Final Report Title:
Maintenance support for the long-term MSR&PC/University of Minnesota Drainage Site

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Summary
In 2011, the Research and Tech Transfer Committee of the Minnesota Soybean Research and Promotion Council (MSR&PC) graciously agreed to fund a unique research project focused on investigating how drainage affects soybean yields, but more importantly, studies how management should differ between well-drained and poorly-drained soils. The University of Minnesota/MSR&PC's Drainage Research site is the only research site of its kind in the world. With this site we can demonstrate the economic and environmental benefits to producers, the public, and legislators of BMP's already in use by Minnesota soybean producers.

The 14-acre site north of Wells, MN includes eight independently-drained blocks so that four have been left in an undrained condition and four have been drained since tile installation. In 2016, the blocks were further split to allow us to examine the interactions between drainage and tillage (conventional, strip-till, no-till). Within these splits, we can examine 15 management treatments. We have examined two- and three-way interactions with soybean management such as populations, seed treatments, foliar fertilizers and fungicides, and many others.

This unique site allows us to examine not only the effects of drainage and tillage on yield and production efficiencies of soybean in a corn/soybean rotation, but we are able to demonstrate environmental benefits of these strategies as well. Moreover, we are able to examine interactions between tillage, drainage, and soybean management (eg what is the relative value of seed treatments in drained/undrained, tilled/strip/no-till, and drained and strip-tilled, etc?).

The findings from this site have been rich. We have confirmed yield stability attributed to both drainage and conventional tillage and have confirmed that strip-till can be implemented without reducing yields when compared with conventional tillage. We have also been surprised by lack of interactions with management. For instance, we have not noted additional benefit to fungicides (as seed treatments or foliar treatments) on poorly-drained soils. Recently we have made important discoveries regarding increased NOx loss from poorly-drained soils and carryover effects of N rates on subsequent soybean crops.

In 2020, after six successful cropping seasons at this site, we were unable to secure funding to initiate a new set of experiments to answer important contemporary questions. Fortunately, the Research Committee of the MSR&PC stepped in and graciously provided much-needed maintenance support to allow our continued access to this site. This project provided $25,000 in support to cover rental fees, and support planting, maintaining, and harvesting research plots as well as general upkeep of the site.

Objectives and Goals

Objective 1: Support much-needed research into yield benefits of artificial drainage, tillage, management, and all interactions for Minnesota producers.
Objective 2: Support long-term research activities that provide real data on production and environmental benefits of artificial drainage, modern tillage systems, and their interactions.

Results

The weather in 2020 was not particularly exceptional. Season-long rainfall was 29.5" compared with 15-year average rainfall of 28.8" and temperature profiles were also similar to the long-term averages. However, distribution of rainfall was certainly weighted toward heavy rain events in late July through early August. Dry early-season conditions certainly reduced any positive impacts of artificial drainage at the site and likely reduced tillage impacts on yields.

With limited funding the 2020 field season was not set up for detailed research activities. However, we did capture yields from all soybean plots across historical N management treatments. For the purposes of this report we will be providing simple means of the six combinations of drainage and tillage in soybean (Table 1). This site has consistently shown yield responses to additional N on soybean. Results of the additional N versus non-fertilized soybeans are provided here (Table 2).

Table 1. Overall averages considering all the treatments (i.e. trt 1-15)

Row Labels	Average of Yield (bu/a 13%)
Drained	**72.3**
CT	72.8
NT	71.0
ST	73.1
Undrained	**72.8**
CT	71.2
NT	72.0
ST	75.2
Grand Total	**72.6**

Table 2. Averages for trt 4 (no nitrogen) and 15 (120 lb N/a).

Average of Yield (bu/a 13%)	Column Labels		
Row Labels	**4**	**15**	**Grand Total**
Drained	**73.4**	**73.9**	**73.7**
CT	73.2	74.3	73.7
NT	74.2	72.9	73.5
ST	72.9	74.7	73.8
Undrained	**73.1**	**75.9**	**74.5**
CT	70.1	77.5	73.8
NT	73.0	74.5	73.8
ST	76.2	75.6	75.9
Grand Total	**73.3**	**74.9**	**74.1**

While no statistical summary is provided here, one can see that drainage had little effect on soybean yields in 2020. As is often noted, tillage had little effect on yields within well-drained treatments. There appeared to be a slight yield increase in strip-till yields under undrained conditions. While the explanation for this is not obvious, it is likely that the combination of in-row tillage affecting emergence and early-season growth, coupled with water savings in a drier than normal spring, likely supported higher yields.

Outreach

Due to COVID-19, we were very limited on in-person field days at the site in 2020. We did hold two small semi-private field days for local MSR&PC and MSGA representatives the 21st day of both July and August.

Current and future activities and plans

Because this (FY20) project provided bridge funding to keep the research site operational, we were able to plan for a new round of research projects to implement when funding became available. We were successful in FY21 and received funding from the Research Committee of the MSR&PC for a set-up year for projects that will begin in earnest in 2022.

The current project revolves around a thorough evaluation of physical, chemical, and biological properties of the soils stemming from drainage, tillage, and N management. We are also outfitting the site with a whole installation? of soil temperature and moisture sensors to evaluate the effects of tillage and drainage on early-season soybean growth and development. Lastly, we are deploying late-summer and fall cover crop and residue management strategies to alter the spring environment to evaluate the effects of changes in C:N ratio, soil moisture/temperature, and other residue effects on early-season soybean growth and development.

PhD student Gabriel Dias Paiao, is currently finalizing his PhD dissertation that will summarize many aspects of tillage, drainage, N management, and environment interactions. Masters student Carlos Sanchez has begun working on the current project. He is characterizing soils from these treatments, installing environmental monitoring, and evaluating soybean growth and development under drainage and tillage treatments. We fully expect multiple published research and extension pieces will be developed from this work over the next few years.