Summer 2020 Virtual Field Day

Clinton County Farm Bureau

Influences of Cover Crops and Manure Management on Reducing Nutrient Losses

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Other project partners: Bryan Henrichs, Henrich Farms, LTD | Danny Potthast | Dean Carrillon, Carrillon Dairy
Dr. Ted Funk | Mike Andreas | Kaskaskia College | Gateway FS | Clinton County SWCD | Illinois NRCS | University of Illinois Extension

About Our Presenters

Brad Conant
Brad Conant holds the IFB Certified Manager designation and has served as the County Manager for the Clinton and Marion County Farm Bureaus (CFB) since 2018. Overall, Conant has been a CFB Manager since 2003, serving in numerous leadership roles within the organization.

Ray Krausz
Ray Krausz is the 5th generation on his family farm. He raised dairy cows, hogs, and replacement heifers and steers on the farm until he officially got out of the livestock business in 2000. He farms 350 acres of corn, soybeans, and winter wheat, plus an additional 400 acres of custom farming. Ray is also an auctioneer for Mark Krausz Auction Service. He has served on the Clinton CFB Board since 1986, and has served as President from 2001 to present.

Lauren Lurkins
Lauren Lurkins serves as the Director of Environmental Policy in the Governmental Affairs and Commodities Division of the Illinois Farm Bureau (IFB). Lauren is responsible for developing and coordinating the organization's natural resources and environmental programs. Prior to her position at the IFB, Lauren practiced environmental law with the law firm of Hodge Dwyer & Driver in Springfield, Illinois.

Cliff Schuette
Cliff is the owner of Schuette Seeds and is a District Sales Manager for Stine Seed Company where he covers 10 counties in Southern Illinois. Cliff has been in the seed business for 32 years selling corn, soybeans, wheat, and forages (cover crops). Cliff also has a passion for raising cattle on a rotational grazing system that helps to reduce cow feed cost and regenerate the soil so future generations can prosper off the land. Cliff is also very active on the Clinton CFB and Soil & Water Conservation District Boards of Directors.

Paul Meyer
Paul Meyer owns and operates Meyer VMS Dairy near Breese. Paul is a 3rd generation dairy farmer who milks 200+ cows, including the use of robots over the past ten years. Meyer's operation focuses on the utilization of the farm's manure to avoid commercial fertilizers and has been working with cover crops for over a decade. Paul also runs his own electrical contracting company and is a DeLaval dairy equipment dealer.

Dr. Amir Sadeghpour
Dr. Amir Sadeghpour is the Assistant Professor of Soil Management and Integrated Cropping Systems in the Department of Plant, Soil and Agricultural Systems at Southern Illinois University in Carbondale (SIUC). Dr. Sadeghpour's research focus is on the climate variability challenges to sustainable food production. His focus is to design regionally adapted cropping systems that are profitable, efficient, sustainable, and resilient.

Mark Litteken
Mark Litteken and his wife, Jenny, own and operate Sugar Creek Valley Farms in Aviston. The farm consists of a 400 head per year beef operation and custom combine and baling services. Mark also runs his own electrical contracting company, is an Assistant Professor at Kaskaskia College for residential and commercial electrical technology, is a volunteer firefighter and EMT, serves on the Clinton County Zoning Board of Appeals, and is the Vice-President of the Clinton CFB. Mark and Jenny have been married for 23 years and have three children, Colby, Carissa, and Caiden.

Terry Wyciskalla CPAg/CCA
Terry and his wife, Renee, reside in Nashville, Illinois, and have three children. He is the owner-operator of Wyciskalla Consulting, LLC, specializing in soil sampling, nutrient management, precision ag management, and soil management. He received both his Bachelor's and Master's of Science degrees from SIUC in Soil Fertility under Dr. Edward Varsa. He started his first soil sampling programs part-time in 1994, and that business has grown ever since. In 1995, he returned to SIUC and worked as a Soil Fertility Researcher for ten years before transitioning to a teaching role for the next six years, covering a broad spectrum of soils, crops, and agriculture-related courses. Finally, in the summer of 2011, he left SIUC and devoted all of his time to crop consulting as the small business grew. In 2002, he earned his certifications as a Certified Crop Advisor (CCA) and a Certified Professional Agronomist (CPAg). He later added the 4R Nutrient Stewardship certification (4R NMS). He was also selected as the 2019 IFB CCA of the Year. The business serves a 15 county region with approximately 100 clients and 80,000 acres.

Clinton County Farm Bureau

The Clinton CFB is a 501(c)5 non-profit organization based in Breese, Illinois serving over 4,200 members. The mission of the Clinton CFB is to "educate, represent our members, lead with a clear vision of the future, and assist members to achieve a rewarding lifestyle."

The Clinton CFB received an IFB Nutrient Stewardship Grant in the amount of $15,000 for their 2020 project that continued to explore the influence of manure management and cover crops on reducing nutrient losses. In partnership with IFB, the Clinton CFB has spent over $70,000 on local Nutrient Loss Reductions Strategy (NLRS) research and education since 2016.

Their multi-faceted NLRS project for 2020 included comparisons of different cropping systems to show impacts on soil health and nutrient loss. From no manure or cover crops, to manure and well-established cover crops, these systems demonstrate how phosphorous and nitrogen are utilized by both cover and conventional crops while improving soil health and water quality.

In addition, Clinton CFB expanded their efforts to emphasize the value and importance of manure (and its management) as a component of their project and contributor to overall NLRS success. They continue to draw from 5 years of NLRS project data to provide results incorporated into educational components for producer and consumer outreach through the following ways:

1. Field day(s) focusing on results from local cover crop plots, including:
   a. Fall cover crop variety comparisons for winter hardiness and late-planted success (12 individual and one 12-way mix)
   b. Summer forage plot (15 individual and one 15-way mix)
   c. Forage production and relative forage quality (RFQ) feed values
   d. Cover crop and manure application economics, and
   e. Overall impacts on soil health
2. Publication of project data for producers to make better management decisions

Illinois Farm Bureau

Since 2015, IFB has contributed to an impressive statewide effort, the NLRS. Through leadership and participation from our farmer members across the state, IFB has been able to make meaningful contributions toward water quality improvements in Illinois. From 2016 to present, IFB has committed approximately $1.5 million of its own funding to build and maintain its sustainability programs.

