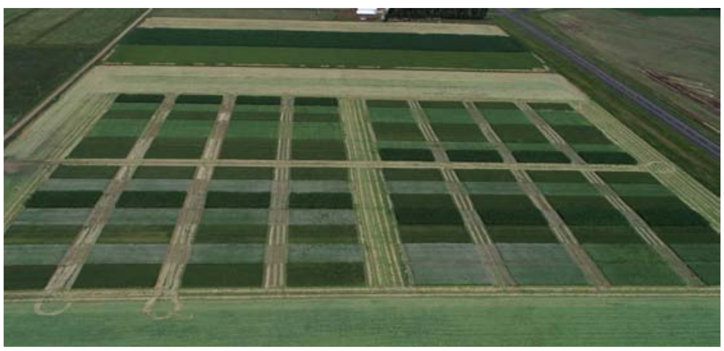
Is It Okay to Harvest My Crop Residue?

Drs. Dave Archer, Mark Liebig, Scott Kronberg

With margins tightening in agriculture it may be tempting to generate more income by harvesting crop residues. But, what are the consequences of harvesting crop residues? The bioenergy cropping systems study was initiated in 2009 to look at effects of harvesting crop residues for bioenergy use but recognizing that biomass also has value for other potential uses including livestock feed and bedding. However, we also know that crop residues provide important soil conservation benefits. The study includes three crop rotation: spring wheat-field pea (W-P), spring wheat-dry pea/cover crop mix (W-P/CC), and spring wheat-dry pea-corn (W-P-C). Within each rotation four residue harvest treatments are included: no residue removal (NONE), baling and removing wheat straw (WHARV), baling and removing residues from each crop (ALLHARV), and grazing all crop residues (ALLGRZ). The entire study is managed using no-till and treatments are replicated four times.



CORN GRAIN YIELDS WERE 14 BU/A LOWER

In This Issue:

Results from the first six years of the study (2010-2015) showed significant corn grain yield reductions in three of the six years for the WHARV and ALLHARV treatments compared to the NONE treatment (Figure 1). The largest reductions occurred in 2013 where the WHARV and ALLHARV treatments resulted in yield reductions of 29 and 33 bu/ac, respectively compared to NONE. The average corn grain yields over the six-year period were 14 bu/ac lower with WHARV and ALLHVARV compared to NONE. It was surprising that similar yield reductions occurred for both the WHARV and ALLHARV treatments since residue is only harvested every third year in the W-P-C treatment with WHARV, but residue is harvested every year in the ALLHARV treatment. Residue removal effects on crop production were immediate, as significant yield impacts appeared within the first three years of the study. It is also interesting that significant yield reductions only occurred with baling and removing residues (WHARV and ALLHARV), but not with grazing (ALLGRZ).

The yield reductions do not appear to be related to soil macro-nutrient differences as soil tests were conducted annually on each plot for N, P, and K, and fertilizer was applied annually based on these tests. During the six-year period, no differences in N, P, and K were noted that would require additional amounts

continued on page 2

continued from page 1

be applied to the WHARV or ALLHARV treatments compared to NONE. The yield impact may be related to water availability due to the effect of crop residues on reducing water losses and trapping and retaining snow. We will be monitoring soil moisture effects as the study is continued. Other soil effects which could influence crop yield (e.g. organic carbon, mineralizable nitrogen, secondary macronutrients) are being measured with intensive soil sampling every three years. Soil outcomes will be evaluated in future analyses.

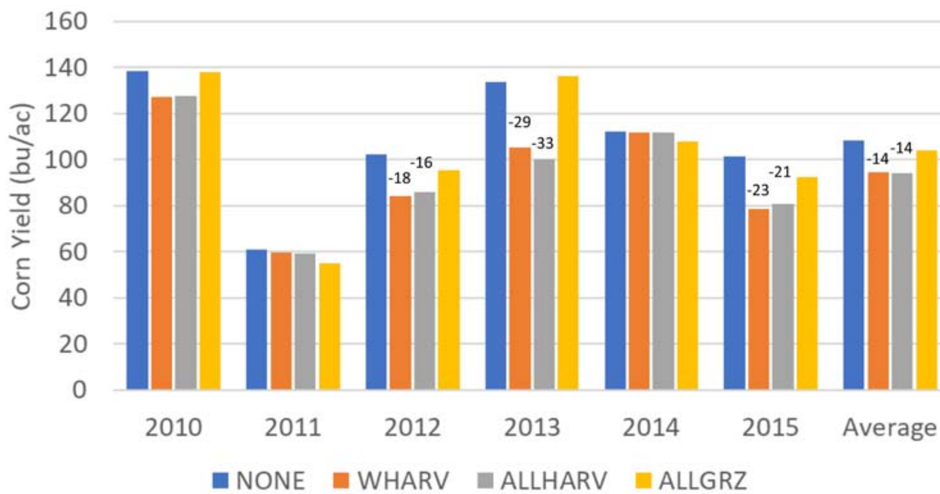


Figure 1. Corn grain yield in a wheat-pea-corn rotation with: no residue harvest (NONE), wheat straw baled and removed (WHARV), residue from all crops baled and removed (ALLHARV), grazing crop residue for all crops (ALLGRZ). Numbers above bars indicate statistically significant reduction (in bu/ac) from the NONE treatment (P<0.05).

No significant rotation or removal effects were found for average dry pea yields. The only significant effect on average spring wheat yields occurred for ALLGRZ compared to NONE in the W-P rotation, with an average yield reduction of 6 bu/ac with grazing compared to no removal. This was likely due to higher weed pressure in the grazing treatment, since grazing was sometimes used in place of post-harvest herbicide applications in the ALLGRZ treatment.

Given the substantial yield reduction associated with harvesting crop residues in the W-P-C rotation, it is not surprising that the harvested crop residues in this rotation led to substantial reductions in profitability. Harvesting residue to generate more income resulted in a reduction in net income of $25-26/acre. Results from this study suggest that producers should take grain production effects into consideration when making decisions about whether to harvest crop residues.

