Lee Thompson

2016 Conservation Innovation Grant

Integrating Side dressing and Inteseeding for Reducing Nitrate Loss and Soil Erosion

Final Report

December 8, 2016

1.) *PROJECT ACTIVITIES COMPLETED DURING THE REPORTING PERIOD. (Describe project progress specific to goals, objectives, and deliverables identified in your project proposal.)*

The first activity of the project was to design and build a machine for interseeding cover crops into standing corn. The overall idea of the design was to build something from what most farmers would have sitting around in their machine shed/grove (junk/unused machinery). Components for the design were sourced from old row crop cultivators, grain drills and an unused valmar granular seeder from a farmer in North Dakota which was mounted on a field cultivator to incorporate sonolan granules as a pre emerge herbicide. The machine was designed as a 12 row 30" applicator (30'). 6 rows were built with disc openers from a grain drill and 6 rows were built for broadcast application. The thought behind the two different seeding methods was to differentiate which one would work better. The machine was also designed to side dress liquid fertilizer next to the base of the corn plant while seeding a cover crop.

The second activity of the project was to actually perform the field operation of interseeding the cover crop and side dressing nitrogen in a single pass.
Due to the fact that the climate nitrogen advisor recommended that we didn't need any more nitrogen, the side dressing portion didn't happen, but the components are built and will allow for additional experimenting next year and also in 2018 during year 3 of this study. The cover crop seeding and nitrogen side dress were implemented to reduce nitrate loss, increase soil health, reduce soil erosion and increase water quality.

This study was performed on a 60 ac field, split in half. The west half received the farmer standard Nitrogen rate (135 #), pre emerge herbicide and no cover crop. The east half received a reduced nitrogen rate (105#), no pre emerge herbicide and a cover crop. Within the cover crop side, there were two different mixes used. Mix 1 was a blend of turnip, radish, rapeseed, triticale and cereal rye with a planned application rate of 30#/ac to cover 10 ac and a 15# rate to cover 10 Ac . Mix 2 was a blend of peas and barley with a planned application rate of 48#/ac.

Hydraulic flow problems with the tractor caused application rate issues. Mix 1 ended up being applied at 15#/ac over 20 ac and mix 2 ended up being applied at around 30#/ac over 7.5 ac. Other than the tractor hydraulic issue, the performance of the machine was excellent. I'm excited to get more acres on the machine in the future. It has earned a spot in the machine shed!!

The third and final activity of the project was in season scouting using a UAV, satellite imagery and walking in the field; nitrogen modeling using the climate fieldview nitrogen advisor, tissue sampling, nitrate testing, harvesting, soil health testing and post harvest strip tillage.

2.) IDENTIFY ANY SIGNIFICANT FINDINGS AND RESULTS OF THE PROJECT. (This could include photo documentation of the project at various stages if you haven't already provided these as well as final relevant images of the project at completion. Any data, graphics or record of observations throughout the growing season or during the field day event are also anticipated.)

Looking back there was something new that was learned at almost each step during the project.

The cover crop was seeded on June 13 @ V7 Corn. It was evident right away that some of the broadcast seed was intercepted by the corn leaves and caught in the whorl. I was amazed at how quickly the cover crop emerged, within a few weeks it was out of the ground a few inches and growing nicely.

Image 1 & 2: Left: Drilled cover crop 2 weeks after planting. Right: broadcast cover crop 2 weeks after planting.

Right from the beginning there was a noticeable difference in stand establishment between the drilled and broadcast rows, with the drilled rows having the best stand and emergence (see image 1 & 2)

Being that the final seeding rate was about 1/2 of planned, I think that the effect of drilled vs. broadcast was magnified. The cover crop grew up well to about 6" tall, then started to grow more lanky and not grow as fast as in the beginning.

Seed size did make a difference in germination/emergence, especially for the broadcast rows. The peas didn't germinate good enough when broadcast on the soil surface, there was an odd one here and there that made it, but not many (see image 3) An interesting observation found when Paul Meints and the Interns from MNCGA were out for a visit during the summer was that the peas were actually growing where the corn plant leaves met the stalk, likely due to the excessive rain this growing season.