The NLRS is a science-based framework for using research, technology and industry experience to assess and reduce nutrient loss to Illinois waters and to the Gulf of Mexico. The NLRS sets forth a plan to leverage existing programs to optimize nutrient loss reduction while promoting collaboration, research, and innovation among the private sector, academia, non-profits, wastewater treatment agencies, the agricultural sector, and state and local government. The primary goals include reducing nitrate-nitrogen losses by 15% and reducing total phosphorus losses by 25% by the year 2025 from established baseline conditions. The NLRS was released in July of 2015 after multiple years of stakeholder discussions in which IFB actively participated. Since 2015, IFB has continued its participation in NLRS meetings and work groups in order to strategically guide the effort. In addition, IFB created new programs in 2015 to support farmer implementation of best management practices (BMPs) to help Illinois meet the goals of the NLRS.

For the past several years, IFB has made it an organizational priority to lead on environmental issues, most notably, the NLRS. IFB's NLRS efforts focus in four priority areas: 1) education and outreach to farmers, landowners and the general public; 2) supporting research of best management practices to reduce nutrient loss from agricultural fields; 3) supporting farmer implementation efforts across the state; and 4) demonstrating progress toward the long-term goals of the NLRS. The IFB Board of Directors committed significant financial resources and support from staff to accomplish some ambitious goals, allowing IFB to tackle environmental challenges head-on. IFB will continue to prove that voluntary, incentive-based conservation, based on science, will move the needle on water quality improvements in our state.

The IFB Nutrient Stewardship Grant Program is one example of the many ways IFB is creating lasting impacts in implementing the NLRS across Illinois. This program funds CFB projects throughout the state focused on improving soil health and water quality. Since 2015, IFB has dedicated over $550,000 to CFBs to complete a wide range of unique projects, including planting test plots of cover crops, watershed planning, water testing, hosting education and outreach activities. For more information on IFB's environmental efforts, see www.ilfb.org/take-action/current-priorities/protecting-our-environment.

Manure Management and Phosphorus Research

Content provided by Dr. Amir Sadeghpour, Assistant Professor, Plant, Soil and Agricultural Systems, SIUC

Research Title: Phosphorus-based as an Alternative to Nitrogen-based Manure Management for Maintaining Soil Test P, Improving Soil Health, and Overall Profitability in Corn or Corn-Winter Cereal Rye Double Cropping Systems

Project Justification:

Animal manure is a valuable source of nitrogen (N), phosphorus (P), and potassium (K) for corn and could maintain or improve soil health and productivity. Manure often has high P/N and K/N ratios compared with corn, which indicates that N-based application rates will increase soil test P (STP) and soil test K (STK) values over time. Elevated STP levels can result in greater loss of P to surface and groundwater, while high STK levels can impact herd health. The NLRS is striving to reduce P losses to 25% by the year 2025. Therefore, management practices that maintain/improve crop production while reducing the environmental footprints of agriculture are encouraged. One strategy to reduce STP buildup beyond the agronomic P response is to shift from N-based (based on the nitrogen need of a corn crop) to P-based (adjusted based on P removal of corn) manure management for corn. While P-based management often does not meet the N need of a corn crop, immediate incorporation/injection could prevent ammonia volatilization from the surface application and thus, improve N availability to corn. In this trial, we are evaluating whether shifting from N-based manure to P-based manure supplemented with inorganic fertilizer can maintain STP and STK, soil quality, and farm profit in a single season corn silage vs. winter cereal rye-corn silage double cropping.

Project objectives:

a) To evaluate changes in rye yield and quality over the spring period

b) To evaluate spring nitrogen recommendation for winter cereal rye

c) To evaluate the impact of method and rate of manure application with and without winter cereal rye as double-crop on:

   (a) Corn silage yield and quality

   (b) N, STP, and STK

   (c) Soil quality

Treatments and measurements:

This study site (Figure 1) is located in Clinton County, IL.

This project is divided into Rye and Corn phases:

Phase 1: Winter cereal rye growth, yield, and quality over time (phase 1a) and N requirement (phase 1b).

Phase 2: Corn silage yield, quality, and nutrient removal and balances as a result of various manure management scenarios.

Figure 1. *Manure trial located on Meyer's farm in Breese, IL. The red triangle indicates the location of the area allocated to the trial.*

PHASE 1A: WINTER CEREAL RYE AS A DOUBLE-CROP

Treatment: Five rye harvesting dates (March 27th-April 23rd)
Manure rate: 6,000 gals/acre
Replications: 8

Measurements:

- Rye biomass and nutrient accumulation over the spring period
- Changes in rye forage quality over the spring period
- Evaluating normalized difference vegetative index (NDVI) to predict rye yield N uptake

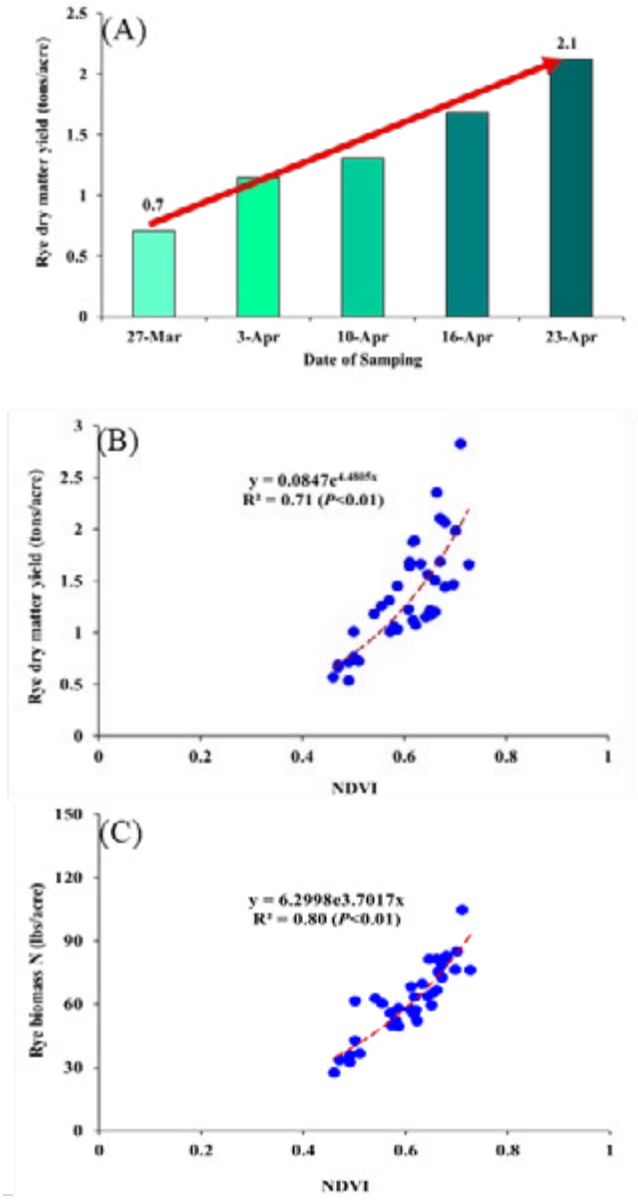


Figure 2. *Winter cereal rye biomass accumulation over the spring period (A); the relation between NDVI and winter cereal rye biomass accumulation (B) and biomass N (C) in 2019.*