Archer, D.W., M.A. Liebig, and S.L. Kronberg. 2020. Dryland crop production and economic returns for crop residue harvest or grazing. Agronomy Journal https://doi.org/10.1002/agj2.20100

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Message from Dave

Dr. David Archer, Research Leader

Producers have many sources of information available to help in making management decisions. But, not all of the information is reliable, and making a decision based on unreliable information can be costly. An important part of the research process is designing the research so that we can have confidence in the results that come out of the research. We design field research to include replication, that is applying the same treatments on multiple plots or fields. This provides assurance that results we see are not a result of something happening at a particular point in the field, and that the results apply more broadly.

Long-term research provides another level of confidence in research results. I have discussed the benefits of long-term research in past issues of the Integrator. Long-term studies allow us to look at systems under varying conditions to see if results occur consistently over time not just some unusual condition that occurred in a particular year. Long-term studies also allow us to track changes that occur over time using measurements taken at the beginning of the study and continued periodically over the length of the study. While these results are valuable for a particular location, the data can be even more valuable and give us more confidence in our results when combined with data from other similar studies across the country and around the world. We have actively participated in several such efforts including a global dataset effort described by Mark Liebig in this issue (p.5). We have laid the groundwork for future reliable research through our participation in the Long-Term Agroecosystem Research Network (LTAR) and establishing common experiments as a part of LTAR. See the report by Mark Liebig on the LTAR project (p.14).

Once the research has been conducted and the results have been analyzed, we report the results in a manuscript that is submitted to a journal for peer-review. In the peer-review process, other scientists scrutinize the research to make sure it was properly designed, sampling and measurement techniques were technically sound, data were analyzed correctly, and the reported results were supported by the analysis. If the manuscript gets successfully through peer-review and is published, this provides one more layer of confidence in the results. This is one reason we provide the journal article citation with the research results summaries provided in the Integrator, so you can see that it has been through the peer-review process and you can read the full details of study for yourself.

We hope you enjoy this issue.

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Farming and Ranching for the Bottom Line

Discover the Triple Bottom Line: Economics, Ecology, & Sociology

February 25 & 26, 2020

National Energy Center for Excellence
Bismarck State College, 1200 Schafer St. Bismarck, ND

DAY 1: Tuesday, Feb 25

8:00	Registration
9:00	Welcome
9:15	Industry Perspective Dr. Tom Rabaey, General Mills
10:15	Rain, Rust, and Ruts: Is there a Silver Lining to 2019? Dr. Mark Liebig
10:45	Links Between Land Management & Food Quality: What Can Archive Samples Tell Us? Dr. Andrea Clemensen
11:15	USDA Soil Health/Human Health Project Dr. Mike Grusak
12:00	Lunch/Book Signing/Posters/Vendors
1:00	NDSU Agribiome Initiative Dr. Gregory Lardy, Dr. John McEvoy
1:45	Building Soil Health Across ND: Innovative Producer Panel Moderated by Dr. Abbey Wick
3:00	Break
3:15	Let Food and Feed Be Our Medicine Dr. Fred Provenza
5:00	Social at the Hampton Inn & Suites

DAY 2: Wednesday, Feb 26

8:00	Registration
9:00	Welcome
9:15	Mending Broken Linkages: Soil, Plants, Herbivores, & Humans Dr. Fred Provenza
10:30	Break
10:45	What Makes People Do What They Do on Their Farms & Ranches Dr. David Toledo
11:15	Perspective From Both Sides of The Desk John Pfaff, Security First Bank
11:45	Lunch/Book Signing/Posters/Vendors
12:45	Weather Crystal Ball Laura Edwards
1:45	Restorative Agriculture: A Farmer's Perspective Greg Busch
2:30	Future Directions & Challenges for Agriculture Dr. Jerry Hatfield
3:30	Speakers Q&A Wrap-Up

*****
This event will be streamed live at www.bismarckstate.edu/livestream
*****

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REGISTRATION: There is no cost to attend this event. Preregistration will guarantee you a seat and meal. However, due to limited space please RSVP by Feb 18th. To register, contact Cindy at 701-250-4518, ext. 3. or visit the Eventbrite page: https://triple-bottom-line.eventbrite.com. For hotel reservations, please call the Hampton Inn and Suites at (701) 751-5656.

NGPRL Research Contributes to Global Dataset on Soil Carbon Under Perennial Crops

Dr. Mark Liebig

Perennial crops occupy about a third of croplands globally, and as such, have a significant effect on the quality of agricultural land. Despite their extensive use and recognized importance to agriculture, effects of perennial crops on soil carbon are not fully understood. This issue is compounded by the fact that there are few long-term data sets documenting soil carbon change under perennial crops.

To facilitate future research on soil carbon and perennial crops, a global research team contributed to a global database on soil organic carbon change resulting from perennial crop cultivation (Ledo et al., 2019). The database includes information from over 1600 paired-comparison empirical values from 180 peer-reviewed studies, 709 sites, 58 different perennial crop types, and 32 countries in temperate, tropical and boreal areas (Fig. 1). In addition to soil carbon data, the database also contains information about climate, soil characteristics, management and topography. As a location well-known for research on perennial grasses and soil carbon change, NGPRL was a key contributor to the global dataset.

The dataset is the first global compilation of soil carbon data under perennial crops. Now that it is available to the research community, the database has potential to support multiple modeling and research efforts aimed at informing management guidelines to enhance soil carbon storage in agricultural lands. Specific applications include the development of climate-smart agricultural strategies and determinations of potential carbon savings from the planting of perennial bioenergy crops.

The full article and associated dataset are available at Ledo et al. 2019. A global, empirical, harmonised dataset of soil organic carbon changes under perennial crops. Sci. Data 6:57. https://doi.org/10.1038/s41597-019-0062-1.

