Tile Drainage: Research Results, Economics, and Where do we go from Here

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Excess water is often a major problem in parts of the northern plains. In 2002 large areas of Northwest Minnesota experienced flooding – some fields were flooded more than once, and some more than twice. One of my colleagues was explaining to me why he didn't have any data from his research study. He said, 'The first time it flooded, the crop came out OK. The second time, it wasn't in too bad of condition. But, the third time killed it.'

2002 is part of a wet cycle that dates back through the 1990's and before. One farmer told me that of the last 20 years on his farm, 17 have been too wet, 1 too dry, and 2 just right. Throughout the 1990's excess water has significantly impacted crop production in Northwest Minnesota. Though excess water is not the only factor that affects yields, during the 1990's it was a major factor. The Minnesota State Climatology Office estimates that the 1990's were the wettest decade of the 20th century in many Minnesota communities. In some areas of Northwestern Minnesota, the aggregate precipitation departure from normal for the decade exceeded 40 inches—the equivalent of receiving an additional two years of average annual precipitation.

The yearly quantity of rainfall, however, is less important than the amount of rainfall received at critical times. During nearly every year in the 90's, at least one month during the summer received one to two+ inches of rainfall above average.

The critical question is, 'what can we do about it?' I have often heard it said, 'Well, we can't control the weather'. That is certainly true. However, there are many things we can do to respond to it. We need to begin thinking about water as a manageable variable in our production system. In reality, we have been managing water for a long time. Much of our area would not produce a crop without surface drainage (ditches). Some areas are utilizing irrigation.

Another way to manage water is through subsurface (tile) drainage. Tile drainage is extremely common in the southern half of Minnesota and throughout the corn and soybean belt. However, tile drainage is relatively rare in the northern plains, even though Northwestern Minnesota and Eastern North Dakota can be (and have been) quite wet. One of the reasons for limited application of tile drainage is the lack of research on the performance of tile drainage in these regions.

Since tile drainage is a significant financial investment, assessing the economic feasibility of subsurface drainage hinges upon knowing the economic benefits of drainage, and surprisingly little data exists to aid such an analysis. Economic analyses of subsurface drainage in the Midwestern U.S. typically point to a limited number of yield studies (1950's – 1970's) conducted in Ohio or Iowa, which indicate that tile drainage resulted in higher yields and reduced yield variability. Although these data give us some insight into the response of small grains (oats) and soybeans to subsurface drainage, current, regional data are essential because regional climate, soil and landscape dramatically influence crop response. The lack of crop response research data generated in this region and the lack of economic analyses pertinent to Northwest Minnesota are significant factors limiting the adoption of tile drainage.

To provide some crop response data specific to this region, Dr. Gary Sands and his colleagues from the University of Minnesota have initiated two tile drainage research studies in Northwest Minnesota. One study is located near Brooks and the other is on the University of Minnesota Research and Outreach Center at Crookston. Crops being tested at both sites are wheat and soybeans. Sugarbeets are being tested at Crookston only. Two years of data are available from Brooks and one year from Crookston. These are multi-year studies, and more years of data will improve its usefulness. There are a couple of important points to keep in mind when viewing this data.

1) The sites were selected based on soil types that are common to the region. These sites were not chosen because they were wet or in particular need of tile drainage.
2) The planting date is the same for all treatments. One of the advantages of tile drainage is the ability to plant earlier. Because of the complexity of designing these experiments, we are not able to plant tile drained plots earlier than un-tiled plots. Therefore, in these experiments we are not able to measure the benefit of earlier planting with tile drainage.

Below are the yield results thus far:

Brooks

	Wheat (Bu/A)		**Soybeans (Bu/A)**	
Tile Spacing (ft)	**2001**	**2002**	**2001**	**2002**
0	51	42	27	31
80	53	45	28	31
50	52	48	27	31
40	49	40	25	30

Crookston

Tile Spacing (ft)	**Wheat (bu/A)**	**Soybeans (bu/A)**	**Sugarbeets (T/A)**	**Sugarbeet Sucrose (lb/A)**
0	48	37	24.2	7050
60	53	40	25.9	7444
40	54	38	28.0	8055
25	58	40	26.9	7623
15	55	43	24.9	6836

Crop response at Brooks has been rather small. Data collected thus far suggest that this site does not require tile drainage due to hydrology of the area, good internal drainage, etc. Larger responses have been observed at the Crookston site. Yield increases in 2002 ranged from 5 to 10 bu/A for wheat, 1 to 6 bu/A for soybeans, and 0.7 to 3.8 T/A for sugarbeets. Of particular interest is sucrose yield per acre, which increased as much as 1005 lb with tile drainage.

Yield is likely the most important benefit of tile drainage, but there is a long list of other benefits also.

Yield related benefits:

- Earlier planting
- Better stand establishment
- Reduced plant stress, so more vigorous, competitive plants
- Better ability to compete against weeds
- Reduction in plant diseases that require saturated soil conditions
- Reduced soil compaction
- Improves ability to harvest in adverse conditions
- Better utilization of water (a wheat crop that yields 10bu/A more uses 3 inches more water)

Reduced cost related benefits:

- Reduced wear and tear on equipment – not operating in the mud
- Less power required for field operations (tillage equipment pulls easier and tractor slippage is reduced)
- More predictable, consistent yields allow more efficient use of resources (you are more likely to hit your yield targets, so you can plan inputs accordingly)

Other benefits:

- Reduced weather risk reduces stress to the farmer – you can sleep better
- A more stable production system provides more potential to produce higher value crops
- More stable yields enhance the ability to contract and forward price

One disadvantage of tile drainage in the corn belt has been loss of nitrate nitrogen into surface waters. Although we will need to closely monitor nitrate losses, this is anticipated to be much less of a problem in this region due to a different cropping system and much lower nitrogen use. The most significant disadvantage to farmers of tile drainage is initial cost. Costs to commercially install tile drainage typically range from $250 to $500 per acre, depending on tile spacing and design. Farmers can potentially reduce expenses by installing their own tile, but they must have the right equipment and a great degree of knowledge about design and installation. No matter how you look at it, tile is a significant investment.

