Research Priority Area:

Title: Flex-grazing and haying of annual forage in place of fallow

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Research Location: The primary research locations will be at the HB Ranch of the Western Kansas Agriculture Research Center (WKARC) near Brownell, Kansas and at the Southwest Research-Extension Center in Garden City, Kansas.

Study Duration Request: 2016-2017

Summary/Abstract:

The useful life of the Ogallala Aquifer for irrigation is limited and it is inevitable that crop production in the Great Plains must transition from irrigated to dryland production. While at the same time the demands on crop and livestock production continue to increase through population growth and reduced crop and range land. In addition, we must strive to reduce inputs and improve our soil health. Dryland cropping systems that increase productivity and sustainability are needed in the region. Fallow is important for stabilizing crop yields in a semi-arid environment, but is expensive to maintain, can increase soil erosion, and inefficiently stores precipitation. Matching cropping intensity to the environment can enhance crop productivity of dryland systems and make better use of precipitation. Annual forages were grown in place of fallow in years with 18-19” or more precipitation without negatively affecting the yield of the following wheat crop, and improved soil health and profitability. However, in drier years, (<18” of annual precipitation), replacing fallow with an annual forage reduced wheat yield and profitability. Growing forage in place of fallow in favorable production years and fallowing in dry years (flex-cropping) may take advantage of extra moisture in the wet years, yet allow for cropping less intensively in dry years. Annual forage can be hayed or grazed. Very little information is available on the effects of grazing annual forages, or if tillage is required to correct potential compaction caused by grazing. Grazing may recycle nutrients, reduce harvest expense, help provide forage at a time of the year when warm season pastures are not actively growing, increase conception rates (due to higher forage quality), and improve soil health compared to haying. By combining flex-planting and grazing of annual forages it may be possible to increase the productivity of dryland cropping systems while improving soil health and sustainability within the semi-arid Great Plains.

Project Narrative:

Objectives:

Irrigation management, proper agronomic practices, and policy may prolong the useful life of the Ogallala Aquifer for irrigation, but it is inevitable that this area must transition from irrigated to dryland production since groundwater withdrawal is greater than recharge.

Alternative management strategies and technologies are needed to increase the productivity and profitability of dryland cropping systems. This project plan addresses sub-objective 2 of the request for proposals "*Develop and evaluate management strategies and technologies that would increase the productivity and profitability of dryland cropping systems*."

This study will evaluate annual forage either hayed or grazed, and grown in place of year-long fallow. Reducing fallow frequency should increase precipitation storage efficiency and reduce evaporation, reduce wind and water soil erosion, improve soil health, and increase profitability. Several integrated grain and forage crop rotations were identified as being potentially successful for the region (Blanco et al. 2013; Holman et al. 2012; Holman et al. 2013a, 2013b). This research will test those crop rotations identified as being potentially successful using a flex planting decision and compare haying and grazing of annual forage. Previous research has not compared haying and grazing of annual forages, and limited information is available on flex planting.

Rationale/Literature Review/Conceptual Framework:

Western Kansas and Texas panhandle relies on the Ogallala Aquifer for irrigation. In recent years, well capacity has been severely reduced, and the quantity and quality of water that can be efficiently pumped is not the same as compared to 10-30 yrs ago (New York Times, 2013; OAP, 2014). In many areas of this region, the water supply of the Ogallala Aquifer can no longer sustain highly-productive cropping systems (e.g. continuous corn with >170 bu/A/yr). In fact, many producers have already transitioned to dryland production. Thus, one of the greatest challenges for crop production is to sustain viable cropping systems that are highly water use efficient, while also sustaining and improving soil health.

Annual precipitation in the study area can range from 12 to 36 inches. Fallow helps stabilize crop yields in dry years by accumulating precipitation in the soil profile. However, fallow is relatively inefficient at storing precipitation when compared to water use of a growing crop. In addition, fallow periods increase soil erosion and organic matter loss (Blanco and Holman, 2012), and are a large economic expense. Precipitation in the Great Plains is "average" about 60% of the time, abundant for the cropping system (>130% of mean precipitation) 20% of the time, and classified as a drought (<70% mean precipitation) 20% of the time (Holman, unpublished data). In years of normal to above normal precipitation the cropping system could be intensified, while in drought years the cropping system needs to be less intensive. Although climate prediction for the region is not precise, it can be used as a tool for making cropping decisions. By combining soil moisture conditions at planting (known) and precipitation outlook (predicted), a producer may be able to make better cropping decisions.