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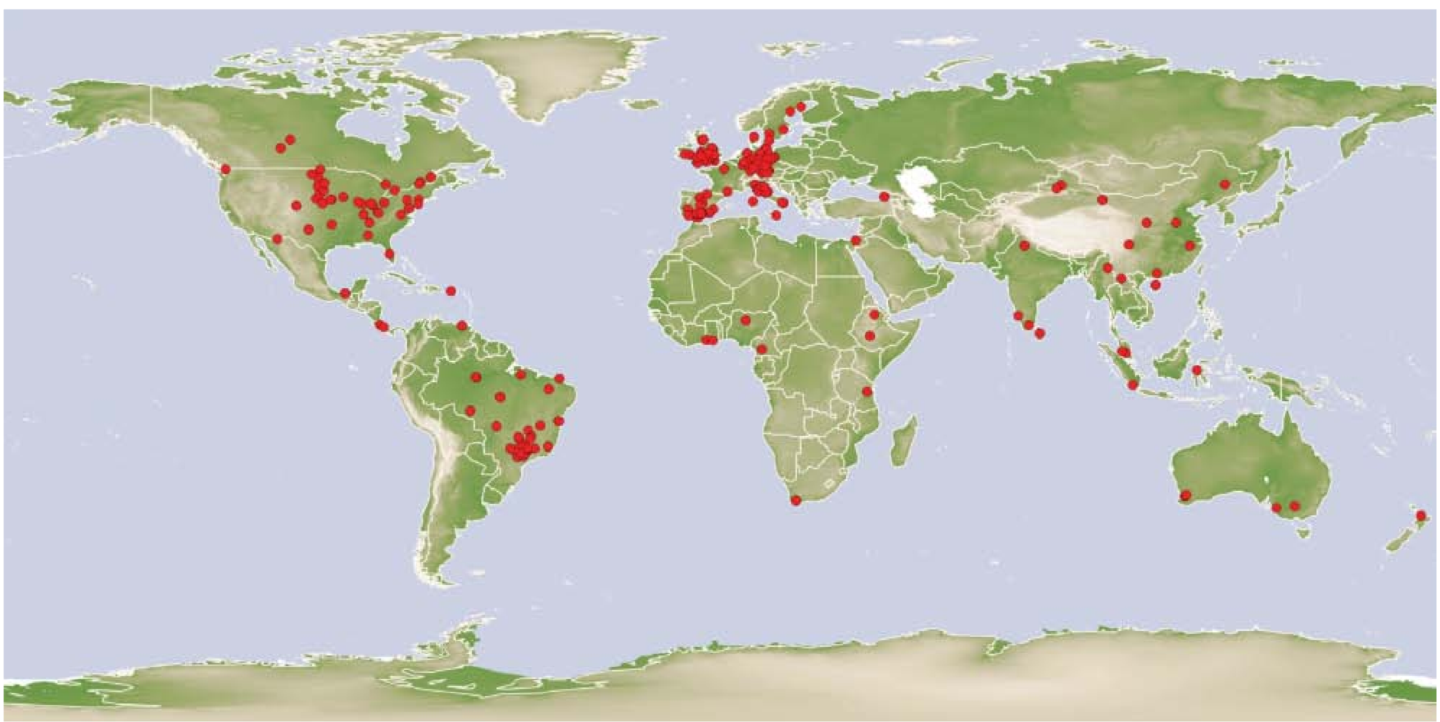

Figure 1. Study site locations included in the global dataset.

Do Tannin or Saponin-Containing Forages Influence the Soil Microbiome?

Dr. Andrea Clemensen

All plants produce primary and secondary metabolites. Primary metabolites are directly involved in plant growth, whereas plant secondary metabolites aid plants in fluctuating environments and protect plants against herbivores and pathogens. These metabolites also offer various health benefits to animals. Incorporating forages that contain different plant secondary metabolites, such as condensed tannins and saponins, may benefit animal agriculture.

Nitrogen loss in these systems is widespread, and the potential for nitrate leaching under grazed pastures is greater than that of mowed pastures. This is because 60-90% of the ingested N is returned to the soil via manure and urine, creating hotspots of N in the soil that are prone to N loss. The presence of tannins or saponins in plants may reduce this problem as tannins and saponins bind to proteins in the digestive tract, increasing the amount of N in manure relative to N in urine. This slows release and leaching of N in pastures. Condensed tannins are large polar molecules that remain in the digestive tract and are excreted in manure, which may then be difficult for soil microorganisms to break down.

In addition to tannins, saponins may affect both C and N cycling in soil. In forest systems, carbon-based compounds such as tannins and saponins generally reduce N mineralization, thereby reducing N mobilization. Reduced N mineralization would benefit pasture systems by reducing N loss. We explored whether the same phenomena that appear in forest soils occur in pasture soils with forages containing tannins (sainfoin) and saponins (alfalfa). We measured soil parameters such as inorganic N, soil respiration, and enzyme activity. We hypothesized that cattle-grazed pastures of non-traditional grass and legume strips including tannin-containing sainfoin and tall fescue (TF) would influence soil microbial activity to a greater extent than "traditional" grass and legume strips of TF and alfalfa, which does not contain tannins, but contains saponins. We also performed a soil incubation study with cattle feces from two different diets consisting of TF mixed with either sainfoin or alfalfa.

The field experiment was designed around a grazing choice experiment where Angus fall-born calves strip-grazed either TF-sainfoin or TF-alfalfa pastures from May-September. Major findings from the field experiment were as follows:

- Soil nitrate was 4.2-fold greater in legume plots than tall fescue plots, and between legumes we observed 3.4-fold greater soil nitrate in alfalfa plots than in sainfoin plots, suggesting reduced nitrification in plots containing tannins.

- Soil microbial activity decreased in sainfoin and alfalfa legume plots compared to tall fescue plots, indicating microbial inhibition in both legume systems.

- Total nitrogen in TF grass tissue was greater in pastures with alfalfa than sainfoin, implying greater plant-available nitrogen with the presence of alfalfa.

- After four years of forage establishment, alfalfa plots increased in soil nitrate but sainfoin plots showed no differences, also suggesting tannin-containing sainfoin forages inhibit soil nitrification.

