



Summer 2021 Nutrient Field Day

Clinton County
Farm Bureau

Influences of Cover
Crops and Manure
Management
on Reducing
Nutrient Losses

Brought to you by your local community partners:



Other project partners: Bryan Henrichs, Henrich Farms, LTD | Danny Potthast | Dean Carrillon, Carrillon Dairy | Dr. Ted Funk
Mike Andreas | Meyer VMS Dairy, Inc. | Kaskaskia College | Clinton County SWCD | 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.

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 Schuette 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.

Dr. Josh McGrath

Dr. Josh McGrath is an Associate Extension Professor of Soil Management in the Department of Plant and Soil Sciences at the University of Kentucky. Dr. McGrath's research focuses on applied extension and research in agronomic soil fertility and nutrient management. He specializes in site-specific nutrient management, manure management, and water quality protection.

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.

Dr. Stacy Zuber

Dr. Stacy Zuber is the Illinois Natural Resources Conservation Service (NRCS) Soil Health Specialist. Dr. Zuber's research background includes research projects focused on soil health indicators following long-term extended crop rotations, no-till, and cover cropped soils. In her role at NRCS, she provides soil health training and information to staff, conservation partners, and farmers.

Terry Wyciskalla CPAg/CCA

Terry Wyciskalla 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.

Blake Rimmert

Blake Rimmert is Clinton CFB's Nutrient Stewardship Intern for 2021. Blake attended Kaskaskia College and Murray State University to receive his Bachelor of Science in Agronomy and Agribusiness, and he is currently pursuing his Master of Science degree in Agronomy at Iowa State University. Blake has also been a sales advisor for NuTech Seed for 3 years, and farms corn, soybeans, and wheat with his father at their operation in Carlyle, IL. Blake is involved in the Clinton CFB Young Leader Committee and is a volunteer fireman for the Wheatfield Township Fire Department.

Clinton County Farm Bureau

The Clinton CFB is a 501(c)(5) non-profit organization based in Breese, IL 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.”

Clinton County was one of 28 CFBs awarded funding from the IFB in 2021 to develop projects that address farmer needs for research, education and outreach, and implementing best management practices for

nutrient loss reduction. This year’s \$20,000 grant is being matched with local dollars and in-kind services to continue to explore the influence of manure management and cover crops on reducing nutrient losses.

Now in their sixth year participating in IFB’s Nutrient Stewardship Grant Program, the Clinton CFB is continuing to provide numerous education and outreach opportunities, primarily focused on manure management, cover crops, and soil health. The project continues its research

comparing cropping systems using cover crops and livestock manure, offers free manure nutrient testing, provides additional services with a Nutrient Stewardship Internship, and invites farmers to learn about NLRs practices at Field Day(s) and additional outreach efforts.

In partnership with IFB, Clinton CFB has committed over \$180,000 in local nutrient stewardship research to-date.

Illinois Farm Bureau

Since 2015, IFB has contributed to an impressive statewide effort, the Nutrient Loss Reduction Strategy (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 \$2 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 \$700,000 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 <http://www.ilfb.org/ifb-in-action/what-were-working-on/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 rectangle 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 vegetation index (NDVI) to predict rye yield N uptake

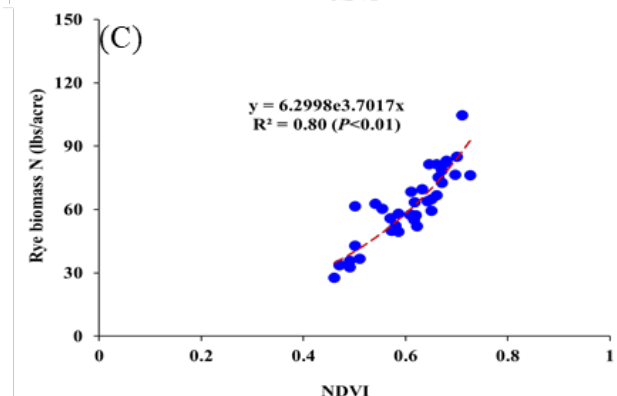
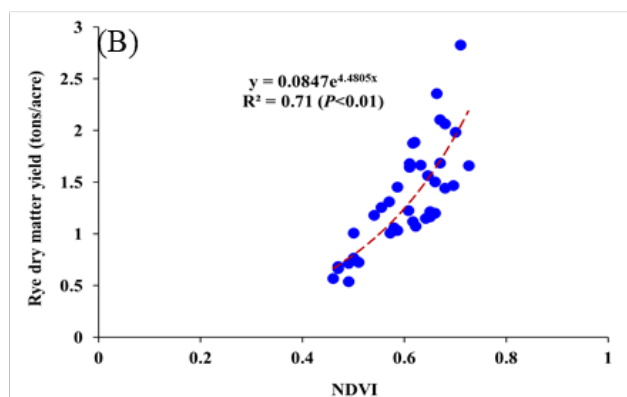
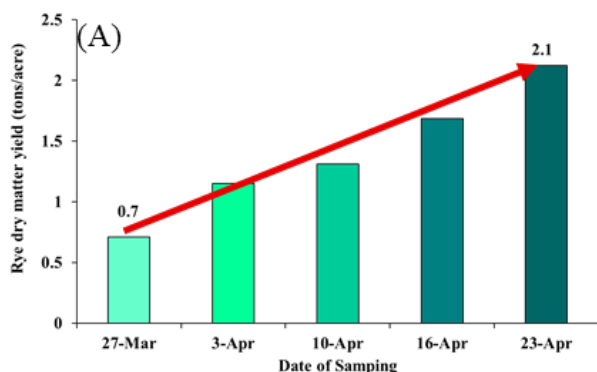