Preliminary results and discussion for Phase 1a:
Winter cereal rye yield increased linearly from March 27th harvesting date to April 23rd harvesting date indicating significant increase in biomass accumulation over the fast growing phase of rye suggesting such increase could have significant benefits for taking up excess P and K from the soil as well *(Figure 2A)*. In year 1, rye yield accumulation and N uptake was predicted using NDVI *(Figure 2B-C)*. Prediction for N uptake was slightly more accurate (r^2 = 0.80) than for biomass accumulation (r^2 = 0.71). These results indicate that we could move towards building prediction models for estimating double-crop/cover crop winter cereal rye. This requires many more site/years across Illinois.

Over time, forage quality of rye decreased as harvesting date was delayed from March 27th to April 23rd indicating a tradeoff between higher yield and higher quality. Our data suggest that if we consider relative forage quality (RFQ) of 140 as the base for a ration of milking dairy cow, harvesting on April 10th would be the cutoff for meeting the baseline quality (RFQ on April 10th was 142.8). Considering April 10th (RFQ = 130) as the date of harvest indicates N uptake of 75.6, P uptake of 9.4, and K uptake of 59.7 lbs/acre (data not shown) based on the forage yield of 1.31 tons/acre (dry matter basis) *(Table 1 and Figure 2)*. These data indicate delaying the harvest is a great strategy for capturing N and P (towards NLRS goals), but also show the limitation in the potential of winter cereals to effectively meet those goals since providing a forage source for dairy cows must be met.

Table 1. *Changes in rye forage quality over the spring period. Day of year (DOY) of 86 is the first harvesting date (March 27th) and DOY of 113 indicates that last harvesting date (April 23rd).*

DOY	ADF	NDF	RFQ	C/N	Lignin	Cellulose	Hemicellulose
	g kg -3				g kg -3		
86. 0	199.9	423.5	185. 0	17.1	25.4	174.5	223.6
93	247.4	521.5	161.1	17.4	29.8	217.6	274.1
100	284.3	618.1	142.8	17.7	33.9	250.4	333.9
106	301.9	639.9	135.1	21.3	37.9	264. 0	338
113	375.7	712.3	99.9	27.4	48.5	327.2	336.7
Trend	L *	L *	L *	E *	L *	E *	Q *

L: linear; E: exponential; Q: quadratic

PHASE 1B: NITROGEN REQUIREMENT OF WINTER CEREAL RYE IN SPRING

Treatment: Six rye harvesting dates (March 27th-April 30th)
Manure rate in fall: 6,000 gals/acre
Nitrogen rates in spring: 0, 21, 42, and 63 lbs N/acre
Replications: 6 (4 for the 63 lbs N/acre treatment)

Measurements:

- Rye biomass and nutrient accumulation over the spring period for 0 N control and 42 lbs N/acre
- Changes in rye forage quality over the spring period
- Identifying the most economical spring N rate for winter cereal rye

Preliminary results and discussion for Phase 1b:
Winter cereal rye dry matter (DM) yield increased with applying N fertilizer (urea) in spring from 2.61 tons/acre at 39% DM (2.29 tons DM/acre) to 3.73 tons/acre at 39% DM (3.27 tons DM/acre) in 2020 indicating when rye was harvested at heading, response to N fertilizer was significant *(Table 2)*. Crude protein increased linearly with N fertilization indicating N applied at rates above 42 lbs/acre does not increase yield but improves crude protein. Relative forage quality was not influenced by N addition and remained unaffected *(Table 2)*. In this study, we also measured biomass accumulation of winter cereal rye at two N rates (zero-N control and 42 lbs/acre) over the spring period. Based on our data in 2020, if winter cereal rye was harvested one week earlier than April 22nd, no N fertilization was required, and 0 N control would have had a similar yield to 42 lbs N/acre *(Figure 3)*.

All treatments received a starter fertilizer of 30 lbs N/acre at planting.

Measurements at the start and during the corn phase:

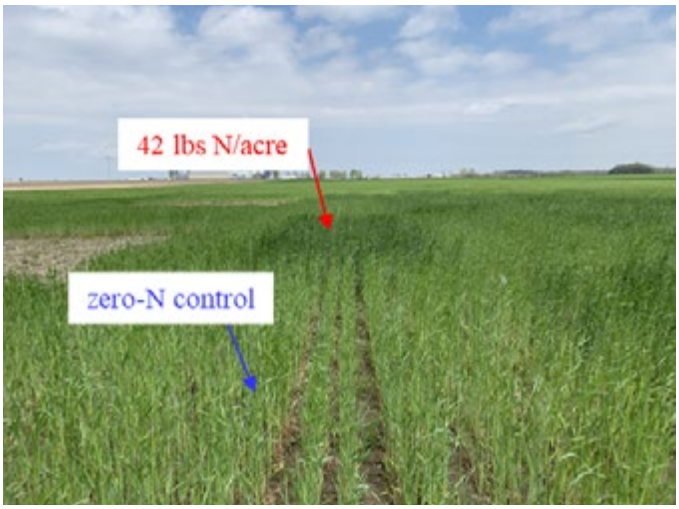
a) Corn morphology (NDVI, LAI, height, SPAD, etc.), corn silage yield, corn silage quality, and nutrient concentrations

b) Soil fertility test (special focus on STP, STK, SOM, and pH) before planting corn; soil test P fractionation; PSNT around V7; CSNT