The laboratory incubation study included cattle feces from two different diets (alfalfa-TF or sainfoin-TF) which was mixed with soil and incubated at 24˚C for 56 days. Major findings from the laboratory incubation study were as follows:

- Overall microbial activity (as indicated by dehydrogenase enzyme activity) was greater in feces treatments from alfalfa diets than from sainfoin diets, indicating reduced microbial activity in feces treatments from tannin-containing sainfoin diets (Figure 1).

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Do Tannin or Saponin-Containing Forages Influence the Soil Microbiome?

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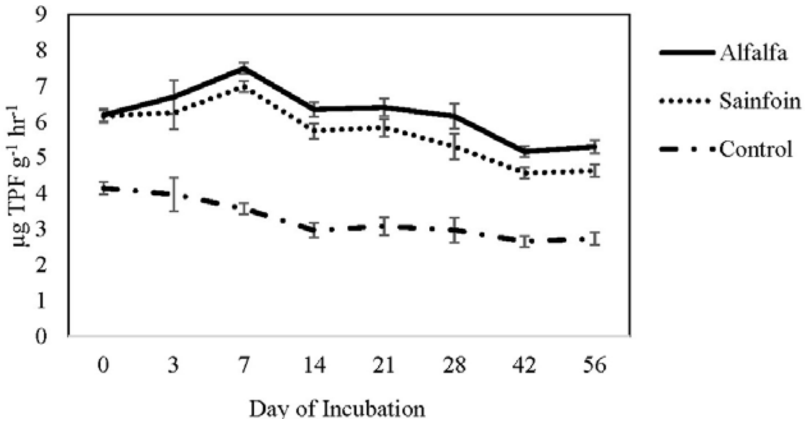

Figure. 1. Dehydrogenase activity, measured in μg triphenyl formazan (TPF) g-1 hr-1, from cattle feces from two different diets of either tannin-containing sainfoin, saponin-containing alfalfa, and a control without the addition of feces, measured eight times over 56 days.

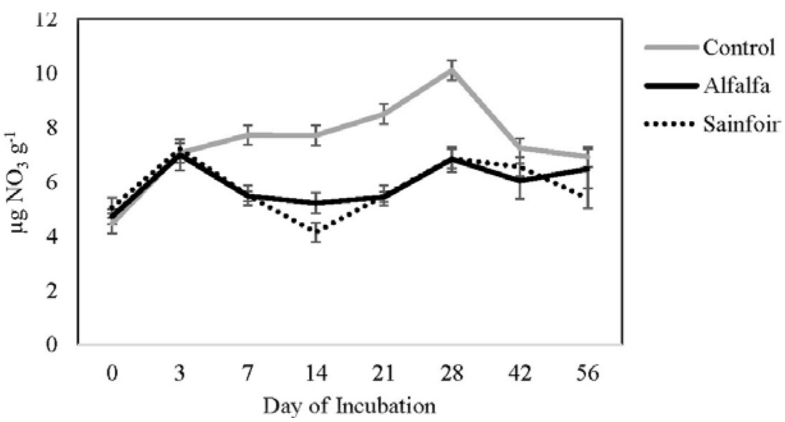

Figure. 2. Nitrate (NO3) results from cattle feces additions from two different diets of either tannin-containing sainfoin or saponin-containing alfalfa, and a control without the addition of feces, measured eight times over 56 days.

• The control treatment, without addition of feces, showed greater nitrate than both feces treatments. This may suggest nitrification is reduced with feces from both diets (tannin-containing sainfoin and saponin-containing alfalfa).

When animals graze diverse forages, the different chemicals ingested improves animal production while enhancing soil quality and nutrient cycling. To our knowledge this is the first study assessing the effects of forages containing tannins or saponins on pasture soil processes. Although this study suggests that tannins from sainfoin, and perhaps saponins from alfalfa, may reduce soil nitrification, more research is needed to determine whether specific plant secondary metabolites might reduce N loss in pasture systems by slowing N mineralization.

This article is adapted from a manuscript currently under review by Agronomy Journal (AJ-2019-09-0737-A.R1): A.K. Clemensen, J. J. Villalba, G. E. Rottinghaus, S. T. Lee, F. D. Provenza, and J. R. Reeve. 2020. Do Plant Secondary Metabolite-Containing Forages Influence Soil Processes in Pasture Systems?

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Can Humic Substances Improve Soil Fertility Under Salt Stress and Drought Conditions?

Dr. Jonathan Halvorson

Semiarid soils may be poor in organic carbon, a necessary source of energy for soil microorganisms that affect plant growth. Excessive salts in these soils may further reduce the benefits of organic carbon and also have direct negative effects on plant growth. Although the addition of amendments rich in organic matter may improve soil chemical characteristics, the effectiveness of different types and concentrations of organic matter in these amendments is poorly understood for semi-arid soils.

This research evaluated the effect of two sources of organic carbon (Humistar® and diluted cow manure) on the chemical characteristics of a semi-arid soil cultivated with passion fruit and irrigated with saline water. Humistar® is an organic soil amendment derived from oxidized lignite (leonardite)*. The experiment took place in Brazil during the most severe drought in 30 years.

Results for the conditions in this experiment contradicted the general idea that organic matter can mitigate the harmful effects of salt in semiarid soils, because the addition of both Humistar® and diluted manure to the soil reduced soil fertility during a severe drought period. Also, during the low rainfall period, the combination of humic substances and saline water aggravated the effects of salt in the soil. Since this effect occurred with Humistar, which has higher humic acid content, this response may depend on the concentration of humic acids in the amendment.

While organic amendments may often be beneficial, this research is useful in highlighting that they may have negative effects under saline conditions in semi-arid regions, and that effects may differ depending on the characteristics of the amendment used.

Suddarth, S. R. P., J. F. S. Ferreira, L. F. Cavalcante, V. S. Fraga, R. G. Anderson, J. J. Halvorson, F. T. C. Bezerra, Sherly. A. S. Medeiros, C. R. G. Costa, and N. S. Dias. 2019. J. Environ. Qual. 48:1605-1613. doi:10.2134/jeq2019.02.0071 https://dl.sciencesocieties.org/publications/jeq/articles/48/6/1605

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Leonardite Extract

Leonardite

Extensive reserves of naturally oxidized lignite (soft brown coal) occur with virtually all lignite outcrops in North Dakota. The naturally oxidized material, is termed “leonardite,” after A. G. Leonard, early director of the North Dakota Geological Survey, who did much of the early studies on these deposits.