Figure 2. Winter cereal rye biomass accumulation over the spring period (A); the relation between NDVI and winter cereal rye biomass accumulation (B) and biomass N (C) in 2019.

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 to April 30th, 2020; March 24th to April 27th, 2021)

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); 5 in 2021 for all treatments

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 to 3.73 tons/acre at 39% DM 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 improve crude protein. RFQ was not influenced by N addition and remained unaffected (Table 2). In 2021, rye did not respond to N fertilization from April 19 application. Winter cereal rye yield was 5.0 tons/acre at 39% DM in the zero-N control which was 1 ton/acre lower than rye yield at the highest N rate (63 lbs/acre) (Table 3). Averaged over all dates, rye yield was higher in fertilized than the no-fertilizer control ($P = 0.03$). Similar to 2020, N fertilization increased CP but had no effect on RFQ (Table 3).

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 zero-N control would have had similar yield to 42 lbs N/acre (Figure 3A). This was not the case in 2021, reflecting on cool weather

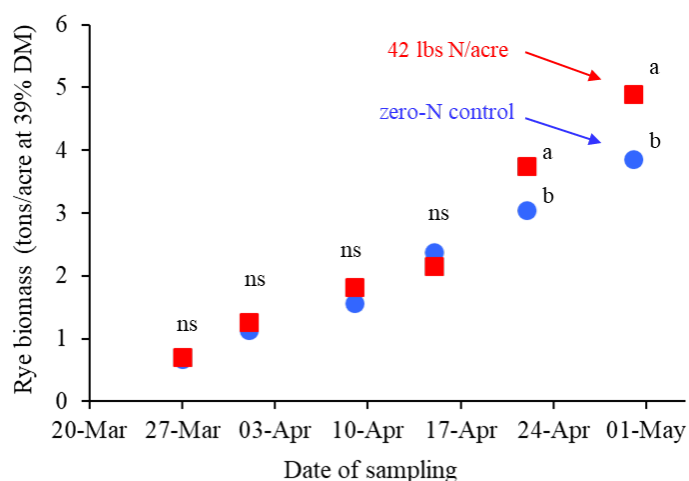
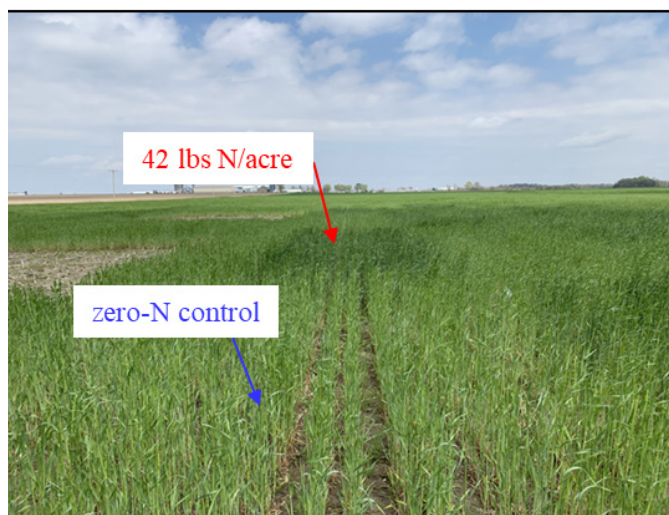


Figure 3. Example of rye response to zero-N control compared to 42 lbs N/acre (photo) and winter cereal rye biomass accumulation over the spring period in zero-N control (blue circles) and 42 lbs N/acre treatment (red squares) in 2020 (graph).

from April 11 to April 27, 2021. In 2021, even at heading, rye did not require N which could be explained by slower than expected growth at and after heading (Figure 3B).

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

TABLE 3. RYE YIELD, CRUDE PROTEIN, AND RFQ AT FOUR N RATES IN HARVESTED IN APRIL 19, 2021.

N rate trial for winter cereal rye in 2021			
N rate (lbs/acre)	Rye yield at 39% DM (tons/acre)	Crude protein (%)	RFQ
0	5.00	8.62	132.0 a
21	5.30	9.28	131.8 a
42	5.45	9.78	133.4 a
63	6.00	10.80	133.2 a
Trend	NS	L *	NS

L: linear; NS: not significant;

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 (INJPNOCFF)
- 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 (INJNOCCL)
- 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)

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

Measurements at the start and during the corn phase:

- Corn morphology (NDVI, LAI, height, SPAD, etc.), corn silage yield, corn silage quality, and nutrient concentrations
- Soil fertility test (special focus on STP, STK, SOM, and pH) before planting corn; soil test P fractionation; PSNT around V7; CSNT

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).