TABLE 2. RYE YIELD, CRUDE PROTEIN, AND RFQ AT FOUR N RATES HARVESTED ON APRIL 22ND, 2020"

N rate (lbs/acre)	Rye yield at 39% DM (tons/acre)	Crude protein (%)	RFQ
0	2.61	8.65	133.7 a
21	2.72	9.54	137.4 a
42	3.73	10.74	137.4 a
63	3.31	11.37	136.5 a
Trend	Q *	L *	NS

L: linear; Q: quadratic; NS: not significant



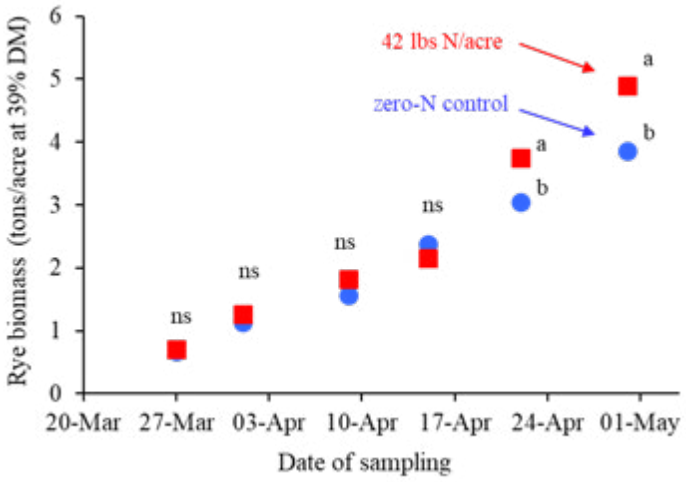


Figure 3. *Example of rye response to zero-N control compared to 42 lbs N/acre (photo) and winter cereal rye biomass accumulation over the spring period in zero-N control (blue circles) and 42 lbs N/acre treatment (red squares) in 2020 (graph).*

PHASE 2: CORN SILAGE YIELD, QUALITY, AND NUTRIENT REMOVAL AND BALANCES AS A RESULT OF VARIOUS MANURE MANAGEMENT SCENARIOS.

This trial is a randomized complete block design with four replications *(Figures 4 & 6)*. Ten treatments are:

P-based liquid dairy manure (five treatments)

- Injected at 12,900 gal/acre with 15 lbs N/acre N fertilizer + rye (INJPCCF)
- Injected at 12,900 gal/acre with 15 lbs N/acre N fertilizer (INJPNOCCF)
- Injected at 12,900 gal/acre (INJPNOCC)
- Surface at 12,900 gal/acre with 110 lbs N/acre N fertilizer + rye (SPCCF)
- Surface at 12,900 gal/acre with 110 lbs N/acre N fertilizer (SPNOCCF)

N-based liquid dairy manure (four treatments)

- Injected at 14,000 gal/acre + rye (INJNCCL)
- Injected at 14,000 gal/acre (INJNNOCCL)
- Injected at 16,500 gal/acre + rye (INJNCC)
- Injected at 16,500 gal/acre (INJNNOCC)

Inorganic N:

- 180 lb/acre side-dress N (150 lbs N/acre + 30 lbs N/acre as starter) (UAN)

Preliminary results and discussion for Phase 2:
Initial soil sampling (plot-to-plot) indicated a great variability, among plots reflecting a field which previously received manure. Soil pH was very high, ranging from 7.6 to 8, suggesting manure had possibly high calcium carbonate which increased the pH levels. Soil test P also showed great variability but mainly at values suggesting 'no-fertilizer P response was likely".

While the weather was not ideal in 2019, corn silage yields were similar to typical corn silage yields expected at the farm. At 65% moisture, corn yields ranged from 16 tons/acre (P-based injection/no-CC) to surface-applied manure supplemented with UAN 22 tons/acre.

While variability in our data did not show statistical significance, our data suggested possible N losses when manure was applied at or prior to planting in a year with excessive early season rainfall *(Figure 5A)*.

The idea that N was slightly limited in higher manure rates (Injected N- and P-based rates) was supported by lower N in grain *(Figure 5B)*. Both inorganic fertilizer only (UAN treatment) and surface-based manure (P-based plus supplemental N at side-dress) showed greater N concentration than other treatments reflecting more N availability due to timing of N additions (side-dressing at V7).

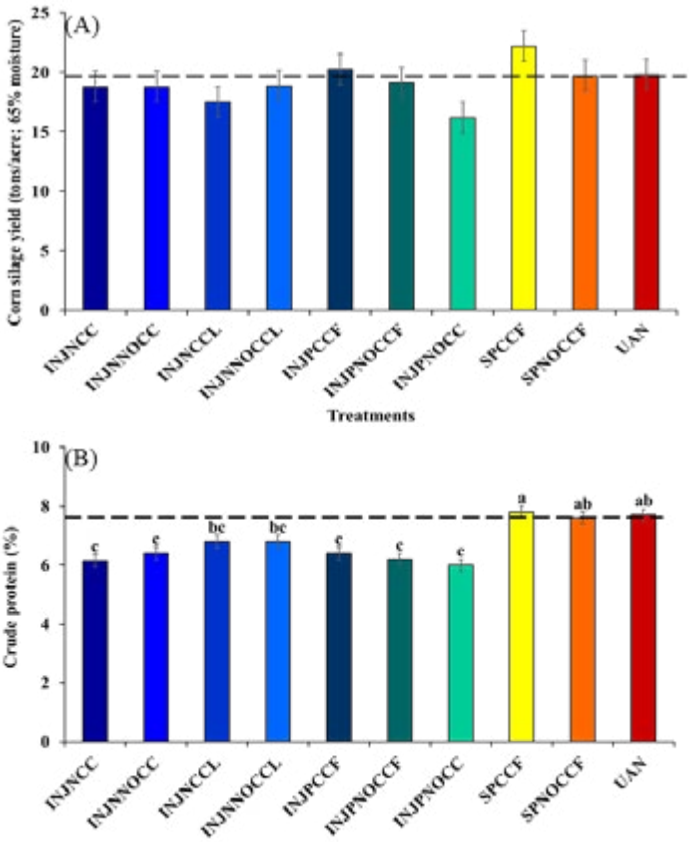


Figure 5. *Corn silage yield (A) and crude protein (B) in response to N-vs. P-based manure management and inorganic fertilizer in 2019.*

