2016 Ogallala Aquifer Program Pre-plan

Title: Extreme Sorghum/Sudan Biomass Cover Cropping for Transition to No-till Dryland Farming in Sandy Soils

Investigators:

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- Katie Lewis, Soil scientist, Texas A&M AgriLife Research, Lubbock
- To be determined (job offer made), new soil biology professor, Plant & Soil Sciences, Texas Tech Univ., Lubbock

Research Location: Lubbock & Lamesa, TX

Summary: In a recent OAP project that initiated a long-term dryland cover crop and tillage project on sandy soils in the Texas South Plains, our novel treatment involved the use of male-sterile sorghum/sudan as a means to maximum biomass to hasten transition to no-till cropping. The objective of this overall project is to demonstrate to producers viable cropping strategies that will enable producers to use less Ogallala irrigation (if they even have much left) and focus their remaining water high-return prospect instead of spreading water use too thinly.

The annual biomass sorghum/sudan biomass produced in our project to date has ranged from <0.6 ton (massive drought) to >3 tons/acre based on rainfall. Thus varying levels of "blanket" were generated among the site-years, but even at high biomass, we were able to plant the next year's crop into the stubble with existing planter equipment.

This project focuses on expanding the sorghum/sudan extreme biomass cover crop work A) to include some estimation of forage production if grazing or haying were involved along with subsequent regrowth to generate some income in the year of S/S cover crop, B) inclusion of pigeon pea (*Cajanus cajan)* to diversify the cover crop, and C) evaluation of soil biology and physical parameters to gauge immediate effects on soil properties in the year of S/S cropping and in a subsequent cotton crop.

Project Narrative:

Objectives:

1. Evaluate the effectiveness of one-time cover cropping with sorghum/sudan (with and without pigeon pea) unharvested vs. mid-season harvest and subsequent regrowth for soil protection;
2. Measure changes in soil biological and physical properties and their potential influence on soil health and reduced erosion potential in a subsequent cotton crop the next year.

Rationale/Literature Review/Conceptual Framework:

Soil health principles include goals that include improving the reduction of soil surface erosion potential; improved moisture (rainfall) capture, percolation, and storage; soil aggregation; and biological diversity. We believe, however, that these goals in a semi-arid region, especially with highly erosive sandy soils, will not be met without significant protection of the soil surface. Cover cropping to achieve these goals faces the unfortunate dilemma of using too much moisture to enable effective primary dryland cropping (in this South Plains region mostly cotton).

The work of Ted Zobeck, USDA-ARS demonstrates how fragile our dryland cropping systems are in the Texas South Plains (Fultz et al., 2013), and it is difficult to significantly build soil organic carbon. Stop-tillage is one option to build soil C, and intensive irrigation would be another, but that is simply no longer possible.

Initial work with drilled sorghum/sudan biomass production as an extreme cover crop demonstrates the potential to obtain over 3 tons of dry matter per acre in years with above average rainfall, but less than 1 ton/acre in drought years. The biomass production for subsequent crop cover the next year, in lieu of income in the year the S/S is grown is not a viable consideration for all but a few landowners and farmers. Some income is needed, if possible hence this project will include evaluate the equivalent of haying (cost of doing so is likely prohibitive) or limited grazing in the late July/early August, thus allowing for significant regrowth into early October (September is the second wettest month) that would still enable soil surface protection as well as a thoroughly rooted soil surface from the drilled forage. (Trostle, 2015). Previous dryland cover cropping using rye, Austrian winter peas, hairy vetch, and cropped grain sorghum, and other species in the South Plains have not yielded sufficient biomass to adequately protect the soil (Keeling, 1997). We propose to investigate the use of legume pigeon pea, which twines up taller crops, and represents potential N fixation as well as a second type of root that may foster different fungal activity compared to a grass root.

Overlooked—literally—is the soil dynamic of microbial communities underneath South Plains sandy soils low in organic (Acosta-Martinez et al., 2010; Cotton et al., 2011). Physical protection of the soil alone may be insufficient to effect long-term stability of soil systems without improvements in the biological contribution of roots, associated microorganisms and their nutrient and carbon cycling (Davinic et al., 2011; Sotomayor et al., 2009).
By establishing what we believe is a maximum potential cover crop with summer sorghum/sudan, which appears to produce the most possible biomass, South Plains producers—if they are willing to learn how to preserve and farm into the residues—can stabilize the soil resource in a way that is not otherwise possible. Should climate change with potential higher temperatures and reduced precipitation become a growing concern, we believe such a system can overcome these negatives and sustain viable dryland cropping on the region's sandy soils.

<u>How objectives will be met</u>:

Field research sites are AgriLife Research stations at Lubbock (sandy loam/sandy clay loam) and Lamesa (sandy loam, loamy sand) where current long-term no-till projects are in place. These soils represent the central and lower South Plains resource, and make up over 2 million acres of bare soil, dryland farming.