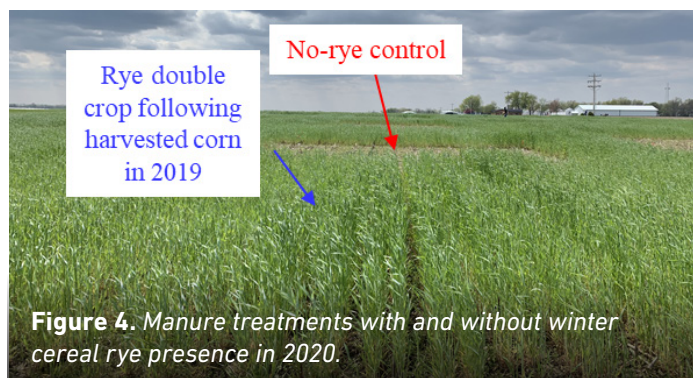


Figure 4. Manure treatments with and without winter cereal rye presence in 2020.

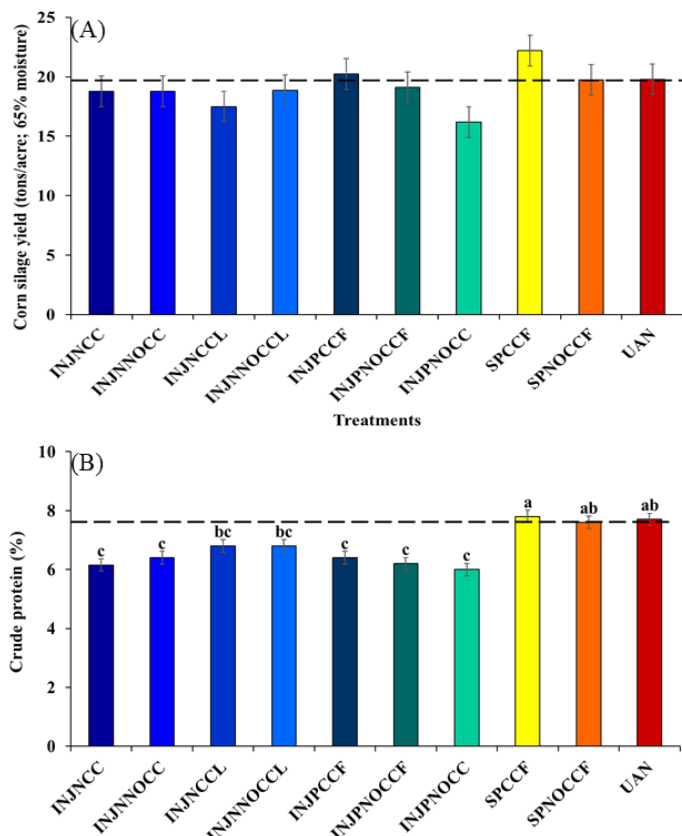


Figure 5. Corn silage yield (A) and crude protein (B) in response to N-vs. P-based manure management and inorganic fertilizer in 2019.

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 6. 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 4*), 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:

The data from 2021 were difficult to interpret as compared to previous years, due to obtained values being dramatically lower than previous years.

1. Values for all locations, with the exception of the DPH Site were dramatically lower and had little variation between the locations, even with differences in crop rotation and manure applications.
2. The DPH Site had the highest Soil Health Score. This location was in permanent pasture through 2017 and put into row crop production for 2018. Of note, the Soil Health sample was collected prior to row crop production in 2018. Hence the higher score in 2018. After the first crop year, Cover Crops were introduced into the crop rotation. This resulted in higher Soil Health scores.
3. While we try to collect the Soil health samples at similar soil moisture and temperature conditions as previous years, 2021 was a challenge. While the conditions at the time of sampling were similar, previous seasonal

environmental conditions were not. January and February produced frozen soils and much snowfall not seen in previous years. Therefore, the soil biology did not have as long of a time frame to “work” in the soil. Additionally, March and April experienced fairly large quantities of rainfall and cooler temperatures. All of these factors could have led to lower amounts of mineralized nitrogen from the biological activity and the potential for increased nitrate-nitrogen (NO³-N) leaching from the root zone of the cover crops before crop uptake. These soil and environmental conditions also led to somewhat decreased cover crop growth.

TABLE 4. CLINTON CFB NLRs PROJECT – ANNUAL FIELD LOCATIONS – HANEY SOIL HEALTH SCORES, 2016-2021

Field ID	Manure History	2016* Score	2017* Score	2018# Score	2019# Score	2020# Score	2021 Score
DC	Y	6.7	15.0	13.3	13.3	19.0	7.8
BH	Y	7.7	18.7	14.6	12.6	16.7	7.0
MLA	Y	7.0	18.2	14.1	15.4	11.8	8.1
MLS	N	5.5	15.9	12.0	10.0	7.2	7.4
DPN	Y	7.7	18.2	14.5	11.4	16.3	9.6
DPS	Y	7.3	18.5	14.2	12.1	21.9	7.2
DPH	Y	15.3	18.5	16.9	14.5	24.9	17.9

* = 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 5):

On October 25, 2020, monoculture cover crop plots were established to take a look at winter survivability, forage tonnage production, and forage quality. Unfortunately, this field location had a tremendous amount of Crimson Clover seed carryover from the previous year that contaminated the plots and put undue competition and pressure on the monoculture species sown.