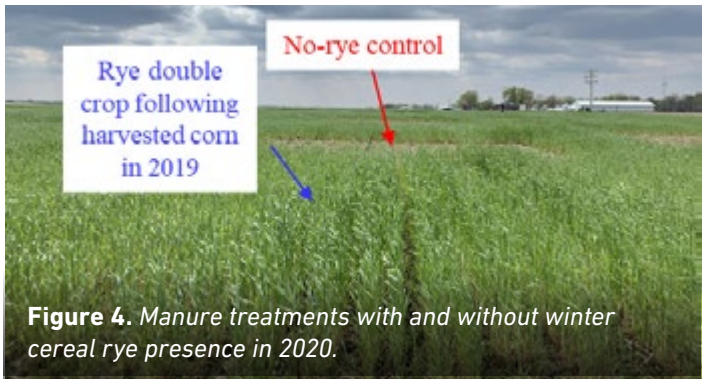


Figure 4. *Manure treatments with and without winter cereal rye presence in 2020.*

Figure 6. *Corn silage in plots July 29, 2020.*

Corn planted into cover crop in Clinton County.

Soil Health in Clinton County

Content provided by Terry Wyciskalla, CCA

Since the inception of the Clinton CFB NLRS Project in 2016, annual soil samples were collected for soil health using the USDA-NRCS Haney Soil Health Test. In the first two years, the soil samples were analyzed by Midwest Laboratories in Omaha, NE, and the last three years, the samples were analyzed by the USDA-ARS Laboratory (Dr. Haney) in Temple, TX. Samples were collected *(Figure 7)* at geo-referenced locations within each field at approximately the same soil moisture contents and temperatures each year. When looking at the presented data *(Table 3)*, note that the Haney Soil Health Test measures on a scale of 0-50, and any value greater than seven falls into the "high" category for soil health.

Data Interpretation:

1. The DC location had a much higher value for 2020 than in previous years. This was due to increased manure additions in the fall of 2019 and the spring of 2020.

2. The BH location had a higher value for 2020 than the previous two years. This was due to manure additions in the fall of 2019 and spring of 2020. It is interesting to note that while this field does not have cover crops in the rotation, manure additions tend to keep the soil health score at a higher value.

3. The MLA location saw a decrease in value due to no manures being applied in 2019 or the spring of 2020. However, cover crops were still planted. This is an important note to observe in the Cover Crop Plot Data.

4. The MLS location saw a dramatic decrease in the Soil Health score for 2020. Cover crops were first introduced to this field in the fall of 2016. However, no cover crops were planted in 2019 or 2020. We are seeing a gradual decrease in soil health score over time, back toward the initial value observed.

5. The DPN, DPS, and DPH locations have values that tend to fluctuate. These fluctuations follow the manure additions to those fields. All three fields received manure additions with larger volumes applied to the DPS and DPH fields.

TABLE 3. CLINTON COUNTY (IL) FARM BUREAU NLRS PROJECT – MULTIPLE FIELD LOCATIONS – SOIL HEALTH SCORES, 2016-2020

Field ID	Manure History	2016* Score	2017* Score	2018# Score	2019# Score	2020# Score
DC	Y	6.7	15.0	13.3	13.3	19.0
BH	Y	7.7	18.7	14.6	12.6	16.7
MLA	Y	7.0	18.2	14.1	15.4	11.8
MLS	N	5.5	15.9	12.0	10.0	7.2
DPN	Y	7.7	18.2	14.5	11.4	16.3
DPS	Y	7.3	18.5	14.2	12.1	21.9
DPH	Y	15.3	18.5	16.9	14.5	24.9

* = Analyzed by Midwest Laboratory, Omaha, NE
# = Analyzed by USDA-ARS (Haney), Temple, TX

Special Notes:
BH is in a Cn-Sb-Wh/DC Soy rotation, heavily manured and NO cover crop use. DPH was a pasture in 2016. It was tilled, manured, and put into production in 2017 with cover crop use. MLS had been in a Cn-Soy rotation. Fall 2016 was the first introduction of cover crops. MLS was not put into Covers in 2019 and went back to a Cn-Soy-Wh/DC Soy rotation.

The USDA – NRCS Core Practices for Soil Health:

1. Keep the Soil Covered as Much as Possible.
2. Disturb the Soil as Little as Possible.
3. Keep Plants Growing Throughout the Year to Feed the Soil.
4. Diversify as Much as Possible by Using Crop Rotation and Cover Crops.

One additional key component is missing from the equation to promote better soil health - that component would be grazing livestock or, at the very least, the use of livestock manures. Livestock manures provide additional "food" for the soil biology to increase microbiological biodiversity. You can then incorporate cover crop mixes into this system. Mixes of different cover crops give you increased plant biological diversity, and each of the different plant species also enhances or feed different groups of soil microbes. All of these combinations can only serve to further increase soil health. As an added benefit when using livestock grazing and/or manures with cover crop diversity in conjunction with the USDA – NRCS Core Practices, nutrients like nitrogen and phosphorus can be tied up or utilized to reduce losses to the environment.

Soil Health Data on Cover Crop Plots *(Table 4)*:

1. When looking at the soil health score for the plots, most of all scores fell into a fairly narrow range of values with the exception of Balansa Clover and the Mix of All Species used.

2. Even the areas where the cover crops failed to survive the winter had very good soil health values. This is due to the addition of manures to the plot area of this field. Of note, the MLA field site value is also included for comparison. These cover crop plots are in the same field as the geo-referenced location that is sampled annually. However, the geo-referenced location did not receive manure additions in 2019 or the spring of 2020.

3. The Balansa Clover plot had the highest soil health value. This may be due to increased microbiological activity in the soil from the legume.

4. The Crimson Clover and the Rapeseed plots did not survive the winter. These plots were on either side of the Balansa Clover plot. It is interesting to note that the failed Crimson Clover plot had a much lower soil health value than the Balansa Clover plot. While the failed Rapeseed plot has a somewhat higher soil health value than the failed Crimson Clover plot. I feel these inconsistencies in values are probably associated with the non-uniform application of manure.

5. Aside from the Balansa Clover, the Mixture of All Cover Crops had the second-highest value. There is increased plant biological diversity, which leads to increased microbiological diversity as well. This plot area (Mixture) also had the best winter survivability for all included species. Even those that failed in a monoculture setting survived in the mixture.

