Nebraska Water Balance Alliance

NEWBA 2014 Demonstration Project

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PROJECT GOALS:

- **Develop the team approach to future water management.**
  Cooperation and input by the participating growers was outstanding as they shared their thoughts and ideas. Many of those ideas have been accepted and are in various stages of implementation.

- **Advance real time (daily) management of water.** Elements measured and studied:
  1. Crop consumptive use
  2. Water applications
  3. Water availability in the soil profile
  4. Residue Management

Daily Real Time Management Objectives:

1. ***Weather Stations (outside the field or on the probe in the field):*** Use weather stations located outside the field to complement ETGages for year round Evapotranspiration (ET) readings. In addition, some growers considered adding weather stations on the probes in the field. This part of the project had very limited participation.

2. ***Crop Stage of Growth and Water Use:*** The crop's planting and crop emergence date was reported by the growers along with relative maturity dates. Growing Degree Days were calculated based on the weather station located outside the pivot. Crop ET and stage of growth was then calculated to determining how much water has been used. Water budgets turned out to be of limited value because most growers didn't irrigate before the first of July. All growers were below their water allocations in 2014**. Irrigation applications ranged from a low of 5.14 inches in the Loomis area to 13.92 inches in the Mitchell area. The average was 10.34.**

3. ***Soil Texture Triangle and Soil Moisture Probe:*** The Soil Texture Triangle test was adopted by the growers providing them with good information on how to better manage the pivots. The soil samples were pulled and tested at the time the probe was installed. This information was used to determine water holding capacity (WHC) at the 1^{st}, 2^{nd} and 3^{rd} foot levels. The test was also use to determine the water intake rate of the soil. The data was then used to recalibrate the probe. NEWBA also encouraged crop consultants to include soil texture testing as part of the sampling process especially if they are zone sampling. Results were then compared with the recalibrated soil probe to better manage water applications during the growing season. Soil probe WHC measurements can be very helpful for irrigation scheduling. Crop consultants were also encouraged to cross check for accuracy when they scouted the fields.

4. ***Complementing flow meter measurements by adding Power Company hours of operation:*** The cost of electrical energy continues to increase the cost of operation for growers. Automated Meter Reading (AMR) capabilities of most power companies provide real time energy use data by the irrigation systems several times a day. Adding real time flow meter readings keeps the grower and the power company informed as to how much water was applied in both in quantity and gallons per minute (GPM). In some cases the pump and sprinkler package design information was shared with the power company so they could calculate how much water was applied. Comparing flow meter readings with power company electric meter allowed the grower to better monitor water applications with daily water use information. A choice then can be made to continue irrigating or shut down, especially in areas of allocations.

5. ***Pressure Gauges.*** NEWBA and the growers discovered in 2013 that when flow meter readings were recorded, many of the irrigation systems and pumps were not delivering the water quantities at the pressure the sprinkler packages were designed for. Operators were encouraged to pay more attention to pressure gauges in 2014 to make sure the sprinkler package was delivering the GPM it was designed for.

6. ***Website dashboard***. As more data and information becomes available it is imperative that the information be placed on a website dashboard that is easy and quick to read. NEWBA had a limited dashboard with Ag Sense in 2014 that included:

<u>The home page:</u>

- AG Sense Crop Link icon for each grower.
- Ag Sense Field Commander icon (for growers that had them)
- Aquacheck or Water mark soil probe icon.

Ag Sense Crop Link Menu

- Temperature gauge
- Relative Humidity
- Precipitation
  Rain fall in the last 12 hrs
  Rainfall in the last 24 hrs
  Total rainfall for the year.
- Gallons per minutes (GPM)
- Pressure per square inch(PSI) at the pivot
- Growing Degree Days (GDD)
- Daily history report.
- Note page to post information during the year.

Ag Sense Field Commander Menu

(Located on the last tower of the pivot)

- GPS location of the pivot in degrees
- Pressure per square inch (PSI) at the end tower
- Start and stop functions
- Adjust the speed the pivot goes around the field. (application rate)
- Variable rate applications in degrees
- Hours of operation
- Total gallons applied
- Total inches applied

Aquacheck probes

- Reads and displays probe sensors at 4, 8, 16, 24, 32 and 40 inches
- Compares readings with the full and refill marks
- Sum readings of all probe sensors.
- Soil tab shows the WHC, Wilting point and refill mark.

