

# 2006

## Solution Days

# *Agricultural Water*

# *Management Strategies*

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2006 University of Nebraska-Lincoln Extension  
Solution Days

# Agricultural Water Management Strategies

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Gary Zoubek, *UNL Extension Educator*

2006soldays-water001

**NEW** **N51-T8**  
RM: 104 (NX5334)



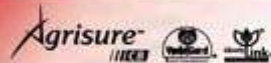
Top-end yield punch and good drought tolerance make an exceptional hybrid. N51-T8 has excellent roots to help resist lodging for smoother harvest. Starts fast with strong emergence and seedling growth. N51-N4 is the conventional version. HES Extra Edge™ hybrid.

#### For Best Performance

- Best on more productive soils & in crop rotation
- Suited for irrigated or dryland fields with good water holding capacity
- Excellent choice for early planting or fields with high residue

2006soldays-water002

**N65-C5**  
RM: 109



Top-end yield punch and consistency. Good ear flex and excellent drought tolerance of N65-C5 enhances its adaptability and use. DGE and HES Extra Edge™ hybrid. N65-M7 is the conventional version.

#### For Best Performance

- Use moderate planting rates
- Manage fields to promote early root growth
- Use caution with growth regulator herbicides

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**N70-T9**  
RM: 112



Broadly-adapted high performance hybrid is a true market leader. N70-T9 also provides herbicide flexibility and corn borer protection. Rapid stand establishment and very good drought tolerance help maintain top yield. DGE & HES Extra Edge™ hybrid.

#### For Best Performance

- Excellent choice for both irrigated and dryland
- Works well across a wide range of populations
- Use caution when using growth regulator herbicides

2006soldays-water004

## N76-D3

RM: 114



High-yielding, dependable hybrid well-adapted for a wide range of growing conditions. N76-D3 has very good drought tolerance, ear flex and some GLS protection. N76-H2 is the base genetics. HES Extra Edge™ hybrid.

### For Best Performance

- Plant early when conditions permit
- Use moderate populations
- Good choice for either irrigated or dryland fields

2006soldays-water005

## WHY IRRIGATION MANAGEMENT IS IMPORTANT?

- Energy saving
- Environmental impacts
- \$\$\$\$
- Limited water supply-water allocations
- Higher crop water use efficiency

2006soldays-water006

## PUMPING COST

### ASSUMPTIONS:

Pumping lift	= 100 ft
Pump pressure	= 35 PSI
System flow rate	= 800 GPM
Electric HP	= 49

### Energy Costs

Diesel (\$/gal)	= 2.60
Propane (\$/gal)	= 1.50
Natural Gas (\$/mcf)	= 11.50
Electric (\$/kWh)	= 0.06
Electric HP charge (\$/hp)	= 34.50

Acres irrigated	= 130
Irrigation water applied	= 12 inches

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## PUMPING COST (\$ac-in)

DIESEL	PROPANE	NATURAL GAS	ELECTRIC
\$4.30	\$4.50	\$3.85	\$2.73

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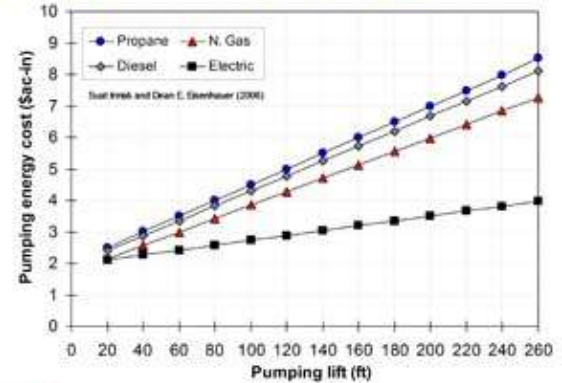
## As pumping lift increases your pumping cost increases