Objective 1:

- Sorghum/sudan cover cropping with or without pigeon pea in a no-till cropping system. S/S will be seeded in early to mid-May by drilling.
- A second set of treatments will be drilled to include a 10% mixture of *Rhizobium*-inoculated pigeon pea by weight.
- Biomass of uncut treatments will be assessed at the end of the growing season.
- In addition, S/S and S/S-pigeon pea mixtures will be harvested for forage biomass assessment in near August 1 to assess the potential biomass and its potential value if it were diverted to income uses. The regrowth will then again be measured at the end of the cropping season to evaluate if sufficient biomass was restored to serve adequately as a cover crop into the next year's cotton.

Objective 2:

- Soil sampling will be conducted just before cropping to assess the following measures: A) soil nutrient and biological status (0-6", 6-24") and soil bulk density.
- Biological measurements will include microbial biomass, fungal:bacterial distribution, and biological activity (CO_2 evolution, enzymic activity). These measures will be conducted in Dr. Acosta-Martinez' lab.
- Identical soil measures will be assessed at the end of the cropping season of each S/S or S/S-pigeon pea mixture.
- Cotton will be planted on all treatments after both the first year and second year of cover crop. Identical soil physical and biological measures will be repeated in May and the end of season the following year (see below).

All trials will be analyzed with appropriate statistical software and comparisons among seeding rates, planting dates, hybrids, and crops will be modeled in simple fashion to ascertain potential best management practices.

Expected outcomes:

This proposed project will provide producers with a novel approach to soil protection and dryland cropping in the South Plains. Over 100 producers have already view the sorghum/sudan cover cropping component at Lubbock and Lamesa, and they have offered substantial feedback including their belief they have the equipment to plant into the residue the next year. This is

Timeline of Proposed Annual Project Field Activities

	May17	Aug17	Nov17	May18	Aug18	Nov18	May19	Aug19	Nov19
Planting Year 1 Cover		Plant							
Forage Biomass Assess, Year 1	X			X					

Soil Sampling (Phys & Biol)	X			X		X		X				
Soil Erosion Assessment				X				X				
Cotton after Year 1 Cover				Plant								
Planting Year 2 Cover				*Plant*								
Forage Biomass Assess, Year 2						*Y*				*Y*		
Soil Sampling (Phys & Biol)				*Y*				*Y*		*Y*		*Y*
Soil Erosion Assessment										*Y*		*Y*
Cotton after Year 2 Cover										*Plant*		

essential. Our overall goal is to encourage dryland cropping and save the only moisture that is available to them for dryland, and demonstrate a potential cropping system as an alternative to Ogallala irrigation that costs much more. Yields alone may not convince growers, but ancillary information on soil properties, soil biology and soil health are needed to bolster incentives to try new farming practices on sandy dryland soils in the South Plains. Results will be a major component of agronomy extension programs in the Texas South Plains.

Relevant Publications:

Acosta-Martínez, V., Burow, G., Zobeck, T.M., and Allen, V.G. 2010. Soil microbial communities and function in alternative systems to continuous cotton. SSSAJ. 74:1181-1192.

Cotton, J.*, Moore- Kucera, J., Acosta- Martinez, V., Burow, G., 2011. Responses of enzyme activities in sandy soils to cropping system changes in a semiarid region. Abstracts, ASA, CSSA, & SSSA International Annual Meeting, San Antonio, TX.

Davinic, M.*, Fultz, L.*, Acosta-Martínez, V., Allen, V., Dowd, S., Moore-Kucera, J. 2011. Soil microbial dynamics in alternative cropping systems to monoculture cotton in the Southern High Plains. Abstracts, ASA, CSSA, & SSSA International Annual Meeting, San Antonio, TX.

Fultz, L.M., Moore-Kucera, J., Zobeck, T.M., Acosta Martinez, V., Allen, V. 2013. Organic carbon dynamics and soil stability in five semiarid agroecosystems. Agriculture, Ecosystems and Environment. 181(1):231-240.

Sotomayor, D., Espinosa, Y. and Acosta-Martínez, V. 2009. Organic matter pools and distribution in a Vertisol under mixed land use. Biology and Fertility of Soils 45:487-497.

Trostle, C. 2016. Dryland Texas South Plains no-till/con-till cropping sequences to achieve stable, long-term production. Report to Texas State Support Committee—Cotton, Inc., Texas A&M AgriLife Ext., Lubbock, TX.

Literature Cited/References:

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Keeling, W. 1997. Annual cover cropping and tillage systems, AG-CARES, Lamesa, TX. Texas Agric. Expt. Station, Lubbock, TX.

Sotomayor, D., Espinosa, Y. and Acosta-Martínez, V. 2009. Organic matter pools and distribution in a Vertisol under mixed land use. Biology and Fertility of Soils 45:487-497.

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