Water Mark Probes

- Reads and displays probe sensors at 1, 2 and 3 feet
- Sum readings of the soil probes.
- Bar graph showing when water is added or consumed.
- Rain received in 12, 24 hours and total

People and organizations involved in the 2014 Demonstration Project

Participating Growers:

Name	Operator	Town	Legal
Rod Clough	Rod Clough	Wallace	SW 15-10-33
Hagan Farms	Ron Hagan	Madrid	SW 26-10-39
Hoehn Farms	Albert Enriquez	Gering	SW 7-19-54
Hoehn Farms	Albert Enriquez	Gering	W 1/2 25-23-56
Amanda Johnson	Amanda Johnson	Hays Center	NW 33-8-31
Redington #4	Nick Lapaseotes	Bridgeport	SE 29-19-51
Larson Farms	Joe Larson	Loomis	SW 31-7-19
LT Farm	Bruce Young	Madrid	E 1/2 18-10-38
Nelsen Farms	Dan Nelsen	Moorefield	NW 34 8-27
Paulman Farms	Roric Paulman	Sutherland	NE 24-11-34
Paulman Farms	Zack Paulman	Sutherland	NE 28-13-33
Paulman Farms	Zack Paulman	Sutherland	SE 28-13-33
Turn West Farms	Shawn Turner	Grant	SW 8-10-39
Wahlgren Farm R&J	Joe Wahlgren	Brady	NE 12-11-37

***2014 Participating Power Suppliers*:**

Service	Contact	Town
Midwest Electric	Randy Schmitt	Grant
Midwest Electric	Jason Bishop	Grant
Dawson PPD	Gwen Kautz	Lexington
McCook PPD	Jim Florke	McCook
SWPPD	Curtis Kayton	Palisade
Wheatbelt PPD	Jim Weeda	Sidney
Roosevelt PPD	Sandra Hendron	Scottsbluff
Wyrulec	Jason Murphy	Torrington
Southern PPD	Susan Green	Grand island

***2014 Participating Vendors and Suppliers*:**

Vendor	Contact	Town	Product/Service
Ag Sense	Scott Rogen	Aurora, NE	Crop Link
McCrometer	Paul Tipling	Salina, KS	Flow Meters
Crop Metrics	Eric Wasenius	Oxford, NE	Aquaview
Aqua Check	Brad Rathje	Bennet	Probe
AquaSpy	Steve Edwards	Denver	Probe
WaterMark	Chad Sager	Atwood	Probe
LandMark	Chad Naprstek	Gothenburg	JD Probe
21st Century	Justin Childears	North Platte	JD Probe
Olsen Labs	Kevin Grooms	McCook	Soil Tests
Simplot	PJ Hoehn	Scottsbluff	Consulting
Simplot	Dave Gleason	Hershey	Probe

2014 Participating Agencies:

Organization	Contact	Town
URNRD	Dirk Dinnel	Imperial
MRNRD	Jack Russell	Curtis
NPNRD	John Burge	Scottsbluff
TPNRD	Ann Dimmitt	North Platte
Tri-Basin	John Thorburn	Holdrege
CNPP&I	Marcia Trompke	Holdrege
UNL	Chuck Burr	North Platte
NCTA	Brad Ramsdale	Curtis

2014 Supporting Staff:

Organization	Contact	Town	Contribution
Dawson PPD	Paige McConville	Lexington	Accounting
Dawson PPD	Marsha Banzhaf	Lexington	Public Relations
NEWBA	Lorre McKeone	North Platte	Admin & Assistant
Midwest	Larry Umberger	Grant	Administrative
Simplot	PJ Hoehn	Scottsbluff	Project Assistant
Extreme Ag	Andrew Hock	Cambridge	Project Assistant
Paulman Farms	Roric Paulman	Southerland	Administrative

Data Explanation sheet

In 2014 we decided to measure real time water use including real time plant consumptive use. It's a start that we believe lays the ground work for future water management opportunities.

Below are explanations for the rows and columns found on the **Grower Fact Sheet Summary:**

C-1 Name of producer

C-2 Legal description

C-3 Acres in the field

C-4 Sprinkler Package as designed for the field.

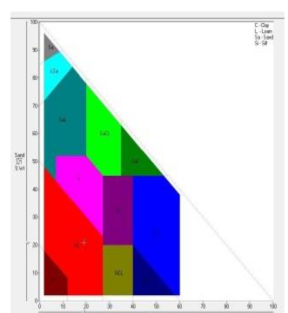
D-1 Measuring the percent residue after planting uses a formula developed by the Natural Resource Conservation Service (NRCS). It is not uncommon to have the NRCS staff assist the growers in measuring the percentage formula.

D-2 Estimating evaporation loss uses a formula developed from a research study done by Norm Klocke from Kansas State University. His studies show that evaporation loss on bare ground can exceed 35% of the precipitation received while 100% residue cover can be as low as 15%. That means a 50% residue cover can save 10% more water than bare ground plus reduced erosion and runoff.

D-3. Soil Texture classification is determined by using the Soil Texture Triangle developed by Washington State University. The classification is measured by taking a soil test to identify the % sand, Silt and Clay in the sample. The results are then placed on the soil texture triangle formula to determine the Soil Texture Class.

