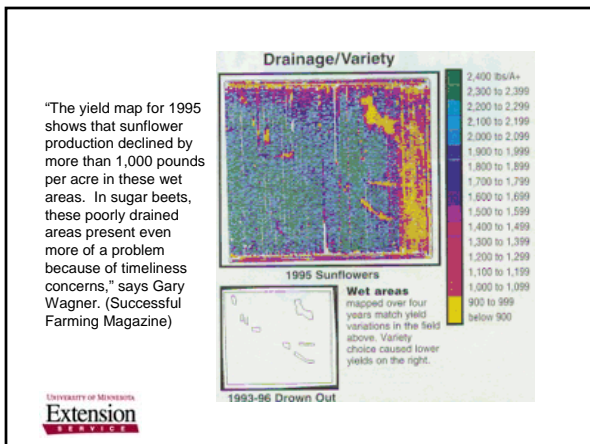
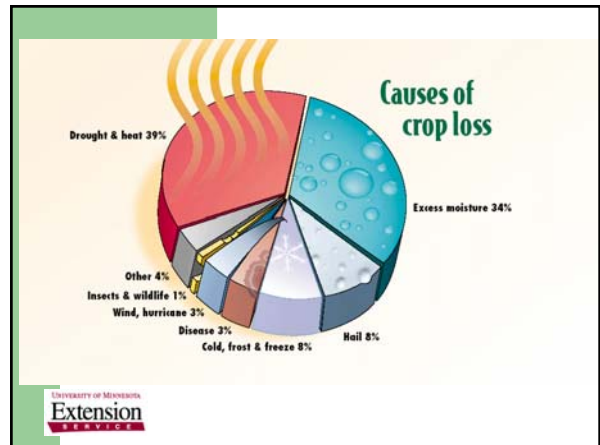
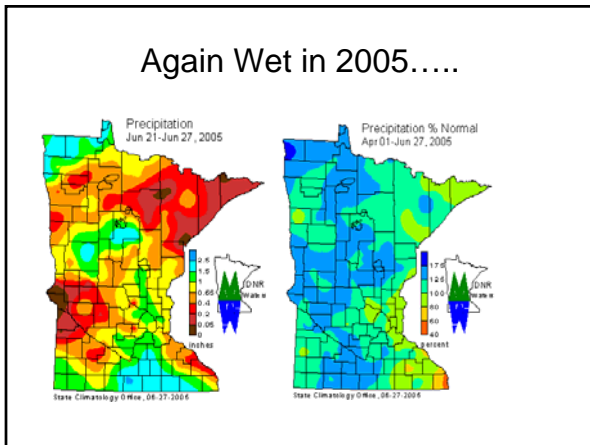
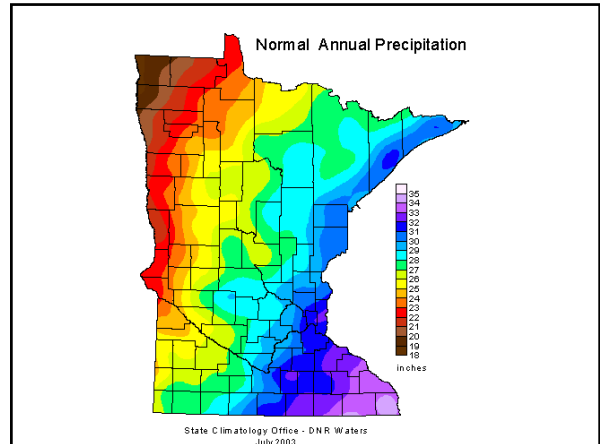


Subsurface Drainage – Reducing Production Risks and Yield Losses

Hans Kandel Ph.D.
U of M Extension Service
Regional Extension Educator



"The yield map for 1995 shows that sunflower production declined by more than 1,000 pounds per acre in these wet areas. In sugar beets, these poorly drained areas present even more of a problem because of timeliness concerns," says Gary Wagner. (Successful Farming Magazine)

"Yield monitoring and mapping techniques have helped identify more than 40 factors that affect yields on our farm."