Image 3: Pea/barley mixture 3 weeks after seeding. Note the seeds on the surface that didn't germinate

During August the grass species seemed to die off and by September, the only blades of grass found were spots in the field where there were missing corn plants (more sunlight). After visiting with Tom Coffman from the Rice County NRCS, he concluded that annual rye would be a better candidate for interseeding as its more shade tolerant

Observing the plot after rain events revealed that even with a limited amount of cover, the soil appeared less eroded from all the splashing rain.

I wasn't very impressed with the roots on any of the cover crop species. It seemed as if after the first few weeks of growth, the plants just focused on top growth and not on root growth. I was expecting that the turnips and radishes would have a big root on them, but in most cases they were barely as big as a pencil (see image 4). The two conclusions I can come up with are from too much rain and from all the shade as I did notice while strip tilling the plot that there were areas with baseball sized turnips. I only saw that in spots that had missing corn plants.

Image 4: Radish Roots

The morning Paul Meints came down for the harvest meeting we had a frost. The headlands of the field were just harvested but not the rest of the field. It was interesting to see the frost affect the cover crop on the headlands but as we walked into the standing corn, the cover crop did not have any frost damage.

Image 5 & 6. Left, frost damaged cover crop on headlands. Right, cover crop in standing corn

After harvest the field looked pretty bleak, most of the cover crops were buried under some corn residue from the combine. The combine has knife rolls on the head so it leaves a pretty good mess of stalks covering the ground (Image 7)

Image 7: Cover crop after harvest

Within a week or so the field started to green up again and the cover crop kept growing. With the long fall we've had and not really a hard frost, the cover crop is still growing as of this writing (11/29/16).

Here's a picture of strip tilling with an ETS Soil Warrior through the cover crop plot this fall. I'm not sure if I was thinking too hard or what, but it did seem that it pulled easier where there was cover crop (Image 8)

Image 8: Cover Crop appearance after strip tillage

Plant performance did not appear to be affected by interseeding. Tissue test results were almost identical. Harvesting with a calibrated yield monitor and using a software program to analyze the data, the following yield maps shows little difference between the two plots. The cover crop plot did have a yield decrease of 6.7 *bushels/ac but it also had 30# less N. With the seasonal rainfall more than 10" above normal, I would attribute the yield decrease to the reduced N rate and not the cover crop.*

Result	Comparative
Nitrogen 2.54% / N - Deficient	Normal: 4.2% - 5.0%
Phosphorous 0.33% / P - Responsive	Normal: 0.35% - 0.60%
Potassium 1.88% / K - Deficient	Normal: 3.0% - 4.5%
Magnesium 0.17% / Mg - Responsive	Normal: 0.19% - 0.50%
Calcium 0.29% / Ca - Deficient	Normal: 0.35% - 1.00%
Sulfur 0.17% / S - Deficient	Normal: 0.28% - 0.35%
Iron 82 ppm / Not in range	Normal: n/a
Manganese 29 ppm / Mn - Deficient	Normal: 69 - 81 ppm
Boron 12 ppm / B - Adequate	Normal: 8 - 14 ppm
Copper 7 ppm / Cu - Responsive	Normal: 8 - 20 ppm
Zinc 32 ppm / Zn - Responsive	Normal: 35 - 60 ppm ppm

Result	Comparative
Nitrogen 2.55% / N - Deficient	Normal: 4.2% - 5.0%
Phosphorous 0.32% / P - Responsive	Normal: 0.35% - 0.60%
Potassium 1.88% / K - Deficient	Normal: 3.0% - 4.5%
Magnesium 0.16% / Mg - Deficient	Normal: 0.19% - 0.50%
Calcium 0.26% / Ca - Deficient	Normal: 0.35% - 1.00%
Sulfur 0.17% / S - Deficient	Normal: 0.28% - 0.35%
Iron 74 ppm / Not in range	Normal: n/a
Manganese 25 ppm / Mn - Deficient	Normal: 69 - 81 ppm
Boron 11 ppm / B - Adequate	Normal: 8 - 14 ppm
Copper 6 ppm / Cu - Responsive	Normal: 8 - 20 ppm
Zinc 31 ppm / Zn - Responsive	Normal: 35 - 60 ppm ppm