Source: Youngs, R.W. and Frost, C.M., 1963. Humic acids from leonardite; a soil conditioner and organic fertilizer. Proceedings of the North Dakota Academy of Science, 17, p.76.

Techniques and Considerations for Adding a Perennial Phase to Your Annual Crop Rotation

Drs. John Hendrickson, Mark Liebig, Dave Archer, Scott Kronberg, Jose Franco, Marty Schmer and Andrea Clemensen

Adding a perennial phase to your crop rotation is a proven way to enhance soil quality. Liebig et al. 2018 showed that compared to continuous spring wheat, perennials 1) **reduced acidity and soil bulk density**, 2) **improved soil aggregate stability (Figure 1) and 3) if intermediate wheatgrass was in the mixture, there were further improvements to soil and bulk density**. However, there is limited information on how producers can successfully incorporate perennials into their annual cropping systems.

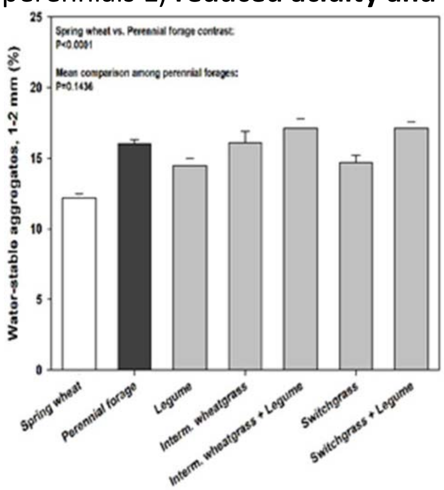

Figure 1. Water-stable aggregate values for continuous spring wheat versus all perennial forages (White and Black bars). Water-stable aggregate values are also shown for alfalfa (legumes), intermediate wheatgrass (interm. wheatgrass), intermediate wheatgrass + alfalfa, switchgrass and switchgrass + alfalfa.

When producers think about adding perennials into their crop rotations, there are several questions they need to consider. First, what perennials are they going to use and how long should they be in place? Second, what is the best crop residue in which to seed with the perennials? Finally, how do they transition from the perennial phase back to the annual cropping phase? The Northern Great Plain Research Laboratory (NGRPL) has done research to help producers with each of these questions.

Committing to a perennial phase in a crop rotation is a major decision. Maximizing the soil and production benefits depends on choosing the best perennial species or species mixture for use in this phase. Besides choosing the species, producers need to think about the length of the perennial phase. The NGPRL recently finished an experiment that examined both questions. In this experiment, 5 perennial monocultures or mixtures were compared to continuous spring wheat. The perennials used in the experiment were 1) intermediate wheatgrass monoculture, 2) switchgrass monoculture, 3) alfalfa monoculture, 4) intermediate wheatgrass-alfalfa mixture and 5) switchgrass-alfalfa mixture. The spring wheat controls were fertilized with 60 pounds of nitrogen annually. The treatments were seeded in plots that were 120 feet by 30 feet and after the 2-year establishment period, ¼ of each plot (30 x 30 feet) was converted to spring wheat. The area that was converted to spring wheat was left unfertilized to assess the benefits of perennials to subsequent crop production. Figure 2 shows a replication of the experiment and illustrates how the plots were transitioned.

As mentioned previously Liebig et al. (2018) found that, compared to continuous spring wheat, perennials improved multiple aspects of soil quality (Figure 1). They also found that, **compared to an alfalfa monoculture, after 5 years an intermediate wheatgrass-alfalfa mixture decreased soil bulk density and increased labile soil organic matter**.

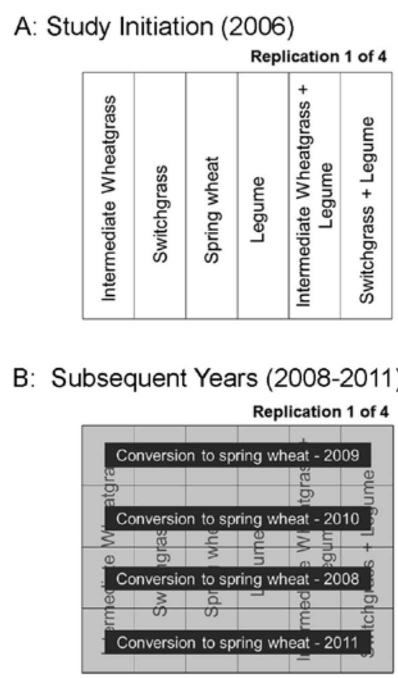

Figure 2. Experimental layout showing treatments and how plots were transitioned into annual crop production.

The data show that an intermediate wheatgrass-alfalfa mixture can maximize soil quality benefits, but do these effects also transfer to subsequent spring wheat production? Spring wheat yields were tracked not only during the transition period but also for four years after the last perennial plots were converted to annual crop production. The yield data suggest that 1) **unfertilized spring wheat yields following 2 years of alfalfa or 3 years of an alfalfa-grass mixture were similar to fertilized spring wheat yields**; 2) **keeping**

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alfalfa in for 4 years or an alfalfa-perennial mixture in for 5 years resulted in unfertilized wheat yields similar to fertilized wheat yields for the NEXT FOUR cropping seasons, and 3) **producers should consider the competitiveness of the perennial grasses used in alfalfa grass mixtures since they can be overtaken by alfalfa** (Franco et al. 2018). It is important to consider that the continuous spring wheat was only fertilized with 60 pounds of nitrogen per acre but the results still demonstrate that perennials can be a powerful tool to reduce inputs. The wheat grain samples from this project are currently being analyzed for mineral and protein content by the Fargo ARS location.