Roughly half of those are environmental conditions that we can't do anything about, but there are enough factors we can manage to more than pay for the technology," says Gary Wagner.

Yield maps have sold more tile than most salesmen.



"Drainage problems pop up on yield maps more often than any other problem," says Ken Ferrie, Farm Journal field agronomist.

University of Missouri Extension

The Wagner's list a dozen of these "manageable" factors that repeatedly occur.

The list includes drainage, variety selection, insect/weed control, crop rotation, tillage, compaction, soil pH, herbicide, seedbed conditions, fertilizer placement, and fertility.

"It's no accident that drainage is first on this list and that fertility is last," says Gary.

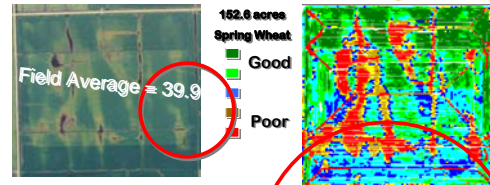
University of Missouri Extension

Water Management



Courtesy of Gary Wagner

Cost of Poor Drainage



- < 15 bushels	21.3 a	14%
- 15 to 30 bus	22.6 a	19%
- 30 to 35 bus	18.7 a	12%
- 35 to 40 bus	37.4 a	25%
- 40 to 45 bus	22.2 a	15%
- 45 to 50 bus	12.6 a	8%
- > 50 bushels	17.8 a	5%

Loss = (\$2,484) for Wheat (\$16.30) / acre

Sugarbeets = (\$30,520)

(\$200) / acre

Soybeans = (\$9,919)

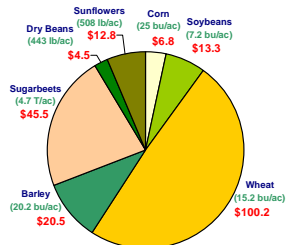
(\$65) / acre

Excess Water in The R R Basin



Estimated Economic Impact

\$203,600,000 per year



"Father" of Tile Drainage in U.S.

John Johnston, who in 1835, laid the first drain tile in the wet clayey soil on his farm (Geneva, New York). By 1856 he had laid over 51 miles of drain tile on his farm enabling wheat yields to be doubled.

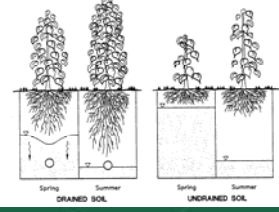


Benefits of tile drainage

- Increased crop yields are experienced with improved soil conditions.
- Soil erosion will be substantially decreased because water will filter into the tile lines instead of running over farmland to waterways.
- Less runoff of nutrients like phosphorous

Benefits of tile drainage

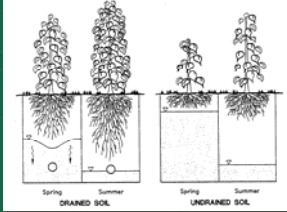
- Roots grow deeper into the ground and develop a more vigorous root system so crops are better equipped to withstand drought conditions.



The diagram shows two cross-sections of soil. The left side is labeled 'DRAINED SOIL' and shows a plant with a deep, extensive root system reaching down to a horizontal line representing a tile. The right side is labeled 'UNDRAINED SOIL' and shows a plant with a much shallower and less developed root system. Both sides are labeled 'Spring' and 'Summer' at the bottom.

Benefits of tile drainage

- Better utilization of water (a wheat crop that yields 10bu/A more uses 3 extra inches of water).



The diagram shows two cross-sections of soil. The left side is labeled 'DRAINED SOIL' and shows a plant with a deep root system. The right side is labeled 'UNDRAINED SOIL' and shows a plant with a shallower root system. Both sides are labeled 'Spring' and 'Summer' at the bottom.