1. Due to the Crimson Clover seed contamination in these plots, we cannot attribute increased or decreased Soil Health scores to any of the monoculture Cover Crop species themselves.
2. The Soil Health scores, while much lower than previously observed, were likely a function of manure application patterns that occurred in 2019. No manure was applied to this location prior to the Fall 2020 seeding.
3. The Brook and Black Oats plots had the highest Soil Health scores. This can be attributed to two factors. First, these plots were closest to the field access road and probably received greater amounts of manure over time. Secondly, these plots saw greater protection from adverse environmental conditions, as they were closest to the fence row on the north side of the plot area.
4. While most all of these Soil Health scores are considerably higher than those observed from the MLA Field site, these higher values are probably attributed to the actively growing Crimson Clover in the entire plot area. Legumes, with their associated *B. Rhizobium* spp.

that “fix” nitrogen in the nodules create an additional layer of biological diversity and an additional nitrogen source to the soil system.

5. When looking at all of the data, one would expect to see higher Soil Health scores in the Cover Crop Legume plots contaminated with Crimson Clover (another legume) versus the Grass Cover Crops. However, this was not the case and strengthens the conclusions that variability in Soil Health scores was a function of previous manure applications.



Figure 7. Soil sampling in Clinton County.

TABLE 5. HANEY SOIL HEALTH, 2020-2021 COVER CROP PLOTS

Plot/Treatment	2021# Score
Brook Oats	36.5
Black Oats	26.9
Barley	10.7
Triticale	11.3
Rymin Cereal Rye	13.6
Wintergrazer Cereal Rye	10.2
ARG-1 Annual Ryegrass	13.6
Passerel Plus Annual Ryegrass	21.0
Hairy Vetch, VNS	15.0
All Sunrise Crimson Clover	14.6
Fixation Balansa Clover	11.9
Viper Balansa Clover	14.1
Meduim Red Clover	21.0
Trophy Rapeseed	9.6
Mix of All Above (14 Way)	9.5
MLA Field Site	8.1

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

Random Field Locations Data

For 2021, several random Soil Health samples were collected from across Clinton County (Table 6). There were a wide array of crop rotations, manure/no manure histories, and cover crop/no cover crop use.

Data Interpretation:

Values for all locations had little variation in the Soil Health scores, even with differences in crop rotation, manure applications, and tillage practices.

The highest Soil Health score was observed in a field with heavy manure applications and was in the third year of alfalfa production (the BH2 Site). The second highest Soil Health score was obtained from a field with no cover crop history, utilized conventional tillage, and no manure applications (the CSE Site). One of the lowest Soil Health scores was obtained at the MLP Site. This is contrary to

initial thoughts because this site was in permanent pasture with a grass / legume mixture and is grazed by poultry (giving a manure component to this soil system).

Conclusions for all Soil Health scores obtained follow the same pattern as the annual, geo-referenced field locations. Values for many of the samples were much lower than anticipated and were probably influenced more by the spring 2021 environmental conditions than anything else.

The observed data from these random fields, as well as the other collected Soil Health samples shows that the Soil Health Test is not infallible and there is still much to be learned about Soils, Soil Health, the Soil Environment, and how all of these factors interact.

At the time of this writing, the results for the Cornell Soil Health Test are not back from Cornell University.

**TABLE 6. CLINTON CFB NLRS PROJECT – MULTIPLE FIELD LOCATIONS (RANDOM SAMPLES)
HANEY SOIL HEALTH SCORES, 2021**

Field ID	Manure History	2021 Score	Notes
BH2	Y	15.7	Heavily Manured, 3rd-year Alfalfa
BRC	N	8.3	No CC, Reduced Till, Corn-Soybean Rotation
CSE	N	13.1	No CC, No Manure, Corn-Soybean Rotation
CSW	N	9.3	No CC, No Manure, Corn-Soybean Rotation
CVN	Y	11.7	Using CC, Reduced/No-Till, Some Manure Use
DC2	Y	8.6	Using CC, Reduced/No-Till, Some Manure Use, Chicken Litter Just Applied Prior to Sampling
DSR	N	7.9	No CC, No Manure, Corn-Soybean Rotation
ESE	N	6.8	No CC, No Manure, Corn-Soybean Rotation
ESW	N	9.7	No CC, No Manure, Corn-Soybean Rotation
MLP	Y	7.7	Continuous Pasture (Clover/Fescue), Chicken Tractor moved Across Area Annually
PM1	Y	10.2	CC Use, Heavy Manure Use, Corn in 2020/Alfalfa 5 years Prior

2021 Cover Crop Plots 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 2020,

monoculture cover crop plots were established to take a look at winter survivability, forage tonnage production, and forage quality.

