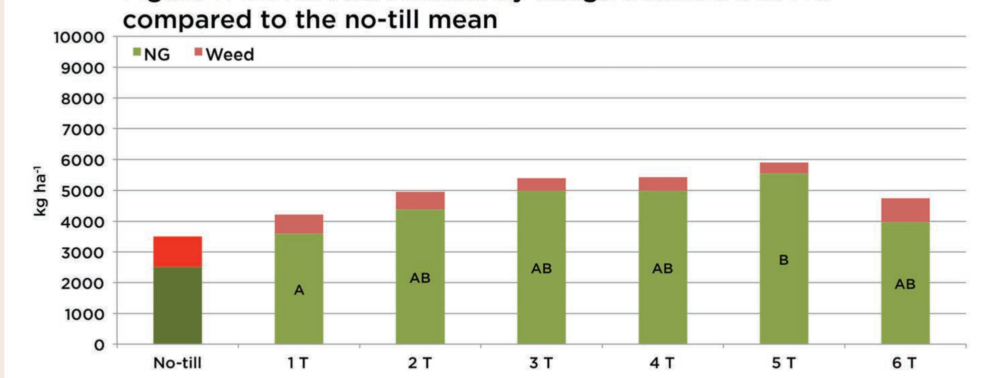
Figure 6. NG harvest 2 means by tillage treatment at RR compared to the no-till mean



*Different uppercase letters for NG yield between treatments are different at P < 0.05.
**Different lowercase letters for weed yield between treatments are different at P < 0.05.

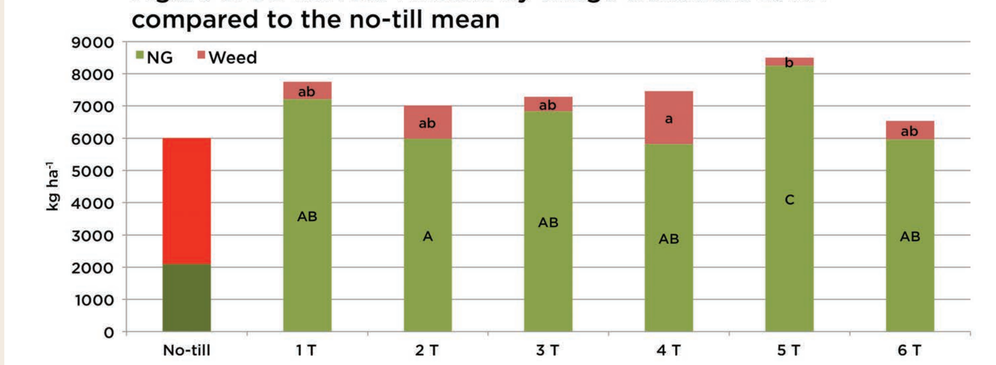
Switchgrass yields were much higher than nativegrass yields at both locations for harvest 1. Little difference between treatments was evident and weed suppression for all treatments was very good (Figures 7 and 8).

Figure 7. SG harvest 1 means by tillage treatment at HQ compared to the no-till mean



*Different uppercase letters for NG yield between treatments are different at P < 0.05.
**Different lowercase letters for weed yield between treatments are different at P < 0.05.

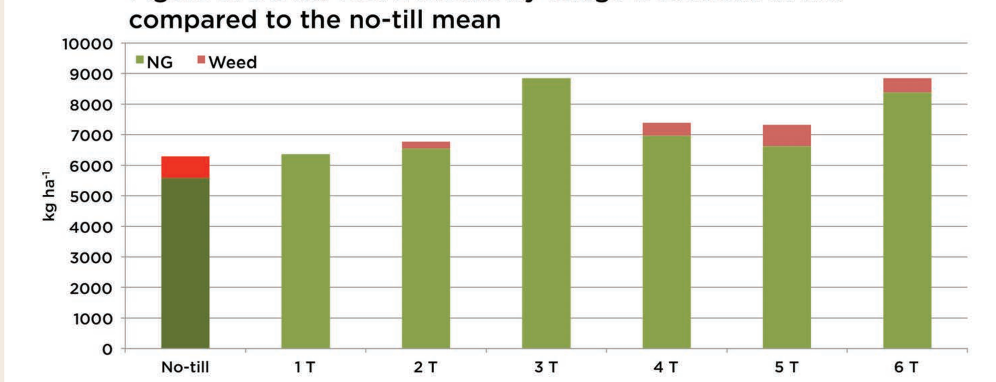
Figure 8. SG harvest 1 means by tillage treatment at RR compared to the no-till mean



*Different uppercase letters for NG yield between treatments are different at P < 0.05.
**Different lowercase letters for weed yield between treatments are different at P < 0.05.

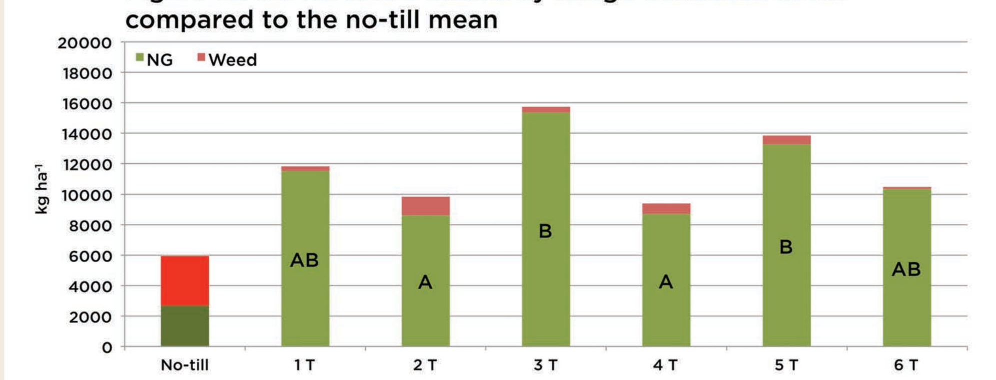
By harvest 2 at the HQ location, there were no difference in treatment means for switchgrass yield (Figure 9). All switchgrass treatment yields improved in harvest 2 compared to harvest 1. It should be noted that no-till switchgrass yield at HQ more than doubled from harvest 1 to harvest 2. At the RR location (Figure 10), there was slightly more variation in treatments though all treatments increased in yield with little weed presence.

Figure 9. SG harvest 2 means by tillage treatment at HQ compared to the no-till mean



*Different uppercase letters for NG yield between treatments are different at P < 0.05.
**Different lowercase letters for weed yield between treatments are different at P < 0.05.

Figure 10. SG harvest 2 means by tillage treatment at RR compared to the no-till mean



*Different uppercase letters for NG yield between treatments are different at P < 0.05.
**Different lowercase letters for weed yield between treatments are different at P < 0.05.