Benefits of Tile drainage

- Soil damage will be reduced from compaction caused by working heavy wet soils.
- Extended growing and harvesting seasons since they will be able to begin planting and harvesting sooner.
- No more waiting for an entire field to be free of wet spots before working the field.

Benefits of Tile Drainage

- Uniform yields on the whole field.
- Soil acts like a sponge to take full advantage of the rains.
- Bacteria needs oxygen to break down the elements in the soil.
- Wider selection of crops and varieties due to less crop limitations.

Benefits

- Saves wear and tear on equipment.
- Not as many breakdowns. Save on parts and labor.
- Lower fuel costs, easier to work fields when soil is friable.
- Tiling is very important where organic systems are used.

Benefits

- Well drained farmland fetches a premium price when sold.
- Rental rates for tile drained land are higher than non-tiled land.

Canadian Example

Crop	Un-drained bu/a	Drained bu/a	Increase in yield in %
Soybean	31	38	23
Wheat	45	61	36
Corn	88	123	40

Pro Drainage Farm Drainage Contractors, Ontario
www.drainage.org/factsheets/fs11.htm

Canadian Example

Crop	Un-drained lb/a	Drained lb/a	Increase in %
Sunflower	1091	1418	30
Canola	1350	1554	15

Pro Drainage Farm Drainage Contractors, Ontario

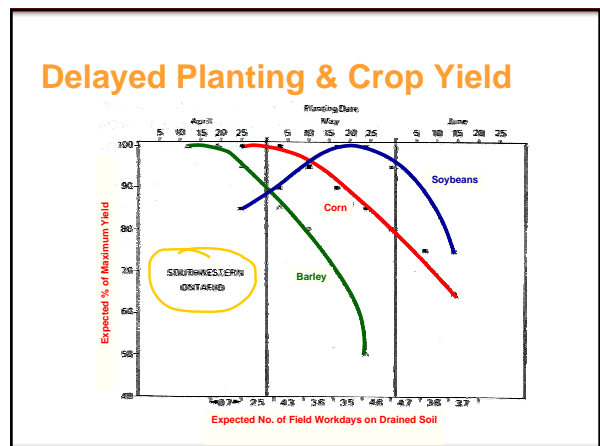
Yield Increase From Tile Drainage:

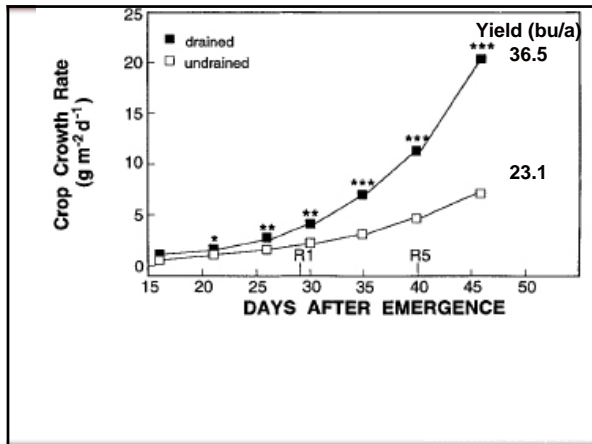
- Iowa: Corn – 10 to 45 Bu/A
Soybeans – 4 to 15 Bu/A
- Ohio: Corn – 12 to 24%
Soybeans – 10 to 20 %
- NW MN: Wheat, Soybean and sugarbeets 10%??