Figure 7. *Soil sampling in Clinton County.*

TABLE 4. SOIL HEALTH, 2019-2020 COVER CROP PLOTS

Plot/Treatment	2020# Score
Brook Oats	18.6
Barley , VNS	18.5
Rymin Rye	20.9
Triticale, VNS	14.9
Elbon Cereal Rye	16.5
Wintergrazer Cereal Rye	20.8
Paserell Plus Annual Ryegrass	20.6
ARG-1 Annual Ryegrass	20.8
Hairy Vetch, VNS	19.5 did not survive
All Sunrise Crimson Clover	15.4 did not survive
Balansa Clover	30.8
Rapeseed, VNS	21.7 did not survive
Mix of All Above	24.7
MLA Field Site	11.8

= Analyzed by USDA-ARS (Haney), Temple, TX

Clinton County Cover Crop Plots: Late-Planted Cover Crops for Winter Survivability and Soil Health

Content provided by Terry Wyciskalla, Mark Litteken, and Cliff Schuette

Over the last few years, weather and late harvests have played a key role in preventing cover crops from being established in a timely fashion. In the late fall of 2019, monoculture cover crop plots were established to take a look at winter survivability, forage tonnage production, and forage quality.

In the fall 2019, the following mixes were planted at the plot (Figure 8):

1. Brook Oats
2. Barley, VNS
3. Rymin Rye
4. Triticale, VNS
5. Elbon Cereal Rye
6. Wintergrazer Cereal Rye
7. Paserell Plus Annual Ryegrass
8. ARG-1 Annual Ryegrass
9. Hairy Vetch, VNS
10. All Sunrise Crimson Clover
11. Balansa Clover
12. Rapeseed, VNS
13. Mix of All Above

In the summer 2020, the following forages were planted:

1. Corvallis Teff Grass
2. Phaceila
3. Root Plow Radish
4. Hybrid Turnips
5. Buckwheat
6. Sun Hemp
7. Cow Peas
8. Non GMO Beans
9. Sweet Pearl Millet
10. German Millet
11. HayKing BMR Sudangrass
12. ProMax BMR Sudangrass
13. Sunflowers
14. Honey Comb Sorghum Sudangrass
15. 310 Forage Sorghum
16. 15 Way Mix

Figure 8. *Left: Hand-full of Sun Hemp seeds. Center: Mixing seed for planting in 2020. Right: Mixed seed in planter.*

Cover Crops Forage Tonnage and Forage Quality Data

To recap, these plots were intentionally planted *(Figure 9)* later than normal on October 24, 2019, as monocultures to look at winter survivability and eventual forage quality. Three days after planting, the area received 5-inches of rainfall, and temperatures dropped to 15 degrees for 3 days. A final plot was established that contained a mixture of all 12 monoculture species. During seeding, there was an issue with seed cracking with the drill on the Hairy Vetch plot. As expected, the Hairy Vetch, Crimson Clover, and Rapeseed did not survive the winter and require an earlier planting date for good establishment, much like alfalfa. The Balansa Clover and all of the Grass Species, on the other hand, had much better survivability, but the stands were somewhat reduced. It was interesting to note that we were able to find all 12 monoculture species in the final Mix Plot. This variety of different cover crops complemented one another and enhanced their winter survivability. When looking at the wet-wrap tonnage data, those species in monoculture averaged about three tons per acre of forage, but the Mix Plot was almost five tons per acre of forage.

The interpretation of data for forage quality is not a simple task. Data from typical forages such as alfalfa or corn silage or that of cover crops can be quite intensive. In many situations for cover crops, there is a lack of available calibration data at the testing laboratories for many of the species being used as covers. So let's start with some terminology definitions to better explain the data presented in the cool-season and warm-season cover crop analysis tables.

Relative Feed Values (RFV) – is a calculation of cool-season grasses and legumes based upon intake of digestible energy. A higher RFV equals higher feed quality. Values range from 120-190. As an example, hay with a value of 160 is considered Feeder Hay, while Dairy Hay should have a value of 180 or higher.

Relative Feed Quality (RFQ) – is based upon the intake of Total Digestible Nutrients (TDN) of all forages. The higher the RFQ, the better the feed quality. It generally ranges from 100-200 and is recommended when grasses are in the forage mixture. This is a newer measurement and recommended over RFV.

Crude Protein (CP) – is simply the nitrogen concentration in percent times 6.25. This is a very dependable test and generally ranges from 18-24%, but some of the atypical cover crops we look for values of 12-18%. Typical forage feed analysis reports do not always give the percent nitrogen in the feedstock. This value can be obtained by back calculating, i.e. – CP divided by 6.25 will give you percent nitrogen. High protein is desirable for milk production and building muscle mass. Therefore, in young stock beef production, we like to have forages with higher protein values to build that body frame and muscle mass. When we are finishing the last 200-300 lbs on that animal, we want a forage with higher sugar content. Higher sugars mean more energy.

Sugars (ESC and WSC) – fall into two categories of Ethanol Soluble Carbohydrates and Water Soluble Carbohydrates. The WSC's are the simple sugars, and the use of these values is more appropriate for hay and fresh grazing forage. The ESC's values are a better measure of converted sugars that occur during the ensiling process. In our data sets, we are reporting ESC's because all of the forages are wet-wrapped and ensiled.

Net Energy for Maintenance (NEM, Mcal/lb) – is an estimate of the energy value of a feed to maintain that animal. It is measured in Megacalories per pound and generally ranges from 0.53-0.62.

Net Energy for Gain (NEG, Mcal/lb) – is the feed used above an animal's body weight to gain pounds over the "maintenance needs." It is also measured in Megacalories per pound and generally ranges from 0.27-0.36.