P. lift (ft)	\$ac-in			
	Diesel	Propane	N. Gas	Electric
20	2.40	2.51	2.15	2.11
40	2.87	3.01	2.57	2.26
60	3.35	3.51	3.00	2.42
80	3.83	4.00	3.43	2.57
100	4.30	4.50	3.85	2.73
120	4.78	5.00	4.28	2.88
140	5.25	5.49	4.71	3.04
160	5.72	5.99	5.13	3.19
180	6.20	6.49	5.56	3.35
200	6.68	6.99	5.98	3.51
220	7.15	7.49	6.41	3.66
240	7.63	7.98	6.86	3.81
260	8.10	8.53	7.26	3.97

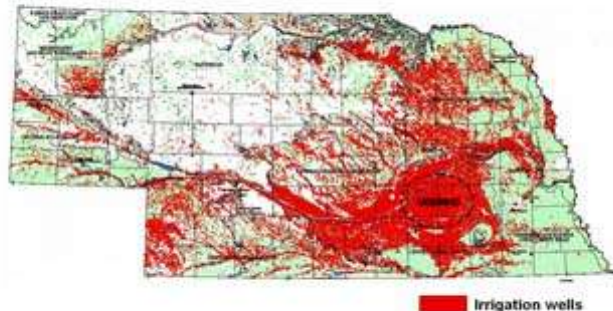
Soat Irmak and Dean E. Eisenhauer (2006)

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## As pumping lift increases your pumping cost increases

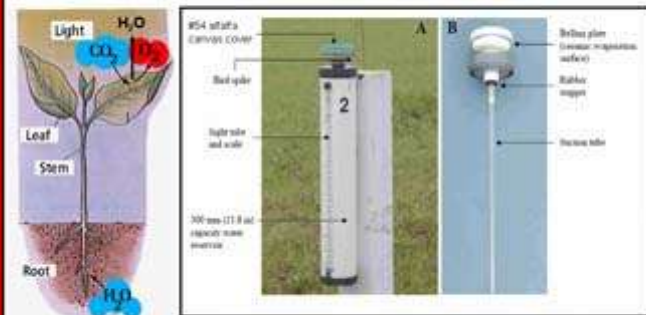


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2006soldays-water011

## ATMOMETERS (ETgage)



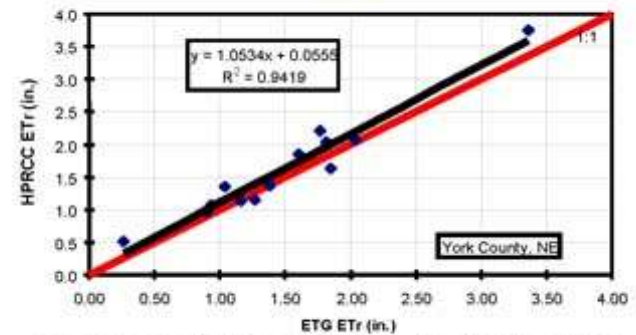
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## Where to install?



2006soldays-water013

## Performance of ETgage (7-day total)



From Irmak et al. (2005) Nebraska Agricultural Water Management Demonstration Network, NAWMDN

2006soldays-water014

## How to use an ETgage for irrigation management?



### Using Modified Atmosmeters (ET<sub>g</sub>)<sup>®</sup> for Irrigation Management

Just Irmak, Joel O. Powers and David L. Martin  
Extension Water Resources/Irrigation Engineers

This NebGuide describes the atmosphere (crop-transpiration) gage and explains how it can be used for irrigation scheduling. Examples are provided to show how information collected with an atmosphere can be used to estimate crop water use for corn and soybeans.

2006soldays-water015

$$\text{Crop water use} = \text{ET}_r \times K_c$$

From ETgage

From ETgage NebGuide

2006soldays-water016

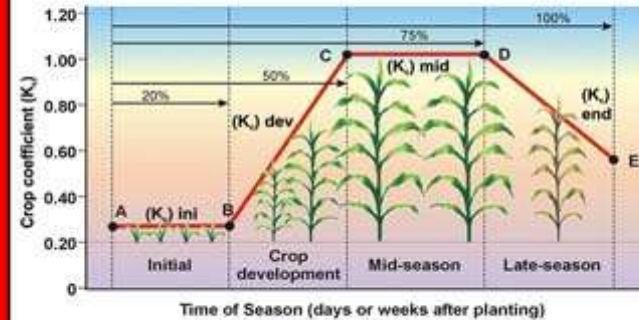
## Crop coefficient (Kc)

Table 1. ARS/US-based crop coefficient (Kc) at the beginning of each growth stage for corn, sorghum, and wheat (High Plains Regional Climate Center, 2002).