Drainage Effects on Corn Yields – Ohio, 13 Year Study

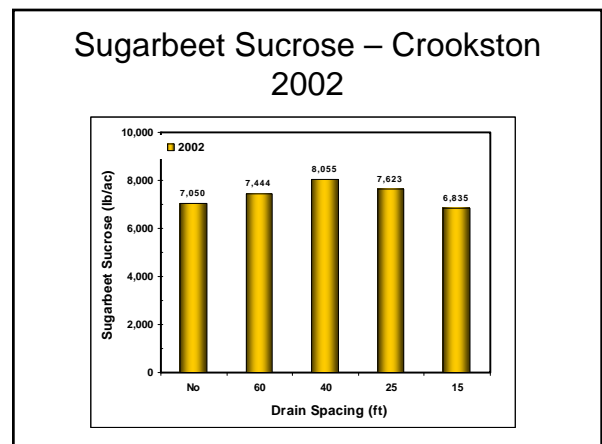
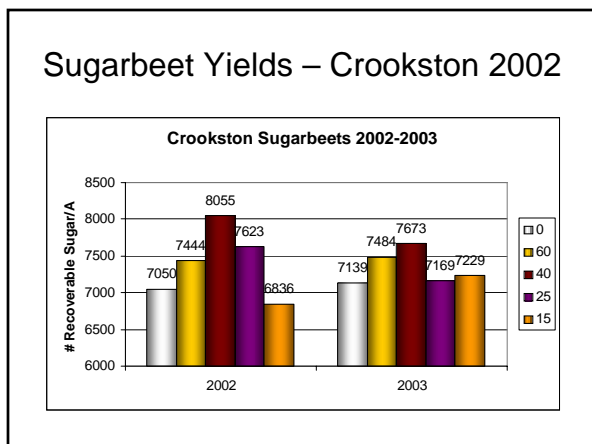
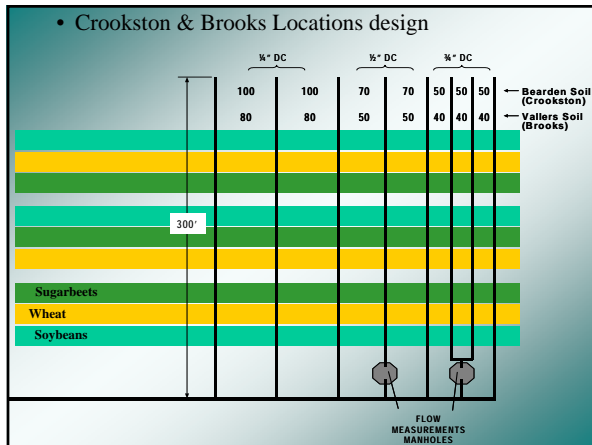
Treatment	Bu/A	C.V.%
Undrained	60	46
Surface	92	33
Subsurface	116	18
Combination	121	17

(Source: G.O. Schwab, 1984)

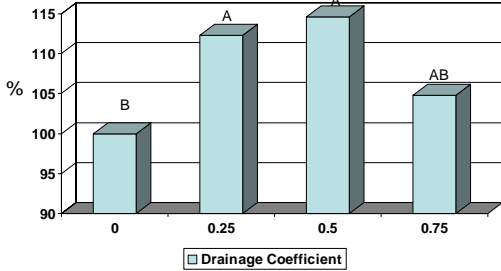




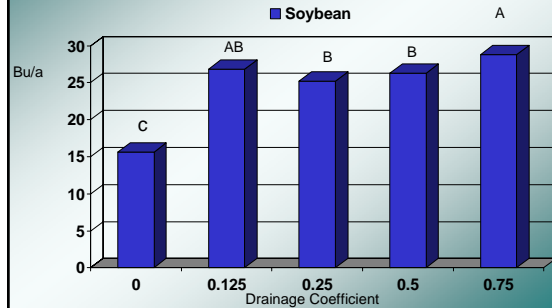
- ### Experimental Details
- Three crops: Wheat, Soybean, Sugarbeet
 - 0, ¼, ½, ¾ inch water removal / 24 hrs
 - Automated water table monitoring to 5ft
 - Automated soil moisture and temps
 - Computer modeling to characterize crop response for range of climatic variability