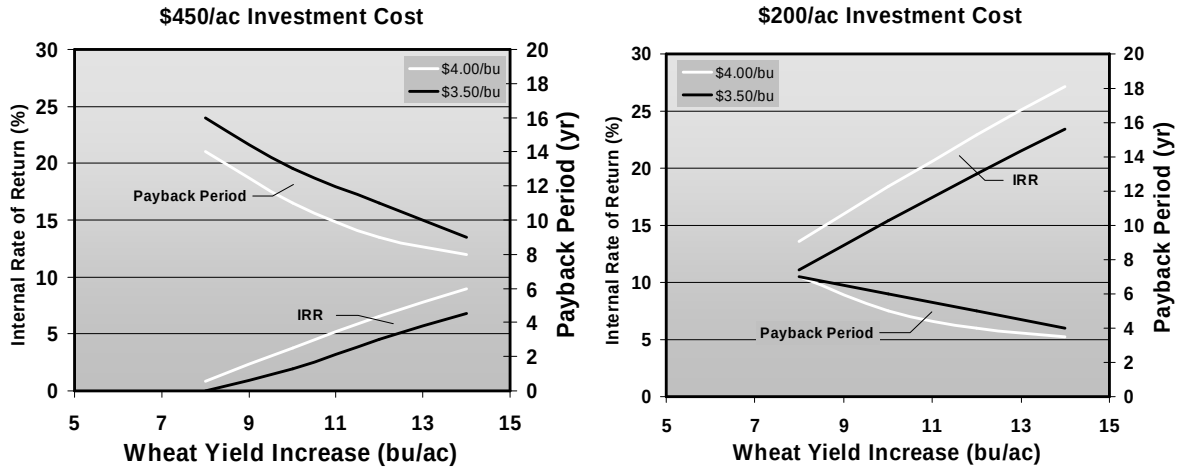
Economics of Tile Drainage Investment

The graphs below present an economic analysis of drainage for a 500-acre wheat enterprise. This analysis makes several important simplifying assumptions:

1) Drainage is installed on the entire 500 acres
2) The life of investment is 15 years
3) Production is continuous wheat (not a rotation)
4) Wheat yield increases (and selling price) are assumed to be constant over the investment period
5) Returns are calculated before taxes
6) No additional expenses or benefits (due to drainage) are considered—in reality, there would typically be some of each

Two levels of investment costs are assumed: $450/A, which represents a contractor-installed price and $200/A, which is more representative of a self-installed system. These numbers are examples - actual costs must be determined on a farm by farm basis. Both graphs show two sets of curves. The first is the payback period, which reflects the number of years before the investment in tile drainage pays for itself. The second is the internal rate of return (IRR), which reflects the before tax interest generated by the investment in tile drainage. The white and black lines use a $4/bu and $3.50/bu price for wheat, respectively. Using the $450/A investment cost, the payback period ranges from 8 to 16 years, depending on the price of wheat and the yield increase. The lowest yield increase assumed (8 bu/A) would require a 14-16-yr payback according to this analysis. The estimated IRR ranges from near zero to 6% for these assumptions. For the $200/A investment level, IRR ranges from 10 to 27% and the payback period from 3.5 to 7 years. There are several important points to keep in mind when interpreting these results:

1) The longer the life of the drainage system, the greater the IRR (systems are expected to last for 50 years or more)
2) Increases in annual expenses due to tile drainage will decrease the IRR and increase the payback period
3) Decreases in annual expenses increase the IRR and decrease the payback period
4) The after tax IRR will be lower than the before tax basis, used in this analysis



The examples above are for wheat. Keep in mind that the return potential may be significantly increased for higher value crops such as sugarbeets, dry beans, potatoes, vegetable crops, etc.

Here is the big question: what should a farmer do in regard to tile drainage? Some farmers look at the cost of tile drainage and immediately discount it as a practice for them. However, what is most important is not what it costs, but what it returns. Every farmer has a different set of financial and field conditions, so it is a site specific decision – there is not one answer for every farm. However, I think there is a process that every farmer can go through to assess the potential for tile drainage on their farm. Here is what I recommend:

1) Seriously consider tile drainage as on option on your farm. Give it a fair look. Tiling is costly, but it is not prohibitive. At $350/A you can tile a 40 acre field for $14,000.

This may turn out to be a very small price to pay to find out how tile will work on your farm.

2) Gather information on tile drainage. An excellent source of information is this web site: http://d-outlet.coafes.umn.edu/
3) Identify the fields or parts of fields that would benefit the most from tile drainage.
4) Put the pencil to it. Estimate, based on past experience with these fields, how much yield increase you think you would get if you could reduce the water problems. Also consider the efficiency benefits to the whole farming operation if you didn't have to work around wet spots and wet fields.
5) Have a tile drainage contractor give you an estimate on tiling one or more areas. Even if you don't do it, it doesn't hurt to know what it would cost.
6) Tile one or more needy areas, then closely observe results. Or, closely observe tiled fields of other farmers in your area. Talk to them and see what they are observing. The number of farmers in Northwestern Minnesota and Eastern North Dakota with some tile in the ground has greatly increased in recent years. Find out who they are and talk to them about the results they are getting.