Corn		Sorghum		Wheat	
Growth Stage	Kc	Growth Stage	Kc	Growth Stage	Kc
2 leaves	0.05	Cotyledon	0.20	Emergence	0.10
4 leaves	0.15	First Node	0.25	Visible Canopy	0.70
6 leaves	0.25	Second Node	0.40	Leaf Emergence	0.80
8 leaves	0.35	Third Node	0.60	Heading	1.00
10 leaves	0.45	Beginning Grain	0.70	Beer	1.10
12 leaves	0.60	Full Grain	1.00	Drinking	1.10
14 leaves	1.00	Beginning Fall	1.30	Flouring	1.30
16 leaves	1.30	Full Fall	1.50	Grain Fall	1.10
18 leaves	1.20	Beginning Seed	1.50	Soft Dough	1.00
19 leaves	1.10	Full Seed	1.30	Ripening	0.70
20 leaves	1.00	Beginning Maturity	0.90	Mature	0.10
21 leaves	0.90	Full Maturity	0.70		
22 leaves	0.80				
23 leaves	0.70				
24 leaves	0.60				
25 leaves	0.50				

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## Crop coefficient (Kc)



2006soldays-water018

## Soybean Growth Stages

### Soybean Growth Stage Terms

- Emergence (VE): Hypocotyl pushes through soil surface.
- Cotyledons (VC): Unfolding endosperm of specialized seed leaves.
- 1- trifoliate (V1): First node containing 3 leaflets of 1 full leaf.
- R0: Seed produced.



Multiply Weekly ETgauge reading change by:

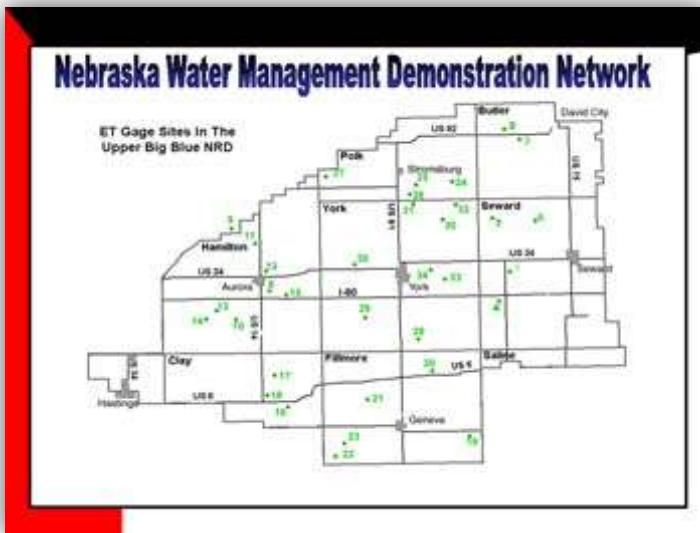
VC = .1 V1 = .20 V2 = .40 V3 = .60 R1 = .90 R2 = 1.0 R3 = 1.10  
R4 = 1.10 R5 = 1.10 R6 = 1.10 Beginning Mature = .90 Fully Mature = .20

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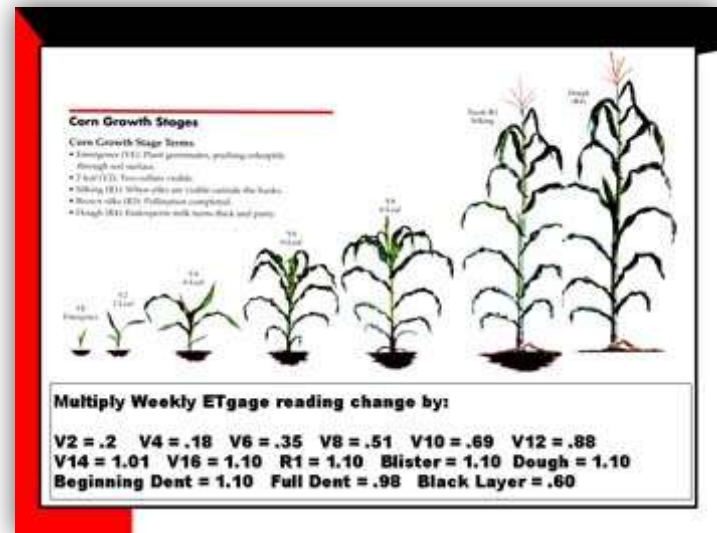
## Solution Site Weekly ET Readings