Figure 9. *Photos of cover crop planting in 2020.*

TABLE 5. FALL PLANTED - HARVEST YIELD DATA RESULTS

Plot	Tmt	Estimated Wet-Wrap 45 % Moisture tons/ac	Relative Forage Quality (RFQ)	Relative Forage Value (RFV)	Crude Protein (%)	Sugar - Ethanol Soluble Carbs (ESC) (% - DM Basis)	Net Energy for Maintenance (NEM, Mcal/lb)	Net Energy for Gain (NEG, Mcal/lb)
1	Brook Oats	2.36	141	133	11.00	13.51	0.608	0.347
2	Barley, VNS	2.81	131	111	9.79	10.70	0.550	0.294
3	Rymin Rye	2.87	104	91	9.22	6.91	0.431	0.183
4	Triticale, VNS	2.96	127	115	12.49	11.08	0.572	0.314
5	Elbon Cereal Rye	1.83	121	106	12.50	9.30	0.513	0.260
6	Wintergrazer Cereal Rye	2.34	112	98	11.31	8.40	0.456	0.207
7	Paserell Plus Annual Ryegrass	4.31	128	127	9.60	13.79	0.571	0.313
8	ARG-1 Annual Ryegrass	3.74	134	125	8.49	13.77	0.572	0.314
9	Hairy Vetch, VNS	0	0	0	0	0	0	0
10	All Sunrise Crimson Clover	0	0	0	0	0	0	0
11	Balansa Clover	2.39	243	195	26.23	8.66	0.746	0.471
12	Rape, VNS	0	0	0	0	0	0	0
13	Mix of All Above	4.80	139	113	13.69	8.26	0.575	0.316
Ave.		3.04	138	121	12.43	10.44	0.559	0.302
	Desired Ranges		100 - 200	120 - 190	18 - 24	***	0.53 - 0.62	0.27 - 0.36

Harvest Dates: Plots 5 and 6 on 4/27/2020, All Others on 5/7/2020

When looking at *Table 5*, we had a fairly wide range of RFQ, RFV, CP, and Sugar (ESC) values. Since we are looking at mostly grass species, we will focus on the RFQ data versus the RFV data. Due to the intentional late planting and early spring struggles of 2020 (plus cold temperatures around April 15th), most forage tonnages were somewhat lower than expected and well as RFQ number. The Cereal Ryes and Rymin Rye had some of the lowest RFQ and energy numbers, but that does not mean they should be discounted because they also had some of the highest CP values. Their prolific root systems were able to find much more nitrogen in the soil than some of the other species. The Annual Ryegrass species had the highest yield tonnages and energy values.

On this farm, we would like to have forages with CP values somewhere between 12-18% but also have fairly high energy values. The Balansa Clover had the highest CP and energy values but is not necessarily recommended as a forage in monoculture and serves better to compliment other species planted at the same time. Balansa Clover would be an excellent choice in monoculture if you want to have "home-grown N" to reduce purchased N fertilizer. Based upon the data at the time of harvest, the Balansa Clover had already produced 110 pounds per acre of nitrogen that would be available to this year's corn crop. Finally, the Mix Plot had the highest CP value (excluding Balansa Clover) and one of the highest energy values.

TABLE 6. SUMMER PLANTED – HARVEST YIELD DATA RESULTS

Plot	Tmt	Estimated Wet-Wrap 45 % Moisture tons/ac	Relative Forage Quality (RFQ)	Relative Forage Value (RFV)	Crude Protein (%)	Sugar - Ethanol Soluble Carbs (ESC) (% - DM Basis)	Net Energy for Maintenance (NEM, Mcal/lb)	Net Energy for Gain (NEG, Mcal/lb)
1*	Teffgrass	2.16	149	105	20.45	2.19	0.605	0.344
2	Phacelia	***	***	***	***	***	***	***
3*	Root Plow Radish	7.15	244	198	20.44	4.32	0.807	0.524
4*	Hybrid Turnips	9.72	277	227	20.24	4.57	0.806	0.523
5	Buckwheat	8.01	146	148	18.05	2.77	0.648	0.382
6	Sunn Hemp	4.72	136	121	18.30	0.51	0.590	0.330
7	Cow Pea	5.53	199	162	21.32	2.02	0.679	0.411
8	Non-GMO Soybean	2.11	199	152	25.71	ND	0.718	0.445
9*	Pearl Millet	6.76	138	99	26.99	2.84	0.536	0.281
10*	German Millet	5.99	151	104	32.28	1.51	0.558	0.301
11	Hay King BMR Sudan	7.27	120	98	14.42	4.61	0.628	0.364
12	Pro Max BMR Sudan	7.73	129	103	15.45	4.82	0.699	0.428
13	Sunflowers	2.98	249	174	24.75	0.87	0.824	0.539
14	Honeycomb Sorghum Sudan	9.53	127	102	13.69	5.43	0.685	0.416
15	310 Foage Sorghum	5.59	118	91	13.82	3.80	0.588	0.328
16	15-Way Mix	9.57	126	103	11.32	6.69	0.590	0.330
East	13-Way Mix (No Man. 2019)	***	167	122	20.62	1.91	0.641	0.377
West	13-Way Mix (Manured 2019)	***	169	131	19.29	1.06	0.672	0.404
Ave.		6.32	167	132	19.83	3.12	0.663	0.396
	Desired Ranges		100 - 200	120 - 190	18 - 24	***	0.53 - 0.62	0.27 - 0.36

Harvest Date: 7/20/2020. * = Earlier than normal harvest.

When looking at *Table 6*, you will notice a dramatic difference in all values as compared to the late-planted fall data. These forages were planted in a timely fashion on June 12, 2020 under somewhat dry conditions and near-ideal temperatures. These plots were No-Till drilled after two cuttings of the previous covers were removed and then chemically terminated. There were some stand establishment issues for a few of the species due to the dry soil conditions, and substantial rainfall did not occur for about two weeks. Phacelia did not germinate/emerge at all. The Sunflowers and Non-GMO Soybeans had reduced stands due to somewhat drier soil conditions just after planting. Of special note, those plots labeled with an "*" were harvested earlier than ideal maturity. Therefore, the data may not be entirely accurate. Tonnages ranged from 4.7 to 9.7 tons per acre of wet-wrap forage (excluding those plots with establishment issues). When looking at the feed quality data, you have to use the RFQ numbers for the grasses and RFV numbers for the legumes/broadleaves to keep the data in perspective.

The highest values observed were on those plots that were harvested prematurely. This would be expected because that forage is lush and has a narrower C:N ratio than the more mature plots, especially for the Radishes and Turnips. Cow Pea and Non-GMO Soybean followed next with high feed values and high CP because they are legumes. The remaining grass forages had somewhat lower feed values but also some of the highest yield tonnages. Crude Protein values ranged from 11 to 27% across all species. That is equivalent to 1.8-5.2% Nitrogen in the plant tissues. Those highest N and CP values were found in the two Millet species trailed by Soybean. The Millets have a very fine and extensive root system that is able to seek out and extract N from the soil. Plus good soil moisture and warm soil temperatures probably contributed to more N release from previously applied manures. Sugar (ESC) values were highly variable depending on species, with the grass species having higher values. However, all species had excellent energy values.