Figure 1 & 2. Tissue Test Results
Left, No Cover Crop, Standard Nitrogen Rate
Right, Cover Crop, Reduced Nitrogen

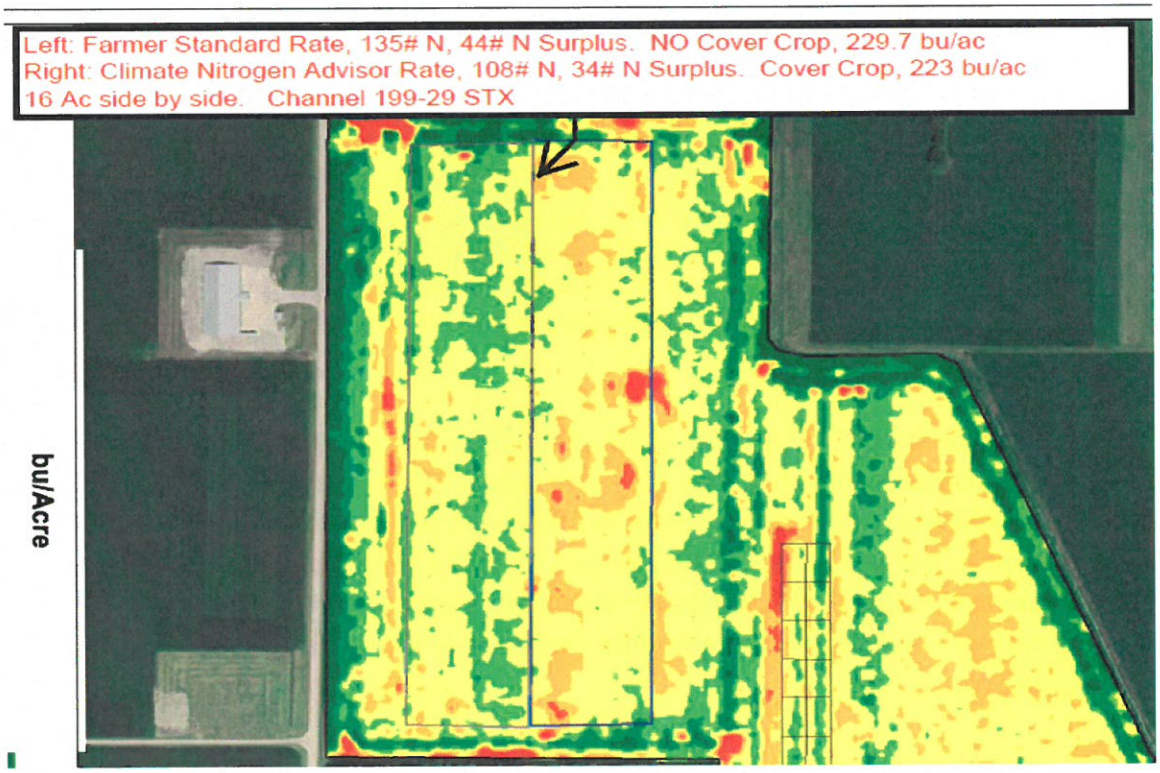


Figure 3: 2016 Corn Yield Map

3.) CHALLENGES ENCOUNTERED. (Describe any challenges that you encountered related to project progress specific to goals, objectives, and deliverables identified in the project proposal.)

