Tile Drainage: some basics

Stewart Brandt
Northeast Agriculture Research Foundation
Melfort, SK.
Outline

• The Basics of Soil Water
• Why tile drainage
• How it works
• NARF tile drainage project
The Hydrologic Cycle
Relationship Between Soil Texture and Soil Water

Inches of Water per Foot of Soil

- Field Capacity
- Permanent Wilting Point
- Available Water
- Unavailable Water
Water tables are higher in NE SK than they have been in the past 50 yr
Observation Well Data Available at:

www.wsask.ca

(Water Security Agency  Moose Jaw)
Why Tile Drainage?

• Excess water regularly limits crop production
  – Roots need oxygen to function, and saturated soil has no oxygen

• Potential to correct saline soil by leaching out salts
Tile Drainage Effect on Crops
Canola and barley in saturated soil
Removal of excess water

- Increases water use by crops
- Increases crop growth and grain yield
- Increases temporary storage space in soil for water from rains or spring runoff.
- Reduces surface runoff and delays peak streamflow after rains.
- Can leach salts from saline soil.
- Allows more timely field operations with lower equipment costs.
Drained soil can benefit from subsoil moisture

Capillary rise of moisture
# Yield Improvement (%) with Tile Drainage

<table>
<thead>
<tr>
<th>Crop</th>
<th>Manitoba(^1) 1990’s</th>
<th>Ontario(^2) 1979-1986</th>
<th>Iowa(^3) 1984-1986</th>
<th>Ohio(^4) 1962-1980</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring grains</td>
<td>20</td>
<td>22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Winter wheat</td>
<td>17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>20</td>
<td>26</td>
<td>10-45</td>
<td>20-30</td>
</tr>
<tr>
<td>Soybean</td>
<td>7</td>
<td>4-15</td>
<td>7-14</td>
<td></td>
</tr>
<tr>
<td>Potato</td>
<td>10-50</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) Verbally reported in surveys; \(^2\) Irwin, 1997; \(^3\) Kanwar et al 1988; \(^4\) Schwab et al 1975, and Schwab et al 1985
DRAINMOD Results – Red River Valley ND
Sands, 2011; Sands et al. 2013
Producer Results from MB 1990s –
Anecdotal - Largest Tiled Farm Reported Benefits

• • BENEFITS SEEN !
• – Earlier start
• – Reduced drown out
• – Access for spraying and cultivation
• – Compaction reduced
• – HOPE for salinity reduction
• – Better timing and utilization of fertilizer/pesticides
• – Decreased surface runoff
Where Tile Drainage Fits Best

- High value crops
- Coarser textured soils
- Crops with low tolerance to excess water
- Level topography
- Large amounts of surface residues
- Poor surface drainage
- Ample or excessive precipitation
- Seeding and harvest times are critical
## Parallel Drain Spacing and Depths (ft)
(Source: University of Minnesota)

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Soil permeability</th>
<th>Good drainage</th>
<th>Excellent drainage</th>
<th>Drain depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay loam</td>
<td>Very low</td>
<td>50</td>
<td>35</td>
<td>3.0-3.5</td>
</tr>
<tr>
<td>Silty clay loam</td>
<td>Low</td>
<td>65</td>
<td>45</td>
<td>3.3-3.5</td>
</tr>
<tr>
<td>Silt loam</td>
<td>Mod Low</td>
<td>90</td>
<td>60</td>
<td>3.5-4.0</td>
</tr>
<tr>
<td>Loam</td>
<td>Moderate</td>
<td>140</td>
<td>95</td>
<td>3.8-4.3</td>
</tr>
<tr>
<td>Sandy loam</td>
<td>Mod high</td>
<td>210</td>
<td>150</td>
<td>4.0-4.5</td>
</tr>
</tbody>
</table>
Drainage pipes or "tile"

Flow to main or ditch

Water table

Saturated soil
Tile Designs

- **Parallel**
- **Herringbone**
- **Double Main**
- **Targeted**
Parallel

- most commonly used design
- usually the most efficient and cost-effective
- The header pipe is installed along the field edge (or edge of the area to be tiled) and the laterals tee in at regular intervals.
Targeted

• designed to target smaller problem areas where other parts of the field do not require drainage.
• Usually a main pipe will be installed and then submains and laterals branch off it.
• This method is best suited to rolling land or fields with springs or salinity pockets.
Where will the water go?

- A tile installation is only feasible if there is a viable outlet
- Point of adequate discharge
Tile Drainage Project

• Initiated in fall 2014
• Funded by co-operating farmer, NARF, ADOPT and Shark Ag consulting
• 40 acre site 1 mile E of Melfort Research Farm
Tile Drainage Project

• Salinity mapping done in summer of 2014 prior to tile installation
• Tile drainage system engineered and installed Oct. 2014.
• 3 piezometer wells installed to approximately 10 ft depth.
  – Well 1: on tile drained perennial forage – installed fall 2014
  – Well 2 on undrained cultivated cropland. Installed fall 2014
  – Well 3: on un-drained perennial forage – installed spring 2015
• Water sampled from wells and outlet for EC measurement starting in fall 2014.
Site Map - Salinity
Tile drains
Perennial forage
Cultivated
Melfort creek
Tile Drainage Project

• Water levels in wells measured weekly from early spring to freeze up.
• Water flow measured at outlet commencing in early spring and continuing until freeze-up.
• Weekly water sampling for EC measurements at the outlet
Tile Drainage Project Evaluation

• Measure forage yield from the drained and un-drained forage areas.
• Obtain yield maps for the cropped area of the field annually.
• Repeat salinity mapping at 5 year intervals.
Results to Date

• Water began flowing as soon as tiles installed. And continued past freeze – up.
• Initial EC was 8000 at outlet and 9000 in the creek.
  – Interesting that creek > than outlet: ie most creek flow is due to subsoil seep into creeks.
• Water continued flowing until early Dec of 2014.
Spring 2015

- Water table was above the top of the well on undrained cultivated land after wet snow in May.
- On un-drained forage water table was within 1 ft of surface in mid-May.
- Drained areas, water table was slightly above tiles.
Results continued

- Impossible to measure when flow began in spring as creek was above outlet.
- First flow measurements made in late April 2015.
- Flow increased after each rainfall event, soil was at or near field capacity above drains.
- Flow decreased to zero by July 20, 2015, but resumed July 27 (5.5 inch rain over 6 hr).
Results

• EC tends to decline after precipitation events, and increase during periods of low precipitation.
  – Range 4000 to 9000.

• In total we have drained in excess of 2 million gallons of salty water from the site
  – Total exceeds 2.5 acre inches.
Results

• No apparent effect on forage yield BUT drained area was highly saline, and undrained much less affected by salts.

• No sign of flooding damage in 2015 Canola crop on drained area.
SUMMARY

• Tile drainage is permitted but requires approvals
  – Water Security Agency
  – Know point of adequate outlet

• Tile drainage is a long term investment
  – Not unlike buying or clearing more land

• Tile drainage likely has much less detrimental impact than surface drainage
  – Slower water discharge and increased temporary storage
  – Less soil disruption

• Tile drainage requires careful planning and consideration
  – Best to have designed professionally
Acknowledgements

The project was supported by the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canada-Saskatchewan Growing Forward 2 bi-lateral agreement.

Technical support from Jessica Pratchler, Stephanie Ginter, Gayelene Daqenais, Jillian Anderson, Rikki Schick