In the fall 2020, the following mixes were planted at the plot:

- | | | |
|----------------------------|--------------------------------|-----------------------------------|
| 1. Brook Oats | 7. ARG-1 Ryegrass | 12. Viper Balansa Clover |
| 2. Black Oats | 8. Passerel Plus Ryegrass | 13. Medium red Clover |
| 3. Barley | 9. Hairy Vetch | 14. Trophy Rapeseed |
| 4. Triticale | 10. All Sunrise Crimson Clover | 15. 14-Way Mix (all of the Above) |
| 5. Rymin Rye | 11. Fixation Balansa Clover | |
| 6. Wintergrazer Cereal Rye | | |

In the summer 2021, the following mixes were planted at the plot:

- | | | |
|------------------------|----------------------------|--------------------------------------|
| 1. Phacelia | 7. Cow Peas | 13. Sweet Six BMR Sorghum Sudangrass |
| 2. Teffgrass | 8. Soybeans | 14. Super Sugar Sorghum Sudangrass |
| 3. Pasja Hybrid Turnip | 9. Sunflower | 15. 14-way mix (all of the above) |
| 4. Root Plow Radish | 10. Tifleaf III Millet | |
| 5. Buckwheat | 11. Pro-Max BMR Sudangrass | |
| 6. Sun Hemp | 12. HayKing BMR Sudangrass | |



Figure 8. Left: Hand-full of Sun Hemp seeds. Center: Cliff Schuette and Carissa Litteken filling the drill for the summer cover crop plot. Right: Mixed seed in planter.

Cool-Season Cover Crops: Forage Quality Data 2021

The area selected for the 2020-2021 Plots had Crimson Clover as a cover crop in 2020. Unfortunately, the Crimson Clover was not terminated in a timely fashion and the crop produced viable seed that germinated in 2021. Therefore, we had severe contamination in all plots by the previous year's Crimson Clover.

It was interesting to note that again this year we were able to find all 14 monoculture species in the final Mix Plot. This variety of different cover crops complimented one another

and enhanced their winter survivability. When looking at the forage tonnage production data, those species in monoculture averaged about 10.1 tons per acre of 45% wet-wrap forage, but the Mix Plot was 14.4 tons per acre of 45% wet-wrap forage (See Table 7, page 13).

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 reiterate the terminology definitions to better explain the data presented in the cool-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 spring 2021 Virtual Field Day

TABLE 7. FALL PLANTED - HARVEST YIELD DATA RESULTS

Plot	Tmt	Estimated	Relative	Relative	Crude	Sugar - Ethanol	Net Energy for	Net Energy
		Wet-Wrap 45 % Moisture	Forage Quality	Forage Value	Protein	Soluble Carbs (ESC)	Maintenance	for Gain
		tons/ac	(RFQ)	(RFV)	(%)	(% - DM Basis)	(NEM, Mcal/lb)	(NEG, Mcal/lb)
1	Brook Oats	7.56	130	142	11.74	16.49	0.633	0.369
2	Black Oats	6.01	149	153	12.22	15.91	0.661	0.395
3	Barley	6.63	133	112	12.66	11.59	0.567	0.309
4	Triticale	8.96	130	123	13.78	12.22	0.614	0.352
5	Rymin Rye	6.95	138	111	12.60	9.75	0.558	0.301
6	Wintergrazer Cereal Rye	12.19	99	92	12.67	6.76	0.402	0.156
7	PPECR2 Ryegrass	13.33	157	133	19.67	9.21	0.659	0.392
8	Passerel Plus Ryegrass	10.05	148	127	17.08	10.50	0.640	0.376
9	Hairy Vetch	9.78	160	158	24.39	8.79	0.662	0.395
10	All Sunrise Crimson Clover	9.06	174	168	19.94	10.05	0.672	0.404
11	Fixation Balansa Clover	No Data	***	***	***	***	***	***
12	Viper Balansa Clover	22.66	186	174	19.59	10.80	0.696	0.425
13	Medium Red Clover	No Data	***	***	***	***	***	***
14	Trophy Rapeseed	8.43	178	154	15.40	10.87	0.649	0.383
15	Mix of All Above	14.40	155	133	17.07	9.37	0.621	0.358
Ave.		9.56	138	125	14.39	11.31	0.595	0.334
	Desired Ranges		100 - 200	120 - 190	18 - 24	***	0.53 - 0.62	0.27 - 0.36