In dry years, growing forage or cover crop during the fallow period reduced subsequent wheat yields, but in wet years, growing a crop during the fallow period had little or no impact on wheat yield (Holman et al. 2013a, 2013b). Forages grown in place of fallow increased profit in normal to above normal precipitation years, whereas growing cover crops were found to reduce profit, since the benefits of growing a cover crop were less than the cost to grow it. Replacing fallow with annual forage or cover crops also indicated long-term improvement in soil health (Blanco et al. 2013). Although most profitable to fallow in dry years due to potential reduction in wheat yield, some yield reduction can be sustained due to the revenue generated by a forage crop. Yet, the negative effects on wheat yields may be minimized farther with flex-fallow. Flex-fallow is the concept of only planting annual forage when soil moisture levels are adequate and the long-range precipitation outlook for the upcoming year is favorable. Under drought conditions such as 2011-2013 and using the flex-fallow concept, a crop would have not been grown in place of fallow. However a crop would have been grown during the fallow period from 2006-2010. Implementing flex-fallow should help minimize negative effects on wheat yield and profitability in dry years, yet take advantage of more precipitation in wet years.

Very little information is available on the impact of grazing annual forages. Baumhardt et al. (2004, 2011) compared grazed and non-grazed wheat and grain sorghum stubble with and without tillage. They concluded that with tillage wheat and grain sorghum could be grazed without negatively affecting crop yields, although soil moisture storage was greater with no-till. Without tillage cattle grazing over time caused shallow compaction, resulting in reduced sorghum yield. The benefits of no-till in the central Great Plains on reduced soil water evaporation and soil health are well documented. However, many producers are struggling to manage herbicide resistant weeds such as three-awn and windmill grass, and are using light tillage during the fallow phase to control these problem weeds. Schlegel et al. (2014) found wheat responds less favorably to no-till than grain sorghum; in support of this finding, most producers till ahead of wheat rather than sorghum. Weed management issues are only getting worse as weeds such as kochia and palmar amaranth develop herbicide resistance to multiple herbicide modes of action. If grazing spring forages does cause some shallow compaction requiring tillage, tillage may also be an important tool for managing weeds. Previous research has not compared haying or grazing annual spring forages or tested the concept of flex-planting. An integrated evaluation of annual forages comparing both hayed and grazed, grown in place of fallow based on a flex-planting decision, with or without tillage on precipitation storage, wheat and sorghum yield, weed population, soil health, and profitability is needed.

Approach and Research Procedures:

We will evaluate five different crop rotations that integrate haying or grazing of annual forage in place of fallow. Results will identify those integrated crop-livestock cropping systems that can be successfully adopted in the region.

1. Control, Year 1: winter wheat; Year 2: grain sorghum; Year 3: fallow
2. Year 1: winter wheat; Year 2: grain sorghum; Year 3: spring triticale/oat *hayed*
3. Year 1: winter wheat; Year 2: grain sorghum; Year 3: spring triticale/oat *grazed*
4. Year 1: winter wheat; Year 2: grain sorghum; Year 3: *flex* spring triticale/oat *hayed*
5. Year 1: winter wheat; Year 2: grain sorghum; Year 3: *flex* spring triticale/oat *grazed*

Spring triticale yielded about twice the biomass and elongated about two weeks earlier than spring oat (Holman, unpublished data). By planting a 50%/50% mixture of spring triticale and spring oat, the grazing season might be extended and forage quality maintained longer into the growing season. Many spring triticale varieties glumes have awns that can cause lump jaw in cattle. In this study, we will use the triticale variety ‘Merlin’ that is an awnless variety to prevent this problem. Treatments will compare: 1) replacing fallow with an annual forage crop mixture of 50% spring triticale and 50% spring oat, 2) haying or grazing an annual forage crop of spring triticale and spring oat, 3) growing a forage crop based on available soil moisture and precipitation outlook (flex-crop), and 4) compare reduced till and no-till cropping systems. Using the flex planting decision, a spring forage crop will only be grown when at least 1.5ft of moist soil is available at the time of spring planting and the summer and fall precipitation outlook is neutral or positive (CPC, 2015). If these two conditions are not met, then the treatment will be fallowed and planted to winter wheat in the fall. Soil moisture will be measured with a Paul Brown probe for making the flex-planting decision, since it is a method that could easily be adopted by producers. All crop phases will be present each year. The experiment will be a split-split-plot randomized complete block design with four replications. Main plot will be crop phase of winter wheat (WW), grain sorghum (S), and fallow (F). Subplots will be fallow management treatments listed above. Subplots will be split with one-half managed as no-till and the other half managed as reduced till. Tillage will be implemented using a residue conserving implement such as a sweep plow in the fallow year only after treatments are completed, i.e. after grazing or haying. Main plot will be 150 feet wide by 100 feet long, sub-plots will be 30 feet wide by 100 feet long, and split-split-plots will be 15 feet wide by 100 feet long.