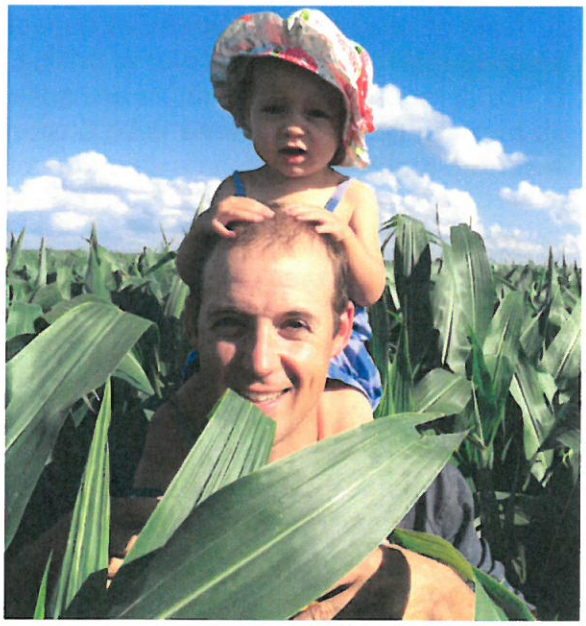
Weed control was the first challenge. For the cover crop plot there was no pre emerge herbicide applied to eliminate any challenges to cover crop establishment. By the time the field got a post herbicide application, some of the waterhemp and giant ragweed were too big to kill. As more people study cover crops, there should be more data available on herbicide programs that are safe for cover crops. Tom Coffman mentioned a few of his studies in Rice county where the farmer applied a 1/2 rate of a pre emerge (I cant remember the specific chemical name), Laudis post emerge and then seeded a cover crop mix a week later with no issues. I would be interested to try a 1/2 rate of a pre emerge and then Status as a post emerge and see how that combination affects cover crop development as Status has a very short residual.

The second challenge was the custom built equipment. There was no blue print to follow and very few if any machines like this in the world. It's maybe not a challenge necessarily in a bad way, farmers like innovation and tinkering-that's half the fun !

The third challenge is what I would call rookie mistakes. improper calibration, inadequate tractor hydraulic flow, later timing than desired, non shade tolerant grass species, big seeds not liking being broadcast (image 3) Nobody likes to make mistakes but to put it into perspective, mistakes in this experiment were actually good, now we know what to do different for next year!! .

4.) EDUCATION AND OUTREACH ACTIVITES. (Describe any opportunities to engage with farmers, influencers or the media about your project.)

There were numerous education and outreach activities during the project. Social media (Twitter and Facebook) helped out tremendously with the network of people connected. Visits by Tom Coffman from the NRCS throughout the summer, visits from curious conservation minded farmers, curious neighbors and even just talking about it in normal conversations with farmers. Also a few posts on facebook and twitter generated a lot of buzz. Even my son in law and his 1.5 and 3 year old daughters enjoyed checking on the cover crop! It's always surprising when talking with farmers at how interested they are in cover crops.



5.) HOW CAN WE HELP? (Please let us know how we can improve the experience for the next generation of projects.)

I would like to thank the MNCGA for being a recipient of the innovation grant. The team has been very helpful in answering any questions regarding any part of the project. The field visits during the growing season are also much appreciated. It's good to have boots on the ground, it really shows that the Corn Growers cares about conservation, innovation and corn.

I would like to be considered for a grant in 2017 in soybeans and 2018 in corn to complete a full crop cycle on this farm.

6. Limitations- Paul asked that I include my thoughts on some possible limitations regarding the practice of interseeding cover crops into a cash crop.

1. Timing. maybe not too bad of a limitation, probably more of an excuse that people might use. Same time frame and challenge as side dressing and there is a lot of corn farmers that side dress
2. Herbicide programs for pre and post emerge. Limited research data/ recommendations. There is some data from Penn State and some of the Ag Talk forums on the internet have useful information, but until you see how something works on your own farm, there's always a hint of skepticism.
3. Species selection. There's not necessarily a wrong species selection, but there's so many different attributes for each species that can be taken into consideration.
4. Not quite a mainstream practice yet.... hard for farmers to try something new, especially something with intangible benefits (since some are very disconnected from the soil/environment-I'm not trying to be mean either). A few farmers that I've visited with often say, "why do you need to plant a cover crop, I've farmed for 40 years and never had to plant one"
5. Cost of seed can be expensive especially if you want to put on a heavy broadcast seeding rate. I'm more in favor of drilling to help reduce seeding rates and cost.
6. Equipment. The parameters are quite different for interseeding into a standing crop so most equipment will need to be custom made. If one can add some components to a current machine, such as a side dress bar, then the equipment isn't that big of deal.