Harvest Dates: Plots 6 on 4/21/2021, Plots 1-6, 7-10, 12, 14-15 on 4/28/2021

When looking at the plot forage data table, 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 2021, most forage tonnages and RFQ numbers were good. With the exception of the Wintergrazer Cereal Rye, which was harvested a little later than the ideal harvest stage. There is a wide range of RFV, Crude protein, and Net Energy values for these cover crops. This is expected when comparing Grasses to Legumes. Just because the Grasses had lower numbers this does not mean they should be discounted and replaced with monoculture legumes. 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 second highest yield tonnages and very comparable 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. This year the Hairy Vetch had the highest CP values but is not necessarily recommended as a forage in monoculture and serves better to compliment other species planted at the same time. Last year the Hairy Vetch did not survive the winter. Therefore, we have no previous data to use as a comparison. Again, this year, any of the legumes 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 Legumes had already produced 35 - 87 pounds per acre of nitrogen that would be available to this year's corn crop (see Table 8)

Cover Crop Planting

Cover crop planting and application equipment can include things such as a cover crop seeder mounted on a rolling harrow, no-till drills, and planters. The rolling harrow setup allows the broadcasting of cover crop seed while completing field finishing. Project experience has expressed

the importance of getting the right planting set up for planting into cover crops. This no-till planter set up (Figure 10) has been converted to apply starter fertilizer and has modifications to the closing wheels to make sure the seed is being covered.



Figure 10. Top Left: Sugar Creek Valley Farms modified corn planter.



Top Right: Rolling harrow for conditioning soil.



Bottom: Roller-crimper displayed at Virtual Field Day.

Cover Crop Termination

Termination of cover crops can be achieved both mechanically and chemically. One mechanical option 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 10). 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.

Chemical Termination

Tyler Voss, Gateway FS Crop Specialist

Cover crops are a 12 month/365 day a year job. We work all year to keep them going in our fields but the most important day of the year is when we try to terminate them for our next crop. A lot of times we only get one opportunity for a successful cover crop termination so we better make the

best of it. To be successful at termination of a cover crop it's important to have a plan that details what crop we are killing, what crop we are rotating to, and what restrictions we have with the herbicides we are using. This plan is the most important part of the process and it's important your local crop advisor is in the loop. When terminating cover crops the environmental conditions are key. When applying herbicides to terminate the cover crop we need warm weather and plenty of sunlight. Sunlight and heat help herbicides translocate through the plant and make termination easier. This herbicide is ideally applied from the hours of 8:00 AM – 4:00 PM when heat and sunlight are at their peak. Termination can be done easily with these conditions. Having a solid plan and sticking to it is crucial. Executing that plan and following a few easy steps make cover crop termination successful.

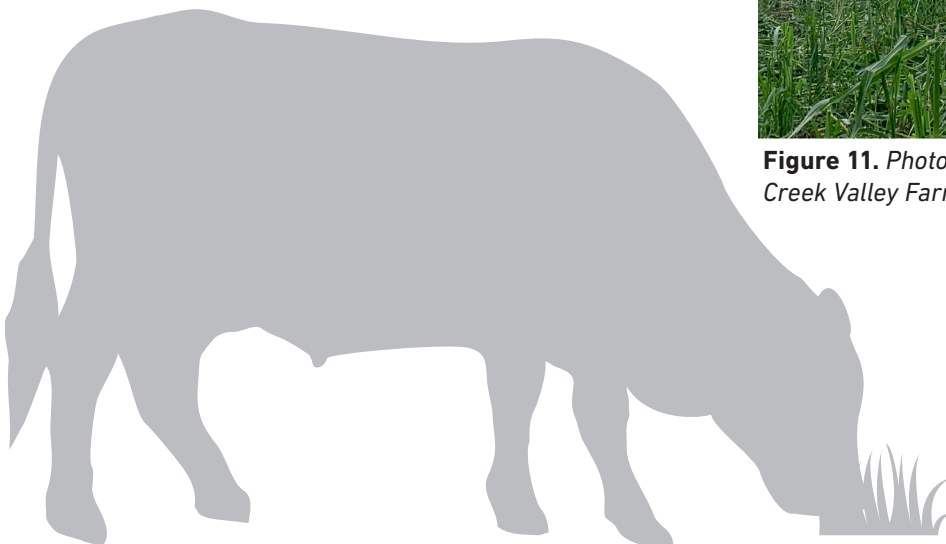
Forage Feeding Management Considerations

When building a forage feeding management program you need to first determine:

1. What are the goals you want to obtain?
 - Do you want high protein content to build muscle mass, or are you after high sugars and energy?
2. Who is available to assist you with the decisions?
 - Crop specialist, animal nutritionist, other producers?
3. What cover crop species mixes will help you reach these goals all year long?
 - Cool-season mixes and/or warm-season mixes.
4. How many species do you need in the mixes?
 - 3-5 species, 5-9 species, 11+ species?
5. Fertility and Manure/Nutrient Management of Your Cover Crops:
 - Are these strictly covers for “home-grown” N and nutrient sinks/traps?
 - Are these covers to be utilized as Forages (*Figure 11*) (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 11. Photos of livestock feeding on cover crops at Sugar Creek Valley Farms.



Forage Nutrient Content Summary and Cover Crop Fertility

Content provided by Terry Wyciskalla, CPAg/CCA

In 2021, we decided to add a new summary of nutrient uptake and sequestration by the cover crop species grown at this plot (Table 8).