The study will be conducted at the HB Ranch of the WKARC near Brownell, Kansas (21" annual precipitation). Grazing is not available at Southwest Research-Extension Center, so only non-graze treatments will be implemented at that site (18" annual precipitation). Grazing will be implemented late May and stocking rate will be managed so that grazing is completed early June. Grazing will be terminated to leave ~60% soil residue cover. Crop regrowth and weeds will be controlled after grazing is ended. Winter wheat will be planted the end of September, a mixture of spring triticale and spring oats will be planted the first of March, and grain sorghum will be planted the first of June.

Grain Yield and Weed Measurements: Wheat and grain sorghum yields, moisture content, and test weight will be determined by harvesting an area 6ft wide by 100ft long area with a small plot combine. Grass and broadleaf plant density will be measured by species in the fallow year in each plot prior to tillage. Weed counts will be done by placing a 1-m^2 quadrat randomly in two locations of each plot and the number of individual plants inside the quadrat recorded. The average of the two counts will be computed to represent weed density within each plot.

Forage Yield and Quality Measurements: In the graze treatments, forage yield will be measured prior to and after grazing from two 1-m^2 quadrat per plot. In the hay treatments, forage yield will be measured from two 1-m^2 quadrat per plot prior to haying. Haying will be implemented once spring oat is fully elongated (oat will elongate after triticale). Forage nutritive value (ADF, NDF, CP, and TDN) will be determined using NIR technique prior to grazing and from hay treatments.

Soil Water Measurements: Soil water availability at winter wheat planting, winter wheat harvest, sorghum planting, sorghum harvest, spring forage planting, and spring forage harvest will be determined gravimetrically to 1.8 m in 0.3 m depth increments in all plots. Two soil cores will be taken from each plot and data averaged for a single soil water content measurement. Soil cores will be weighed wet, then placed in an oven at 105°C for at least 48 hours, and then weighed dry on consecutive days until a constant weight. Data generated will be used to assess water use and storage for each tillage and fallow management system.

Soil Quality Measurements: Soil samples will be taken from 0 to 5, 5 to 10, 10 to 15, and 15 to 30 cm soil depths at the beginning of the study (baseline soil data) and at 12 and 24-mo after tillage operations. These samples will be analyzed for changes in soil quality parameters including bulk density, aggregate size distribution, wind erosion fraction, pH, SOC, N, P and K distribution. Briefly, bulk density will be determined by core method, dry aggregate size distribution and wind-erodible fraction by the rotary sieve method (Chepil, 1962), total N and

SOC by dry combustion using Leco C/N analyzer after acid treatment. The NH_4-N and NO_3-N concentrations in samples will be determined on Seal AQ2 discrete analyzer after extracting the soil with 2 M KCl, and soil P and K by Mehlich-3 extraction method (Mehlich, 1984).

Schedule:
2015: Implement all crop phases in initial year and collect baseline soil sample data.
2016: Collect forage and grain yield, forage nutritive value, soil water, and soil quality data. Write progress report.
2017: Collect forage and grain yield, forage nutritive value, soil water, and soil quality data. Write progress report. Disseminate research information at field days and producer meetings.
2018: Collect forage and grain yield, forage nutritive value, soil water, and soil quality data. Present poster at annual OAP meeting. Disseminate research information at field days and producer meetings. Publish findings in journal and extension publication for first 3years of data. Secure funding for 3 more years of research for a total of 2 crop rotation cycles (6 years).