The data suggest that an alfalfa – intermediate wheatgrass mixture provides the maximum soil quality and yield benefits in our semi-arid environment. The next question was, does the crop residue that is planted into impact perennial establishment and yield? NGPRL scientists conducted an experiment where different perennial monocultures and mixtures were seeded into 5 different crop residues (Schmer et al. 2018). The perennial monocultures and mixtures were 1) intermediate wheatgrass (IW); 2) switchgrass (Switch); 3) IW + Alfalfa; 4) Switch + Alfalfa; 5) Cool Season mixture that used Minimum Inputs and had Moderate Diversity (CS-MIMD); 6) Warm-Season mixture that used Minimum Inputs and had Moderate Diversity (WS-MIMD) and 7) a Low Input High Diversity Mixture (LIHD). The crop residues were canola, corn, dry pea, soybean and wheat. While soybeans had the greatest overall establishment frequency, which is a measure of stand establishment, crop residue influenced perennial productivity. Figure 3 shows that for switchgrass, seeding into soybean residue is the best, while for intermediate wheatgrass-alfalfa mixtures or the cool-season mixture (CS-MIMD), seeding into canola residue produced the greatest perennial yield.

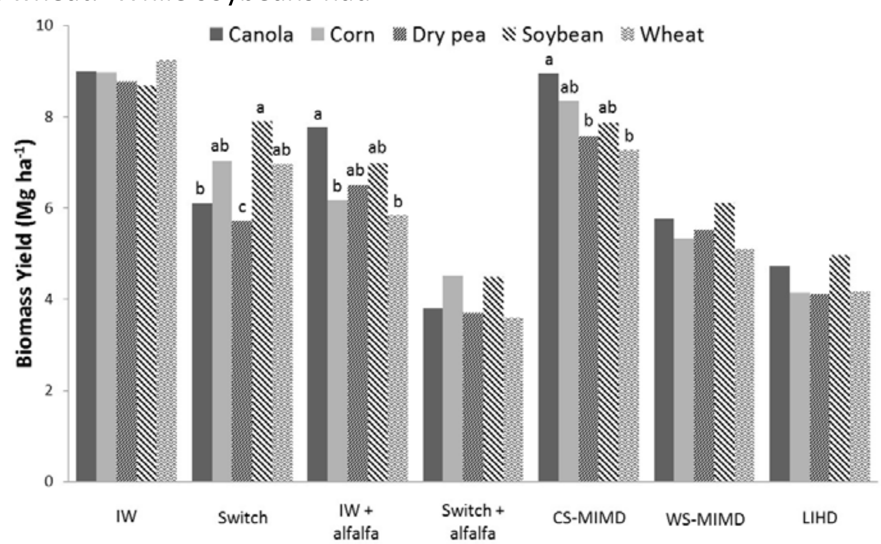

Figure 3. The impact of previous crop residue on the productivity of different perennial monocultures and mixtures.

Finally, producers need to think about how to transition from perennials back to annual crops. NPGRL scientists converted intermediate wheatgrass plots, which were grazed at 3 different growth stages, to annual crop production using either No-Till or Minimum-Till techniques and glyphosate herbicide (Hendrickson et al. 2014). An undercutter was used on the Minimum-Till plots prior to seeding the annual crop. Generally, the **No-Till plots had greater crop yields than did the Minimum-Till plots**. An interesting side note to this project was that previous grazing history impacted annual weed seed populations. The trends were not enough to make a strong recommendation, but it shows the impact of previous management history on annual crop yields.

While every farm is different, this data can provide information for producers in the semi-arid Northern Great Plains who are interested in adding perennials to their crop rotation. First, it appears that an alfalfa-intermediate wheatgrass combination, left for 5 years provides the maximum soil quality and crop yield benefits. It is important to note that perennials need to be left in place at least 2 years for any crop yield benefits to occur and the longer the perennial phase is left in, the longer the benefits appear to last. Second, if this is the mixture chosen, then seeding into canola residue appears to provide the greatest productivity during the perennial phase. Finally, converting back to annual crop production with the least disturbance possible is important for preserving crop yields.

These data provide important information, but it is important to

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recognize that there is a need for further information. We still don't know the best crop sequence to follow the perennial phase. In some regions, annuals are being grown in existing stands of perennials, but it is unclear if this will work in our semi-arid region. Finally, as interest increases in perennial food crops, i.e. perennial grains such as Kernza-intermediate wheatgrass and perennial oilseeds such as Silphium integrifolium, we don't know how they fit into existing crop rotations.

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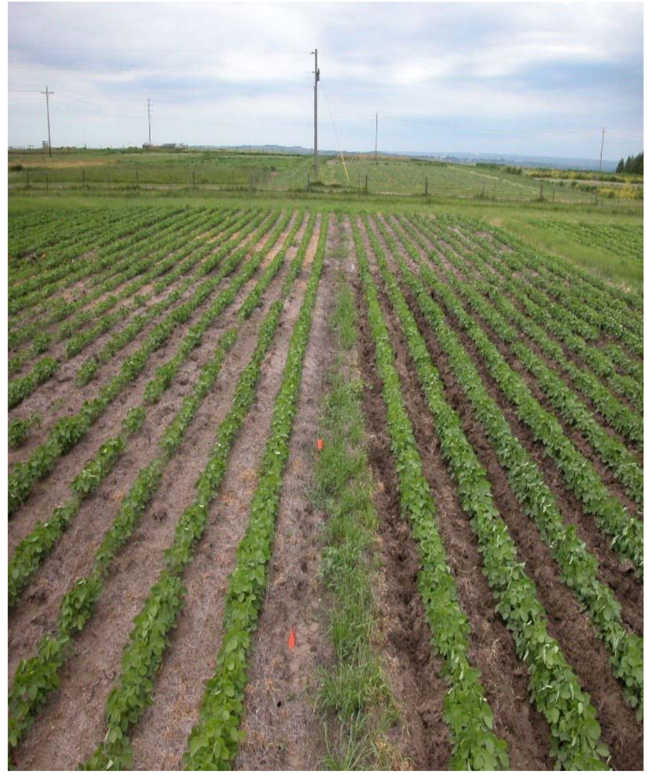

Soybeans planted into intermediate wheatgrass residue.