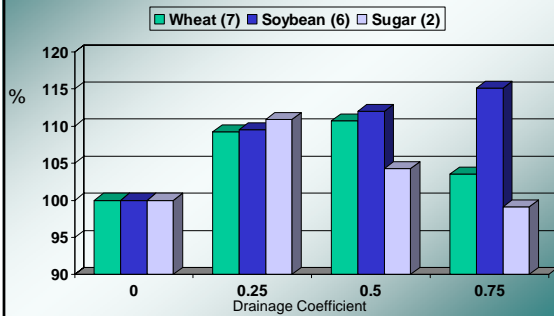
Average Wheat Yield In % of non-tiled plot, Crookston 02-03 and Brooks 01-03



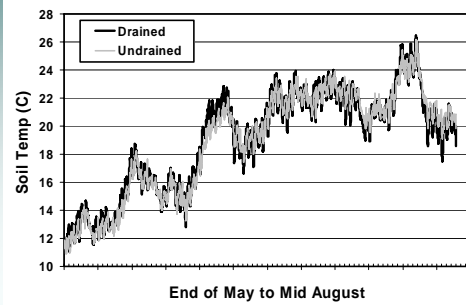
Soybean Yield in Bu/A, Crookston 2004



Average Wheat, Soybean, and Sugar Yield In % of non-tiled 2001-04

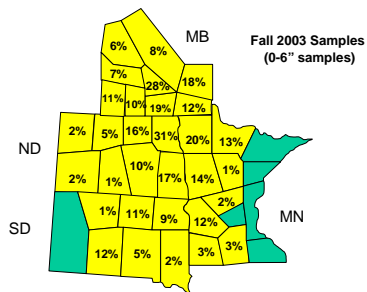


2001 Soil Temps at Brooks

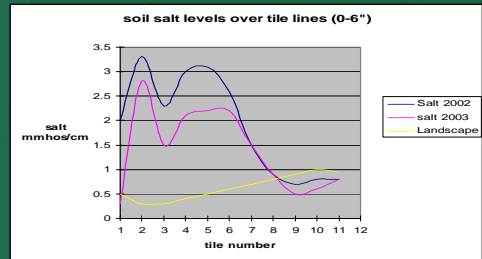


Prevalence of High Salt Soils (Agvise)

% Soil Samples with Salts greater than 1.0



Reduction of Salt





Managing Saline Soils

- The only way to remove salts is to leach them out.
- Tile drainage permanently lowers the water table and provides an outlet for excess water.
- Time required to reduce salt levels depends on:
 - Soil characteristics
 - Amount of water removed through tile

Late season flow

Tile can run long into the fall season and create a storage capacity in the spring. Less likely to get winter kill in winter wheat or alfalfa

www.nstf.gov/research/nitrogen/iddm.html

A photograph of a tile drainage pipe outlet with water flowing out into a ditch.

Denitrification (anaerobic)

13 different bacteria:
 $NO_3^- \rightarrow NO_2^-$, NO, N₂O, N₂
 Nitrate to gaseous forms of N
 (nitrite, nitric oxide, nitrous oxide, N gas)

A photograph of a field with standing water, indicating waterlogging conditions where denitrification occurs.

Can lose up to 2-4 pounds/acre/day

Denitrification (anaerobic)

Can lose up to 2-4 pounds/acre/day
 Prices of Urea 300/ Ton = 30 ct /lb

Loss 60 ct /acre/day x 3 to 4 days =
 \$1.80 loss /acre per saturating rain event.