7. Economic Information-Paul asked if I'd share some of the economic information regarding this project.

Table 1 below shows the economics of the trial this year. There were a few variables that may not make the final numbers 100% accurate, but I am confident that we can still learn from the data.

The first variable is Nitrogen. The experiment was set up with the check having the full rate of N as a pre plant application and the cover crop area having 30# of N side dressed since the goal of the study was to integrate cover crop seeding and side dressing into a one pass system. However, while utilizing the Climate Nitrogen Advisor, no additional Nitrogen was recommended on the cover crop area.

The second variable was testing not only the cover crop, but how the cover crop system would work on my farm. This is main thing I look at when comparing the two different methods; the system used to get to the final result. For testing this part of the system, I rented a tractor to pull a rented strip till machine. Using the same tractor, I also rented a DMI ripper from the local equipment dealer. I kept track of fuel use and productivity using the performance monitor on the tractor. Labor was figured at $20/hr.

In the cover crop method, The cover crops are acting as my full width tillage tool, and strip till will serve as the primary tillage for next years soybean crop, so therefore I'm combining cover crops and strip till into a "system". In the no cover crop method, a DMI ripper is used for full width tillage and a field cultivator will be used in the spring to complete this "system". The cover crop system resulted in profit loss of -$6.52/ac compared to the no cover crop system in 2016.

I'm happy with that even though it's a loss because I think that the reduced nitrogen rate coupled with the excessive rain were the underlying factors. The exciting aspect I like about my cover crop "system" is that if you look at the individual tillage components compared to the no cover crop "system", the cover crop system saves 1 trip across the field with a stalk chopper, fuel and labor for a net savings of $11.02/ac.

Operation	***Cover Crop***	***No Cover Crop***
Seed Cost	9.60	0
Interceding/Side dressing Cost	0	0
Extra Nitrogen	0	12.15
Tillage	Strip Till $10/ac	DMI Ripper $10/ac
Stalk Chopping	0	5
Fuel	1.08	4.5
Labor	.74	3.35
Sub Total	21.42	35
Yield	223	229.7
Gross Income	669	689.1
Net Income	647.58	654.1
Difference	-6.52	0

Table 1: Economic Information of Cover Crop Plot (dollars/acre)

MVTL

MINNESOTA VALLEY TESTING LABORATORIES, INC.
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2616 E. Broadway Ave. ~ Bismarck, ND 58501 ~ 800-279-6885 ~ Fax 701-258-9724
1201 Lincoln Highway ~ Nevada, IA 50201 ~ 800-362-0855 ~ Fax 515-382-3885
www.mvtl.com

MEMBER ACIL

Haney Soil Health Analysis Report

Report Date: 5 Dec 2016
Work Order #: 201611-03288
Account #: 040491
Purchase Order Number: CREDIT CARD