Maintaining Invasive plant Species with Goats

Jacob Notermann KFYR TV Jul 14, 2019

Invasive plant species are getting the U.S. Department of Agriculture's goat, and vice versa.

The Northern Great Plains Research Lab in Mandan is using goats to maintain the natural landscape to help cattle grazing.

With the spread of new species of brush and foliage, less landscape is available for the plants cattle eat. They're studying whether or not goats can properly eat the unwanted species.

"There's a few people who might consider small ruminants, but typically speaking a lot of cattle ranchers are not too open to adding a species or two of ruminants. And so they hope the herbicides will solve their problem, but they seldom do," said Scott Kronberg, research animal scientist.

The study started this summer and are still a few years away from having results. In the meantime, Kronberg said he is looking to acquire at least 100 goats.

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ARS Scientists Study Environment and Genetic Control Interactions in Intermediate Wheatgrass to Improve Forage Traits

John Mortenson

Increased forage productivity of cool-season grasses due to breeding is often less than anticipated. This lack of response may be because plant breeders often conduct evaluations using plots with widely-spaced individual plants which do not resemble the production environments of monoculture and mixture swards.

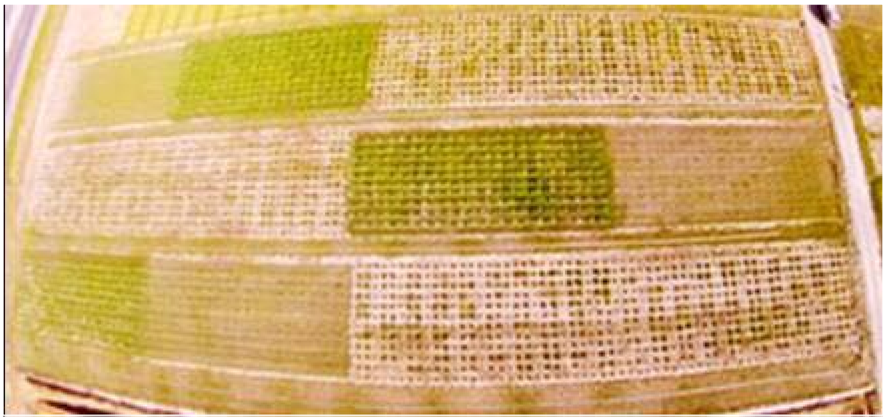

Figure 1. Aerial view of the ASU research plots, Nibley, UT

Many assume that the genetic control of forage traits, especially biomass, for grasses growing as spaced-plants versus swards and in monocultures versus mixtures is at least partially different, however, these assumptions are largely untested, especially at the DNA level. Therefore, ARS scientists used an intermediate wheatgrass population to examine the genetic control of forage traits when grown under three different competition environments (spaced-plants, and grass monoculture and grass-legume mixture swards).

Biomass, morphological traits, and forage nutritive value were moderately to highly heritable within all three environments and genetic control of forage nutritive value was similar among all environments. However, this study verified that the genetic control of grass biomass in a monoculture is not entirely the same as a grass-legume mixture, with additional genes expressed in the monoculture. Further, biomass in widely spaced-plants is predominantly under different genetic control than swards.

These results indicate that selection for improved grass biomass will be most successful when conducted within the targeted grass monoculture or grass-legume mixture sward environment per se.

Quantitative Trait Loci (QTL) for Forage Traits in Intermediate Wheatgrass When Grown as Spaced-Plants versus Monoculture and Polyculture Swards, 2019, Mortenson, J.S.; Waldron, B.L.; Larson, S.R.; Jensen, K.B.; DeHaan, L.R.; Peel, M.D.; Johnson, P.G.; Creech, J.E. Agronomy 2019, 9, 580.

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Research Profile: New Long-Term Experiments Started at NGPRL

Dr. Mark Liebig

Long-term experiments are essential for understanding the sustainability of agricultural management practices. For over a century, NGPRL has conducted dozens of long-term experiments that have generated critical information to help producers better manage their farms and ranches. Most experiments, however, have not been coordinated with other long-term studies throughout the USA, limiting the applicability to a single region. Moreover, nearly all experiments have used designs that don't allow for treatments to change over time, resulting in their decreased relevance as management practices evolve.

In response to these drawbacks, the Long-Term Agroecosystem Research (LTAR) Network established a Common Experiment to facilitate the adoption of agricultural practices throughout the USA that support the delivery of multiple ecosystem services for improved economic, social, and environmental outcomes.

To date, 16 experiments have been initiated at LTAR sites within cropland and integrated system land uses. Additionally, grazing land experiments have been initiated at five LTAR sites (Figure 1).

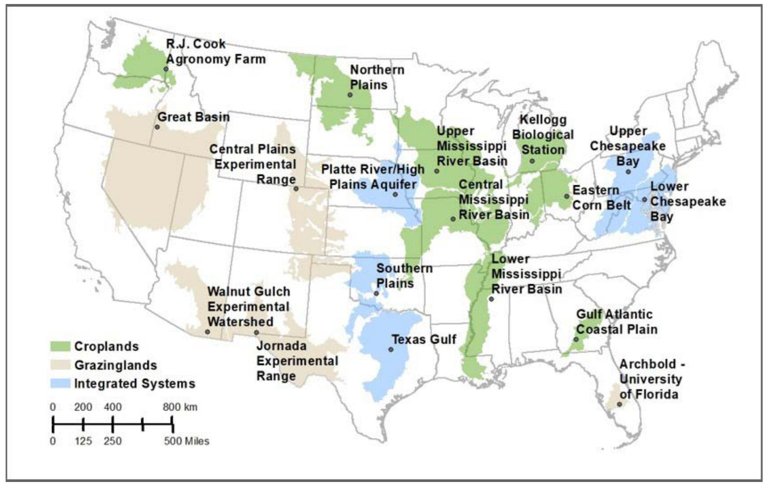

Figure 1. Sites included in the Long-Term Agroecosystem Research Network.