Date	Weekly EI	Crop Stage	Factor	Crop EI
6/12/06	2.30	V6	.35	.81
6/19/06	1.75	V8	.51	.89
6/26/06	1.75	V10	.69	1.21
7/3/06	2.00	V12	.88	1.76
7/10/06	1.50	V14	1.01	1.51
7/17/06	1.63	V16	1.10	1.79
7/24/06	1.85	R1	1.10	1.82
7/31/06	1.90	R1	1.10	2.09
8/7/06	1.70	Blister	1.10	1.87
<b>Total</b>	<b>16.18</b>		<b>Total</b>	<b>13.75</b>

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2006soldays-water021



2006soldays-water022

## Example

Corn is at 12-leaf growth stage and the water level in the ETG (with a No. 54 canvas cover) sight tube decreased 1.30 inches during the 7-day period since the last irrigation. Determine the actual crop ET (ET<sub>c</sub>), net irrigation requirement (NIR), and the gross irrigation requirement (GIR) if irrigation is applied with a center pivot with an irrigation efficiency of 90 percent (IE = 0.90). Rainfall = 0.

ET<sub>r</sub> = 1.30 inches (evaporation from the ETG)

K<sub>c</sub> = 0.88 (from Table / for the 12-leaf stage)

ET<sub>c</sub> = ET<sub>r</sub> × K<sub>c</sub>      ET<sub>c</sub> = 1.30 inches × 0.88 = 1.1 inches

NIR = ET<sub>c</sub> – Rainfall      NIR = 1.1 inches – 0 = 1.1 inches

GIR = (NIR) / (IE)      GIR = 1.1 inches / 0.90 = 1.2 inches

2006soldays-water023

## How to use Watermark sensors for irrigation management?

Nebraska **EXTENSION**  
Lincoln

EC783

### Watermark Granular Matrix Sensor to Measure Soil Matric Potential for Irrigation Management

Scott Irwin, Isaac O. Peters, Dean E. Eisenhauer, William L. Krutz, Dennis L. Martin, Gary L. Zoubek, Jennifer M. Ross, Andrew P. Christiansen, Dan Leisinger