When we looked at the different cover crop species there are large quantities of (N) and (K) being taken up by the forages but only modest amounts of (P). The highest amounts of N, P, and K uptake were by the Cereal Ryes and Annual Ryegrasses. This is partly due to them being closer to physiological maturity than the other cover crop species but more than likely due to their more extensive, deeper root systems to seek out and sequester these nutrients in the soil. It is unfair to say that the legumes have sequestered N since they are also producing nitrogen via their nodules.

When considering a soil fertility program for cover crops whether you are using manures or not, you must first ask yourself; “Do cover crops make fertilizer?” and “What do I need to consider within my soil system?”

Legume cover crops make N but they do not make P or K. Their root systems are acquiring P and K from deeper in the soil profile but they are not physically making these nutrients. Now in the case of Hairy Vetch, research has shown that root exudates from Vetch help solubilize P-containing compounds making more P available to the crop and also increasing soil test values slightly.

With regards to K, very large quantities are taken up and removed with cover crop forage harvest. Therefore, a maintenance potassium K fertilization program needs to be

considered. Southern Illinois soils have large amounts of K in them. However, this K is bound in the soils / parent materials and is plant “unavailable”. Over time potassium becomes plant available but only at a rate of 1-5 pounds per acre per year. This is not enough to maximize crop production and could possibly lead to potassium depletion/deficiency in the soil.

**TABLE 8. 2021 COVER CROP PLOTS
MARK LITTEKEN FARM – FORAGE NUTRIENT CONTENT -
ROCK RIVER LABORATORY**

	N Uptake (lbs/ac)	P Uptake (lbs/ac)	K Uptake (lbs/ac)
Grass Cover Crops	30.3 - 103.1	5.4 - 14.5	43.1 - 107.7
Legume Cover Crops	34.9 - 86.7	5.3 - 9.4	40.0 - 88.8
14-Way Mix	71.2	8.5	77.3

- Uptake of N, P, and K is an average across all grass or legume forage types.
- Values are in Pounds per Acre of N, P, and K.
- Wide ranges in nutrient uptake values are influenced more so by total forage tonnage produced.



Figure 12. Photos of baling forage and conducting forage quality sampling.

Nutrient Stewardship Internship

The Clinton CFB offered a local internship position to help facilitate a few areas associated with our 2021 Nutrient Stewardship Grant project. This position focused several of our efforts to help provide livestock producers a better understanding of their operations, the economic value and benefits of their manure, and tools for better recordkeeping and management.

We used this opportunity to transition from our in-person Manure Management Workshops to a more tailored producer experience. Through our internship position, we were trying to bridge the gap between providing self-help tools at our previous workshops to offering in-person assistance to producers that needed help achieving their manure management goals.

Some of the available services included:

- Helping producers organize their data and identify gaps
- Provided instructions on sampling, rate calculations, and mapping tools
- Provided consultations on feedlots, structures, and etc.
- Helped streamline recordkeeping functions and package management plans for success

By packaging the tools and resources from our workshops, we also worked with our CCA, consultants, and intern to provide a producer service to collect, organize, and analyze manure data/records and offer application recommendations all free of charge to participants.



Figure 13. Left: Clinton CFB Nutrient Stewardship Intern Blake Remmert shares information about the process of calibrating manure spreaders and taking manure samples with Mark Litteken and Cliff Schuette.



Right: Nutrient Stewardship Intern Blake Remmert helps collect soil samples from the cover crop plot in April.

Livestock Manure Testing Results 2021

Livestock Manure Testing Results 2021 – Narrative by Terry Wyciskalla, CPAg/CCA

Livestock manures are an integral part of crop and forage production in animal agricultural systems, especially in Clinton County. A good quality manure sample that is tested annually for nutrient content along with soil testing, is essential in monitoring each field to determine if additional fertilizer inputs are necessary and if necessary, and at what rates. Actual testing results from the applied manures are more accurate than simply using published book values from approved NRCS sources. Each year, as part of the NLRS Project, free manure sample testing has been provided to our CFB Members.

Table 9 shows some of the manure testing results collected in Clinton County for 2021. The table is divided into two parts, Solid Manures and Liquid Manures by animal species listed below each type. As you look through the data, most all of these values obtained from the testing laboratory are higher than published book values. There is also a high degree of variability between nutrient contents and within animal species. This variability can be attributed to several factors like: feed ration, animal size/age, how the manure was collected, whether the manure was well agitated, etc. Nutrient availabilities listed at the bottom of the table are based upon guidelines set forth in the Illinois Livestock Management Facilities Act (LMFA). For the best testing results, manure samples should be collected during field application and sent to the testing laboratory as quickly as possible. Testing results should come back from the testing laboratory in plenty of time to address any supplemental fertilizer needs, if necessary.