Figure 2. Aerial photo of NGPRL Croplands Common Experiment, July 2019.

NGPRL supports two Common Experiments: cropland and grazing land. Both experiments are designed to enhance ecosystem service responses using aspirational treatments over the long-term. Aspirational components in the cropland experiment include cover crops, no-tillage, and variable nutrient management, whereas in the grazing land experiment, multi-species grazing, prescribed fire, and high intensity-short duration grazing comprise the aspirational components. The cropland experiment started in 2019 (Figure 2), and the grazing land experiment is slated to begin in 2020.

The Common Experiment uses a simple design, contrasting 'Business as Usual' and 'Aspirational' treatments representative of a region. The 'Business as Usual' treatment reflects the prevailing practices in an LTAR site's area, whereas the 'Aspirational' treatment is designed with a vision for the future to deliver site-prioritized ecosystem services (e.g., flood protection, pest/disease suppression, habitat conservation, etc.) in addition to food/feed/fiber/fuel production. To maintain relevance with stakeholders, practices within each treatment are revisited periodically and adjusted based on experimental outcomes, adoption rates, technology/innovation, and socioeconomic change.

To leverage strengths of cross-site, coordinated research, LTAR sites will use common measurements and observations. Doing so will improve understanding of factors underlying tradeoffs and synergies among the many ecosystem services measured at the different LTAR sites.

In a world where agricultural producers are challenged to increase production and efficiency while also improving stewardship of natural resources, the LTAR Common Experiment has an important role to play in achieving these goals in a sustainable manner.

Additional information about the LTAR Common Experiment can be found at https://ltar.ars.usda.gov/.

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Presentations of NGPRL Science

Since the last issue:

On June 14th, Dr. Rachael Christensen led a tour of NGPRL research for 22 members of the North Dakota Women's Cattle Organization. She discussed the use on cattle and goats in research and discussed how the research at Mandan has potential to help cattlemen/women.

On June 20th, Cal Thorson, USDA-ARS Technical Information Specialist, provided Bismarck-Mandan Middle School Teachers an update on Agriculture and Agricultural Research at the Chamber of Commerce in-service course. He focused on career opportunities, the rapid advancement of technology and science on the farm, and how important teachers are for public confidence in scientific advancements in food production.

On July 8 -11, 2019, ARS Research Animal Scientist Rachael Christensen, attended the American Society of Animal Science/Canadian Society of Animal Science Annual Meeting and presented an invited presentation, "*Plant secondary compounds and milk production and milk products*" and three abstracts and posters, in Austin, TX

On July 9th, 23 students from Legacy High School in Bismarck, ND toured research at the Northern Great Plains Research Lab. The event included presentations on drone use in agriculture, ruminant research with a fistulae cow, and a discussion about soils and foods.

On July 18, 2019, the staff opened the doors of the lab to the public for their 35th annual 'Friends & Neighbors Day'. The event, sponsored by the Area 4 SCD Cooperative Research Farm, featured exhibits on how USDA-ARS research is accomplished and equipment displays, tours of ongoing research, the 15-acre research campus, children's activities, and exhibits from other USDA Agencies. The event attracted over 750 family farmers, ranchers, and from the community.

On July 23rd, Dr. Dave Archer, NGPRL Research Leader, presented "*Feedstock Production Decisions and Post-Harvest Economics*" at the Illinois Switchgrass V conference, in Peoria, IL.

On July 25th, 56 producers and agricultural advisors from Becker County MN toured NGPRL research, enjoyed a barbecue sponsored by the Area 4 SCD Research Farm, continued one-on-one discussions with USDA-ARS Researchers on soil conservation research. The tour was organized by Dr. Mark Liebig (Research Soil Scientist) with presentations by Liebig, Dr. Scott Kronberg (Research Animal Scientist), Drs. David Toledo and John Hendrickson (Research Rangeland Management Specialists), and Roberto Luciano (NRCS Soil Scientist).

On September 26, 2019, ARS staff hosted students and teachers from the local tribal colleges for the afternoon. The event included presentations from scientists on current research projects and 'hands-on' learning activities for the students. The group was also treated to a barbecue sponsored by the Area 4 SCD Cooperative Research Farm.

On November 10-13, 2019, ARS staff attended the American Society of Agronomy-Crop Science Society of America-Soil Science Society of America International Annual Meeting in San Antonio, TX. Research Soil Scientist Mark Liebig presented "*The LTAR Croplands Common Experiment: Long-Term Research for Improved Agricultural Sustainability*" and "*Nitrous Oxide Flux from Integrated Crop-Livestock Management in a Semiarid Region*". Research Rangeland Management Specialist John Hendrickson presented "*Do We Have to Sacrifice Our Grasslands for Corn and Soybean Production?*" Supervisory Research Agriculturist David Archer presented "*LTAR Human Dimensions: Grappling with Rural Prosperity*" and "*Winter triticale vs. winter wheat in Washington's drylands: Economic returns*".

On December 11, Dr. David Toledo, Research Rangeland Management Specialist, presented *"Application of Existing Long-Term Studies to Develop Management Options that Reduce Production Risks and Enhance Ecosystem Services Under Increased Weather Variability"* at the AGU Fall Conference in San Francisco, CA.

New Science Published

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New Faces

Camryn Hall, Administration Secretary, is originally from Maine. She served eight years in the US Coast Guard. Camryn holds an Associate Degree in Office Systems from Gulf Coast Community College in Panama City FL. She has been a Federal employee since 2003, working for the Corps of Engineers in Florida and North Dakota, and at Fort Rucker in Alabama. Camryn lives in Stanton with three cats and spends summers hiking and swimming in Lake Sakakawea.

Scott Jensen has been hired as Carpenter Worker. He recently moved to North Dakota from the Black Hills of South Dakota and is excited about the adventures his new location may bring. Scott and his wife have three grown kids who are now off on their own separate adventures. In South Dakota he worked in building maintenance for Custer State Park. Scott is looking forward to fishing when spring arrives to North Dakota.

Northern Great Plains Research Laboratory Staff 2019