Expected Outcomes:

Economic Assessment Analysis:

Production costs and potential revenues will be determined comparing the different cropping systems to the typical dryland cropping system of winter wheat-grain sorghum-fallow. An economic analysis will determine the point where flex-cropping should either implement growing forage or fallow, and when it is best to graze versus hay annual spring forage.

Sustainability:

It is the intent of this study to be part of a long-term study (six years) to evaluate longer term changes in soil health (bulk density, aggregate stability, water infiltration, soil organic matter, etc.). It is our hypothesis that replacing fallow with annual forage will improve soil health, and that grazing may be more beneficial and profitable than haying. At the completion of this study short-term changes in soil health (i.e. water storage, soil organic carbon, and bulk density), effects on crop yield, and partial enterprise analysis will be completed.

Technology Transfer:

All the information generated from this project will be utilized in different avenues for research and extension purposes (conference papers, field days, training for extension agents, farmers, and agronomists). In addition to the previous, an extension publication will be prepared as a sub-product of this research project ("Growing Annual Forages in Place of Fallow: Best Management Practices"). Finally research will be published in peer-reviewed journal articles.

Relevant Publications:

1. Blanco, H., J. Holman, A. Schlegel, and J. Tatarko. 2013. Replacing fallow with cover crops in a semiarid soil: effects on soil properties. Online. Soil Sci. Soc. Am. J.: doi:10.2136/sssaj2013.01.0006
2. Holman, J., C. Thompson, R. Hale, and A. Schlegel. 2010. Forage yield and nutritive value of hard red and hard white winter wheat. Agronomy Journal. 102(2):759-773.
3. Holman, J., C. Thompson, R. Hale, and A. Schlegel. 2009. Grazing effects on yield and quality of hard red and hard white winter wheat. Agronomy Journal. 101(4): 775–788.
4. Holman, J., C. Hunt, J. Johnson-Maynard, L. Van Tassell, and D. Thill. 2007. Livestock use as a non-thermal residue management practice in Kentucky bluegrass seed production systems. Agronomy Journal. 99(1):203-210.

5. Islam, M.A., A.K. Obour, M.C. Saha, J.J. Nachtman, and R.E. Baumgartner. 2013. Small grains have forage production potential and nutritive value in Central High Plains of Wyoming. Forage and Grazinglands. doi:10.1094/FG-2013-0121-02-RS.
6. Islam, M.A., A.K. Obour, M.C. Saha, J.J. Nachtman, W.K. Cecil, and R.E. Baumgartner. 2013. Grain yield, forage yield, and nutritive value of dual-purpose small grains in the Central High Plains of USA. Crop Management. doi:10.1094/CM-2012-0154-RS.
7. Klocke, N. L., R. S. Currie, and J. D. Holman. 2013. Alfalfa response to irrigation from limited water supplies. Transactions of the ASABE. 56(5): 1-10.

References:

1. Blanco, H. and J. Holman. 2012. Cover crops reduce wind and water erosion. Kansas State University Agricultural Experiment Station and Cooperative Extension Service Report of Progress. 1070:7-11.
2. Blanco-Canqui, H., J. Holman, A. Schlegel., J. Tatarko, and T. Shaver. 2013. Replacing fallow with cover crops in a semiarid soil: Effects on soil properties. Soil Sci. Soc. Am. J. 77:1026–1034
3. Climate Prediction Center. National Weather Service. Online.http://www.cpc.ncep.noaa.gov/
4. Holman, J., T., Dumler, T. Roberts, and S. Maxwell. 2012. Cover crop forage biomass yield. Kansas State University Agricultural Experiment Station and Cooperative Extension Service Report of Progress. 1070:12-17.
5. Holman, J., T. Roberts, and S. Maxwell. 2013. Fallow replacement crops (cover crops, annual forages, and grain pea) impact on wheat yield. Kansas State University Agricultural Experiment Station and Cooperative Extension Service Report of Progress. 1088:5-11.
6. Holman, J., A. Schlegel, T. Roberts, and S. Maxwell. 2013. Cover crop, annual forages, and grain pea effects on soil water in wheat-fallow and wheat-sorghum-fallow cropping systems. Kansas State University Agricultural Experiment Station and Cooperative Extension Service Report of Progress. 1088:12-19.
7. The New York Times. 2013. Wells dry, fertile plains turn to dust. Online.http://www.nytimes.com/2013/05/20/us/high-plains-aquifer-dwindles-hurting-farmers.html?pagewanted=all