Forage Feeding Management Considerations

1. What are the goals I want to obtain?
   - Do I want high protein content to build muscle mass, or am I after high sugars and energy?

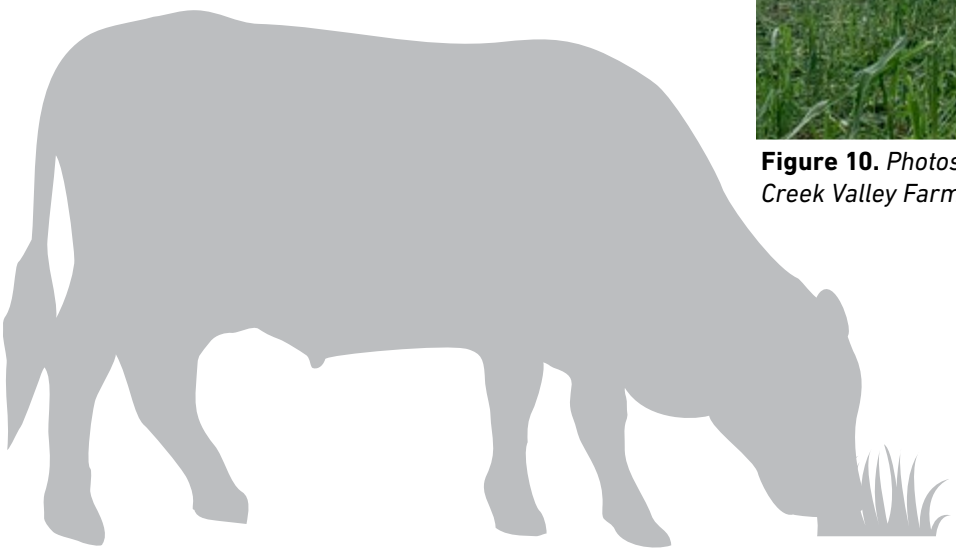
2. Who is available to assist me with the decisions?
   - Crop specialist, animal nutritionist, other producers?

3. What cover crop species mixes will help me reach these goals all year long?
   - Cool-season mixes and/or warm-season mixes.

4. How many species do I need in the mixes?
   - 3-5 species, 5-9 species, 11+ species?

5. Fertility and Manure/Nutrient Management of My Cover Crops?
   - Are these strictly covers for "home-grown" N and nutrient sinks/traps?
   - Are these covers to be utilized as Forages *(Figure 10)* (ties back to Point 1)?
   - If I have manures available, how much can I reduce purchased fertilizer inputs?
   - Am I making an impact on soil health, soil quality, and water quality around my farm?

Figure 10. *Photos of livestock feeding on cover crops at Sugar Creek Valley Farms.*



Cover Crop Planting and Termination Equipment

During the 2020 Virtual Field Day, Justin Detmer of Midwest Tractor Sales demonstrated cover crop application equipment, including a cover crop seeder mounted on a rolling harrow. This setup allows the broadcasting of cover crop seed while completing field finishing. In addition, Mark Litteken of Sugar Creek Valley Farms, expressed the importance of getting the right planting set up for planting into cover crops. He demonstrated his no-till planter set up *(Figure 11 top)*, which has been converted to apply starter fertilizer and has modifications to the closing wheels to make sure the seed is being covered.

Termination of cover crops can be achieved both mechanically and chemically. One mechanical option highlighted by Justin Detmer at the Virtual Field Day is a roller-crimper, which is a water-filled drum with chevron-patterned blades that attaches to the three-point hitch of a tractor *(Figure 11 middle)*. As the farmer drives over the cover crop, this implement rolls and crimps the plants down, effectively terminating the crop. Once terminated, the cover crop remains on the ground where it forms a thick mulch that suffocates weeds.

Additionally, drones were highlighted as an application and termination option. Brian Pickering, an Application Services Contractor for Rantizo, joined on-site with his drone equipment at Mark Litteken's farm *(Figure 11 bottom)*. Rantizo is an agtech company that uses drones to deliver ag inputs in the field precisely when and where they are needed. The Rantizo platform integrates with field imagery data to prescribe and precisely deliver liquid and dry solutions, using targeted drone-based agricultural spraying. The technology can also be used for other in-field applications such as cover crop seeding, beneficial insect deployment, and pollination. Rantizo is the only company approved for drone-based agricultural spraying in multiple states and recently became the first company approved by the FAA for nationwide swarm spraying.

Figure 11. *Top: Sugar Creek Valley Farms modified corn planter. Middle: Roller-crimper displayed at Virtual Field Day. Bottom: Rantizo drone equipped to broadcast cover crop seed.*

Contact Information

You can contact the Clinton CFB at:

618-526-7235

To learn more about all other IFB Nutrient Stewardship Virtual Field Days, visit: www.ilfb.org/FieldDays

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Dr. Ted Funk | Mike Andreas | Kaskaskia College | Gateway FS | Clinton County SWCD | Illinois NRCS | University of Illinois Extension

NLRS PROJECT - LATE PLANTED COVER CROP FOR WINTER SURVIVABILITY

CLINTON COUNTY FARM BUREAU®

COVER CROP ECONOMICS

EXPENSES	PER ACRE
Manure Hauling	$25
Cover Crop Seed (7-Way Mix)	$35
Seed Drilling	$20
Cutting	$20
Raking	$10
Baling/Wrapping/Logistics	$60
Tractor Crimping/Rolling	$15
Corn Seed	$54
Corn Planting	$20
Pesticide Applications	$52
Nitrogen Fertilizer (28% UAN)	$52
Corn Started Fertilizer	$21
Combining	$30
TOTAL EXPENSES	$414
INCOME	**PER ACRE**
1st Cutting Cover Mix	$320
4 ton/ac at 63% moist., 2 ton DM	
RFQ = 132 $160/ton	
Corn Grain Marketed	$721
2019 Ave = 206 bu/acre	
Using $3.50/bu	
TOTAL INCOME	$1,041
POSITIVE CASH FLOW	$627

Rental Ground without full forage removal needs 149 bu/acre to reach the breakeven point at $3.50/bu Corn Grain.