DAN COFFMAN
LANE RIDGE FARMS
40642 441ST AVE
NICOLLET MN 56074

Date Received: 16 Nov 2016
Date Sampled: 15 Nov 2016

Farmer Name: LANE RIDGE FARMS
Sample ID: H120 COVER CROP
Lab Number: 16-V1800

1:1 Soil pH	6.5
1:1 Soluble Salts, mmho/cm	0.42
Excess Lime Rating,	1
Organic Matter, %LOI	6
WDRF Buffer pH	6.9
Solvita CO2 Burst	
Solvita CO2-C, ppm C	141
Water Extract	
Total Nitrogen, ppm N	33
Organic Nitrogen, ppm N	18.3
Total Organic Carbon, ppm N	220
H3A Extract	
Nitrate, ppm NO3-N	12.9
Ammonium, ppm NH4-N	2.6
Inorganic Nitrogen, ppm N	15.5
Inorganic (FIA) Phosphorus, ppm P	34.3
Total (ICAP) Phosphorus, ppm P	46
Organic Phosphorus, ppm P	11.8
ICAP Potassium, ppm K	85
ICAP Calcium, ppm Ca	571
ICAP Aluminum, ppm Al	286
ICAP Iron, ppm Fe	178
Calculations	
Organic C:Organic N	12
Nitrogen Mineralization, ppm N	18.3
Organic Nitrogen Release, ppm N	18.3
Organic Nitrogen Reserve, ppm N	0
Phosphorus Mineralization, ppm P	11.8
Organic Phos Reserve, ppm P	< 0.1
Phos Saturation Al/Fe, %	9.9
Phosphorus Saturation Ca, %	8.1
Soil Health	
Soil Health Calculation	15.8
Cover Crop Suggestion	30% Legume 70% Grass

Nutrient Quantity Available for Next Crop	
Nitrogen, lbs N/A	67.7
Phosphorus, lbs P2O5/A	114
Potassium, lbs K2O/A	102
Nutrient Value, $/A	139.11

Nitrogen Savings by Using the Haney Test	
Traditional Evaluation, lbs N/A	25.8
Haney Test N Evaluation, lab N/A	67.7
Nitrogen Difference, lbs N/A	41.9
N Savings, $/A	26.81

Results generated by MVTL, Inc. in cooperation with Ward Laboratories, Inc.

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DAN COFFMAN
LANE RIDGE FARMS
40642 441ST AVE
NICOLLET MN 56074

Date Received: 16 Nov 2016
Date Sampled: 15 Nov 2016

Farmer Name: LANE RIDGE FARMS
Sample ID: H120 NO COVER CROP
Lab Number: 16-V1801

1:1 Soil pH	6.6	ICAP Aluminum, ppm Al	301
1:1 Soluble Salts, mmho/cm	0.37	ICAP Iron, ppm Fe	242
Excess Lime Rating,	1		
Organic Matter, %LOI	5.9	**Calculations**	
WDRF Buffer pH	7.2	Organic C:Organic N	11.5
		Nitrogen Mineralization, ppm N	16.8
Solvita CO2 Burst		Organic Nitrogen Release, ppm N	16.8
Solvita CO2-C, ppm C	123	Organic Nitrogen Reserve, ppm N	0
		Phosphorus Mineralization, ppm P	14.7
Water Extract		Organic Phos Reserve, ppm P	0.6
Total Nitrogen, ppm N	33.3	Phos Saturation Al/Fe, %	12.7
Organic Nitrogen, ppm N	16.8	Phosphorus Saturation Ca, %	10.2
Total Organic Carbon, ppm N	194		
		Soil Health	
H3A Extract		Soil Health Calculation	14.3
Nitrate, ppm NO3-N	14.5	Cover Crop Suggestion	40% Legume 60% Grass
Ammonium, ppm NH4-N	2.9		
Inorganic Nitrogen, ppm N	17.4		
Inorganic (FIA) Phosphorus, ppm P	53.6		
Total (ICAP) Phosphorus, ppm P	69		
Organic Phosphorus, ppm P	15.3		
ICAP Potassium, ppm K	92		
ICAP Calcium, ppm Ca	678		

Nutrient Quantity Available for Next Crop		**Nitrogen Savings by Using the Haney Test**	
Nitrogen, lbs N/A	68.5	Traditional Evaluation, lbs N/A	29
Phosphorus, lbs P2O5/A	157	Haney Test N Evaluation, lab N/A	68.5
Potassium, lbs K2O/A	110	Nitrogen Difference, lbs N/A	39.5
Nutrient Value, $/A	160.07	N Savings, $/A	25.29

Results generated by MVTL, Inc. in cooperation with Ward Laboratories, Inc.