**Objectives:**

1) Evaluate the long-term impact of phosphorus rate and timing in a corn-soybean rotation on soybean grain yield and quality.

All research data for objective 1 has been compiled and work has been completed at all locations.  I included the 2018 results with past results evaluated P and K response for individual blocks at each research site. With the completion of the project I also looked at long term trends in the data. The final report includes an economic evaluation of optimal P and K rates from years 3-6 and 7-10.  These time frames were evaluated to determine if the economic optimum rate changes over time potentially as a result of soil test changes from application rates less than crop removal. I also combined data over years to get a more definitive answer to whether application timing impacts corn and soybean yield. Yearly data was inconclusive and a greater analysis over years was needed and provided a more definitive answer on the impacts of application timing.  The P and K balance data was updated through 2018 but I also looked at long term soil test trends for rates of application of 2 years to see what rates maintained initial soil test values.  That data is reported and is interesting as it contrasts with the P and K balance data showing a greater need for P and K to maintain soil test levels.  I also included all 2018 corn and soybean grain P and K concentration in my database to update concentration data.

2) Determine if the application of Cl has negative effects of soybean grain yield and quality.

Grain samples were sent off and analyze for K for the LTK sites, P for the LTP sites, and K, Ca, and Mg for the K source trials.
Analysis has been completed on all samples from 2018 and all data have been compiled into a 2018 master data file.  The 2018 summary is given in the attached final data report.

3) Evaluate the impacts of macro-nutrients on the distribution of essential amino acids in soybean grain

Soybean amino acid data has been summarized from two former and one current research trial. A P-K-S trial funded by AFREC from 2011-2013 was summarized for the final report along with a micronutrient trial previously funded by the MN Soybean Research and Promotion council from 2013-2014.  I also summarized results from the K source trials for objective
2.  For the final report I focused on essential amino acids for livestock which are typically limiting and need to be supplemented.  I have additional data for other amino acids for the 2019 final report.  I also am planning on compiling data available for the long term P and K trials and some of the previously funded iron deficiency chlorosis trials for the FY 2019 report.

**Achievements:**

Ten year years of research was completed on the three P and three K trials.  Amost all planned data were collected from the trials.

A final analysis was completed on the long-term P and K trials focusing on economics for the application rates and further studying application timing. All data are reported in the final data report.  The analysis across years shows clear benefits of timing in the rotation for both nutrients.  Application of P ahead of corn tended to give a yield benefit to corn while avoiding applicaiton of K ahead of soybean appeared to provide a yield benefit to sobyean.

The corn and soybean P and K removal database was updated through 2018.

The critical P and K soil test level data was updated with 2018 data.

A second year of data collection was completed from the potassium source trial.  I am finding a clear increase in soil Cl content at Crookston and a small increase a Morris.  The 2017 and 2018 growing seasons have been relatively wet at Morris, Lamberton, and Waseca which have reduced the risk of Cl buildup at these sites.

I started to organize past amino acid data to determine trends in amino acids from fertilizer practices. Data from 3 studies is summarized for the final report for selected amino acids

**Challenges:**

None

**Tech Transfer:**

SROC Winter Crops Day
Jan 18, 2019 - Waseca and Rochester
~100 Growers and consultants

MVTL Agronomy Update
Jan 31, 2019 - New Ulm
~150 Growers and consultants

MINCA Crop Consultants Meeting
Feb 6, 2019 - Hutchinson
~20 consultants

The above events are were the primary focus of my talks were related to research fudned by MN Soybean.  One of our major focuses has been on the release of material on the web.  I do not have a full account of all news releases where data generated by my projects has been used but I have been identifying material crediting where data generated by the MN Soybean Research and Promotion Council is being used.