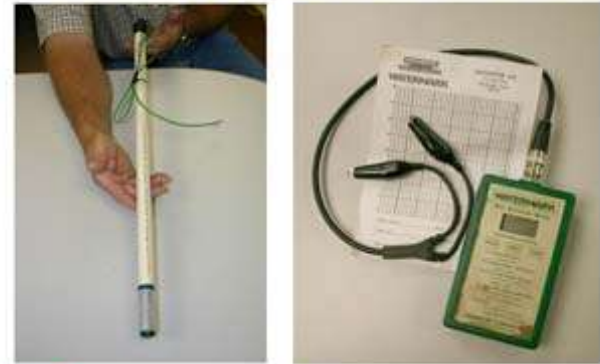
2006soldays-water024

## Monitoring Soil Water

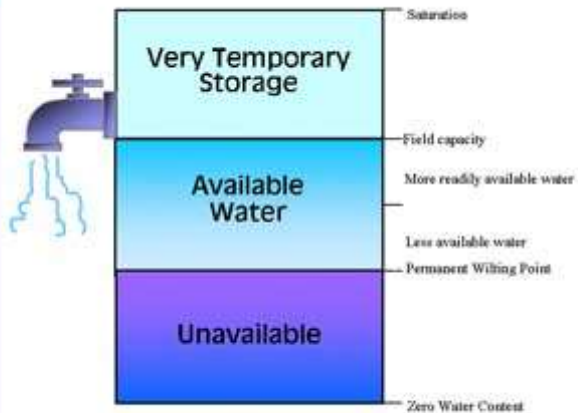


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## Monitoring Soil Water

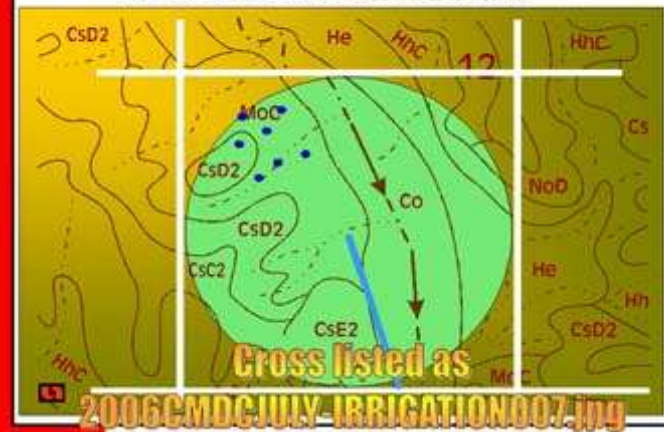


2006soldays-water026



2006soldays-water027

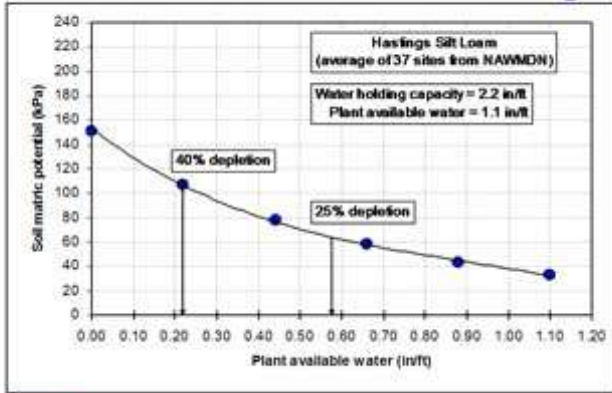
## Monitor Soil Water During Scouting



2006soldays-water028



### Relationship between plant available water and Watermark readings



2006soldays-water029

### Solution Site Weekly Irrigation/Rain

Date	Rain/Irrigation	Estimated Crop ET	13.75*
6/21/06	.18 rain		
6/17/06	.90 rain		
6/21/06	.10 rain	Rainfall	4.07
6/22/06	.30 rain	Irrigation	6.70
6/29/06	1.00 irrigation	Soil Depletion	1.68
7/3/06	1.30 irrigation	Total	12.45
7/11/06	1.30 irrigation		
7/14/06	.60 rain		
7/21/06	.60 rain		
7/25/06	1.50 irrigation		
7/31/06	1.60 irrigation		
8/2/06	.50 rain		
8/7/06	.89 rain		

Watermark Sensor Readings 8/7/06		
1'	18	1.10
2'	74	.46
3'	134	.08
4'	149	.02

Soil moisture status = 1.62 \*

2006soldays-water030

### Solution Site Weekly Irrigation/Rain

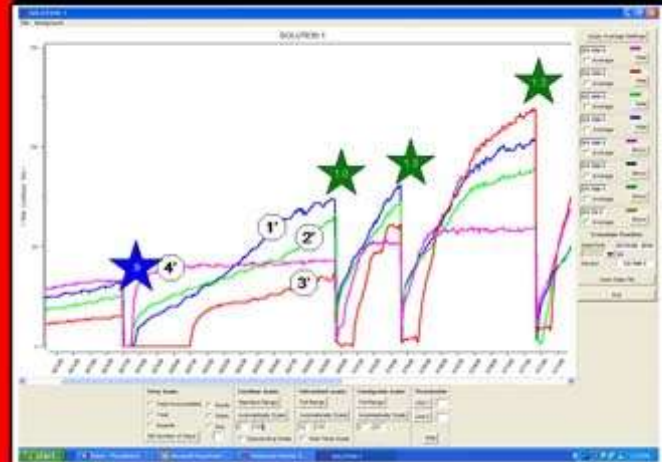
Date	Rain/Irrigation	Estimated Crop ET	13.75*
6/21/06	.18 rain		
6/17/06	.90 rain		
6/21/06	.10 rain	Rainfall	4.07
6/22/06	.30 rain	Irrigation	6.70
6/28/06	1.00 irrigation	Soil Depletion	1.68
7/3/06	1.30 irrigation	Total	12.45
7/11/06	1.30 irrigation		
7/14/06	.60 rain		
7/21/06	.60 rain		
7/25/06	1.50 irrigation		
7/31/06	1.60 irrigation		
8/2/06	.50 rain		
8/7/06	.89 rain		
8/8/06	2.80 rain		
8/10/06	.18 rain		