Soil Management

- Need to build or maintain organic matter
- 10% increase in wheat yield (5-6 bushel) will give 350 lb more dry matter (straw) to be added to the soil.
- Reduce tillage and maintain 30% residue coverage (less blowing soil \$2.50 /acre)
- Reduced cleaning of ditches \$0.50 /acre
- 4-5 bushel more soybean will give 3 lb higher N credit per acre = \$ 0.60 / acre
- Increase crop rotation effects with more crops

Effect on the whole farm

- Plant crop one day earlier in the spring
- Rest of the farm will finished planting one day earlier
- Average yields decrease 1% a day
- Increased yield on non tile drained fields
1% of 50 bushel wheat = 0.5 bushel x 3.25 = \$ 1.63 per acre

External Benefits \$

- N retained per rainfall event \$1.80 / a
- Less blowing soil \$2.50 / a
- Reduced cleaning of ditches 50 ct / a
- Higher N credit per acre = 60 ct / a
- Chisel 32 ct / a + Seeding 38 ct / a
- Better quality 50 ct / a
- Harvest efficient = 50 ct / a + loading 10 ct
- \$ 1.63 increase per acre non tiled
- Total of these external benefits = \$ 8.83

External Benefits \$


- Timeliness of planting
- Herbicide application
- Fungicide application
- Harvest
- Fall tillage
- Total risk management of the operation
- Sleep
- Less stress



Will tiling pay on your farm? Rented land?

Would a landlord consider investing in tile drainage?

How much more rent would a producer be willing to pay if your landlord invested in tile drainage?




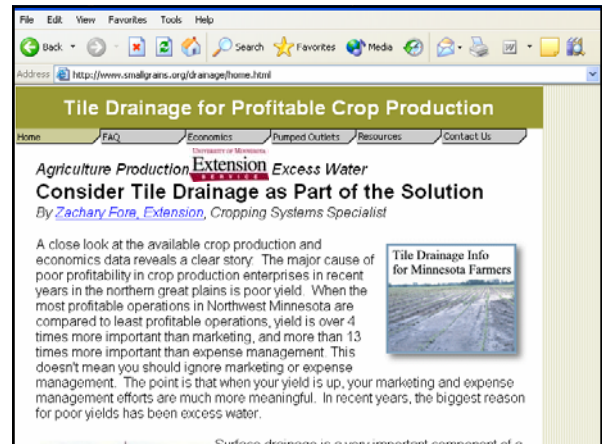
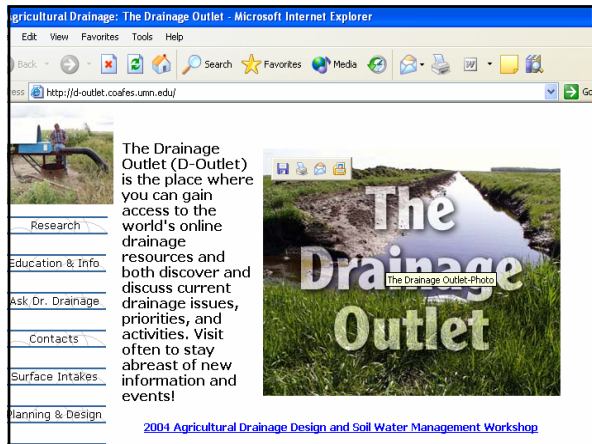
Summary Of Average Land Rents

Year	Average	Percent of Tiled Acres				Responses	
		100	75	50	25		0
<i>\$/Acre</i>							
1998	97.65	104.70	100.93	101.03	94.62	86.99	1,743
1999	100.63	106.78	102.66	102.10	97.97	93.62	1,557
2000	102.19	106.82	106.60	101.40	101.65	94.46	1,607
2001	102.46	109.24	105.51	103.04	103.72	90.80	1,515

MN Counties: Blue Earth, Faribault, Le Sueur, Nicollet, Sibley, and Waseca

Data Provided by Gary Hachfeld, Extension Educator, Nicollet County





What to do About Tile Drainage on Your Farm

1. Seriously consider tile drainage as an option on the farm. Give it a fair look. Tiling is costly, but it is not prohibitive. At \$500/A you can tile a 40 acre field for \$20,000. 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/>

What to do About Tile Drainage on Your Farm

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.

What to do About Tile Drainage on Your Farm

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. they are getting.

Negatives of Tile Drainage

- Nitrates may increase in drain water
- New technology for ND and NW MN
- Risk of investment
- It is addictive!