Using the highlighted results from each portion of the table and using application rates of either 10 tons/acre

TABLE 9. NLRS PROJECT - LIVESTOCK MANURES TESTING RESULTS 2021								
SOLID MANURES								
	Pounds Per Ton							
Species	Total N	NH ₄ -N	Org-N	P ₂ O ₅	K ₂ O	Ca	Mg	S
Beef	13.2	0.8	12.4	16.0	26.3	142.2	13.9	4.5
	10.4	3.6	6.8	8.1	19.2	4.5	1.6	2.5
	23.1	3.2	19.9	28.2	38.7	21.8	7.5	7.9
	12.5	2.2	10.3	15.2	16.5	8.7	4.9	2.9
Swine	15.0	0.8	14.2	75.3	6.2	83.6	7.2	3.5
Dairy	11.6	2.2	9.4	3.5	6.2	9.8	2.4	1.0
	10.1	2.0	8.1	6.1	17.7	5.7	2.1	1.8
	12.9	9.6	3.3	9.9	15.5	17.9	3.5	2.8
	13.6	1.8	11.8	6.6	13.8	11.4	2.7	2.1
	11.3	0.8	10.5	7.1	25.4	6.8	2.7	2.2
AVERAGE (all types)								
	13.4	2.7	10.7	17.6	18.6	31.2	4.9	3.1
LIQUID MANURES								
	Pounds Per 1,000 Gallons							
Species	Total N	NH ₄ -N	Org-N	P ₂ O ₅	K ₂ O	Ca	Mg	S
Beef	7.9	3.3	4.6	9.1	5.1	3.7	2.7	0.8
	84.4	37.5	46.9	56.5	52.3	41.1	13.1	9.9
	24.2	7.5	16.7	19.3	19	27.4	6.5	4.8
Dairy	17.9	7.5	10.4	8	18.4	14.3	4.6	2.1
	26.6	16.7	9.9	8.8	16.4	9.8	3.9	2.2
Swine	43.6	30.8	12.8	22.4	30.5	6.1	6.5	3.7
AVERAGE (all types)								
	34.1	17.2	16.9	20.7	23.6	17.1	6.2	3.9

NH₄-N: 100% Available on first year after application.

Org-N: 35% Available on first year after application.

P₂O₅: 90% Available on first year after application.

K₂O: 90% Available on first year after application.

S: 90% Available on first year after application.

for the Solid Manure or 10,000 GPA for the Liquid Manure (both application rates are typical when private or custom applied) to following amounts of nutrients would be potentially applied to a field.

For the Solid Manure sample (10 tons per acre), 102.0 lbs/acre Actual Available N, 254.0 lbs/acre Phosphate (P₂O₅), 348.0 lbs/acre Potassium (K₂O),

and 71.0 lbs/acre Sulfur (S) would be applied to a crop field. After doing the conversion, one would be applying 552 lbs/acre Phosphorus Fertilizer Equivalent as Triple Super Phosphate (0-45-0) and 580 lbs/acre Potash Fertilizer Equivalent (0-0-60). There is no conversion needed for N or S.

For the Liquid Manure sample (10,000 GPA), 539.0 lbs/acre Actual Available N,

509.0 lbs/acre Phosphate (P_2O_5), 471.0 lbs/acre Potassium (K_2O), and 89.0 lbs/acre S would be applied to a crop field. After doing the conversion, one would be applying 1107 lbs/acre Phosphorus Fertilizer Equivalent as Triple Super Phosphate (0-45-0) and 785 lbs/acre Potash Fertilizer Equivalent (0-0-60). There is no conversion needed for N or S.

To put these numbers into perspective with adequate soil test values:

A 200 bu/acre Corn crop would require approximately 190-240 lbs/acre Actual N, 160 lbs/acre 0-45-0, 100 lbs/acre 0-0-60, and 20 lbs/acre Sulfur.

A 65 bu/acre Soybean crop would require approximately No Actual N, 105 lbs/acre 0-45-0, 125 lbs/acre 0-0-60, and 20 lbs/acre S.

From these numbers, one can conclude that the Solid Manure sample did not provide enough N for the Corn crop but was well in excess of other nutrient needs with 3 times the P need and 6 times the K need. The Liquid Manure sample would provide excesses in all nutrients, N would be 2.5 times to the crop needs with P at 7 times and K was 8 times the crop needs. In fact, enough nutrients were applied to sustain a Corn crop and subsequent crops for several years, with the exception of N on the Solid sample.

To put some economics to these numbers:

Using some predicted prices for 2022; with Anhydrous Ammonia = \$875/ton, Triple Super Phosphate = \$675/ton, and Potash = \$550; the above Solid Manure rate would supply \$51/acre Actual N,

\$186/acre Phosphate, and \$160/acre Potash not including Sulfur. In contrast, the above Liquid Manure rate would supply \$271/acre Actual N, \$374/acre Phosphate, and \$216/acre Potash not including Sulfur.

Conclusions:

Manure Testing, Soil Testing, and calculating the Economics of manure application rates are very important for production inputs savings, identifying where additional inputs may be necessary, and potentially reducing environmental impacts from over-application of livestock manures.



Figure 14. Photos of manure spreader and manure pit agitator.

Contact Information

You can contact the Clinton CFB at: 618-526-7235

To learn more about all other IFB Nutrient Stewardship Field Days, visit:
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