Watermark Sensor Readings 8/8/06		
1'	5	1.10
2'	3	1.10
3'	3	1.10
4'	30	1.10

Soil moisture status = 4.40 \*

2006soldays-water031



2006soldays-water032



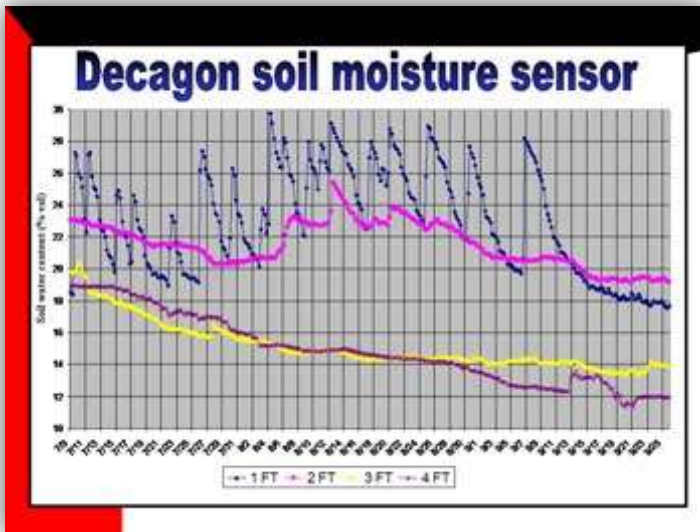
2006soldays-water033

Soil type, depletion in inches per foot associated with a given soil matrix potential value measured by the Watermark sensors, and available water holding capacity for different soil types

Soil matrix potential (kPa)	Soil type, depletion in inches per foot associated with a given soil matrix potential value measured by the Watermark sensors, and available water holding capacity for different soil types							
	Silty clay loam topsoil, Silty clay subsoil (Sharpberg)	Silt loam topsoil, Clay loam subsoil (Keith)	Upland silt loam topsoil, Silty clay loam subsoil (Hastings, Coche, Holdrege)	Bottom land silt loam (Webster, Hall)	Fine sandy loam	Sandy loam	Loamy sand (O'Neill)	Fine sand (Valentine)
0	0	0	0	0	0	0	0	0
20	0	0	0	0	0.20	0.30	0.30	0.30
31	0.20	0.14	0	0	0.55	0.50	0.45	0.55
50	0.45	0.36	0.32	0.30	0.80	0.70	0.60	0.70
60	0.50	0.40	0.47	0.44	1.0	0.80	0.70	0.70
70	0.60	0.50	0.59	0.50	1.10	0.80	0.80	0.80
80	0.65	0.55	0.70	0.60	1.20	1.00	0.95	1.00
90	0.70	0.60	0.78	0.70	1.40	1.20	1.00	-
100	0.80	0.60	0.81	0.80	1.60	1.40	1.10	-
150	0.90	0.66	1.00	1.20	-	-	-	-
200	1.00	0.95	1.20	1.20	-	-	-	-
Available water capacity (in/ft)	1.8-2.0	1.8-2.0	2.2	2.0	1.8	1.4	1.1	1.0

Table 1. Depletion (in, ft) in available soil water versus soil matrix potential for different soil textures.

2006soldays-water034



2006soldays-water035