D-4-5-6 The soil test result represents the % sand, Silt. Clay and organic matter found in the soil sample.

D-7 Organic matter (OM) percentages come from the soil test from 0-12, 12-24-24-36 inches. The Soil Texture Triangle uses the OM in determine the WHC.



D-8 The Soil Texture Triangle can also identify Water Holding Capacity (WHC) or how much water can be stored in the soil to a certain depth based on soil test results. The soil intake rate can also be determined by the Soil Texture Triangle.

D-9 Once the WHC is calculated the producer can decide on how much water can be extracted before starting to refill the profile with irrigation. Soil probes are generally used to determine the % or inches of water are available to a depth of 36 inches or more. The length of the probe is determined by the crop grown. Sugar Beets have a deep tap root and may require a 60 inch probe. 36 to 40 inch probes are adequate for Corn, wheat and beans. Soil moisture levels can also be estimated by pulling a core sample and use the feel method. The WHC is very helpful in determining how much irrigation water can be applied at a given time.

E-1 Crop planted.

E-2 The crop yield information is from harvesting equipment, measuring crop storage or scales

F-1 Gallons of water applied, The gallons applied is available from the flow meter.

F-2 Total Acre Feet. Take the total gallons applied and divide by 27154 to get acre Inches. Then divide the acre inches by 12" = Acre Feet.

F-3 Equals total acre inches applied on the field.

F-4 Hours of operation is received from the pivot panel hour meter, or the engine hour meter or from the Power Company.

F-5 The average pressure at the pivot is available from a pressure transducer that records real time at the well or pivot. Pressure readings can also be taken manually and recorded at scheduled times. Pressure readings are very important in determining the accurate performance of the sprinkler package. Pressure readings above or below the sprinkler design results in faulty distribution of water.

F-6 Inches of water applied/acre. This information is available by dividing the gallons applied by 27154 and then by the acres in the field

Example: 2,715,400 Gal/ 27154 = 100 inches /10A = 10 inches/Acre.

G-1 Irrigated Gallons per Bu is determined by dividing the yield into the irrigation gallons per acre.

G-2 Precipitation received is available from a rain gauge or weather station at or near the field.

G-3 Irrigated gallons plus rainfall is divided by acres in the field to equal gallons per acre. The gallons per acre are then divided by the yield to get the gallons per BU (Unit).

G-4 Population. This information is available from the grower at planting time.

G-5 Gallons per plant. Gallons per acre is divided by the population to get gallons per plant.

Example: (Gal/A) 271,540 / (Population) 10,000 = 27.15 gal/Plant

G-6 Emergence Date. The grower provides this information which is very important in determining Growing Degree Days (GDD).

G-7 Evapotranspiration (ET). This information is available from the ET Gauge or weather station that calculates ET on a daily bases.

G-8 Growing Degree days (GDD). The information is available from a weather station that calculates it on a daily bases.

G-9 Growing Degree Day Budget. This is for future management.

H-1 Pump Efficiency is derived by using ultrasonic testing equipment to measure both PSI and GPM. Most pump companies and NRDs have ultrasonic testing equipment available to run the tests when requested.

H-2 Pump Horse Power

H-3 Average pumping lift. This number is derived from how many feet the water has to be lifted to get to the surface.

H-4 Total Energy cost for the field. The information comes from the power company or fuel supplier.

H-5 Energy costs per acre. To get energy costs per acre divide total energy cost for the field by the number of acres in the field.

H-6 Field Cost to apply 1 inch per acre. Divide total energy cost by inches applied to = cost to apply 1 inch of water over the whole field.

H-7 Energy costs per inch. Energy Cost Per Inch is derived from dividing total energy used by total inches applied and then by total acres.

Example: (Total energy cost) $2000.00/(total Acres) 100 A = $20.00/A/ (inches applied) 10" = $2.00/inch.

H-8 Energy cost per Bu (unit). Divide Cost per acre x yield to get cost per Bu (Unit)

Example: Cost/A $20.00 / yield 200 Bu = $.0100/Bu

Attached is the 2014 summary sheet

Residue Management results

Since saving water has such a high priority it is only logical to concentrate on the areas with the most potential for water savings. Reducing evaporation loss from the soil surface by 10 % or more has such a significant impact on how much water can be saved. It was appropriate to highlight what the participating growers were doing to save water.

The Natural Resource and Conservation service (NRCS) participated in gathering the pictures and data needed for this report and deserve to be recognized for their contribution.

The percentage of residue cover is calculated by laying out a 100 foot tape at a 45 degree angle to the row. The residue percentage is then determined by counting the number of times a piece of residue is seen directly below each foot mark. This is repeated 5 times and then averaged to get the percent residue coverage.

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Below is a summary of percent residue coverage of each participating grower.

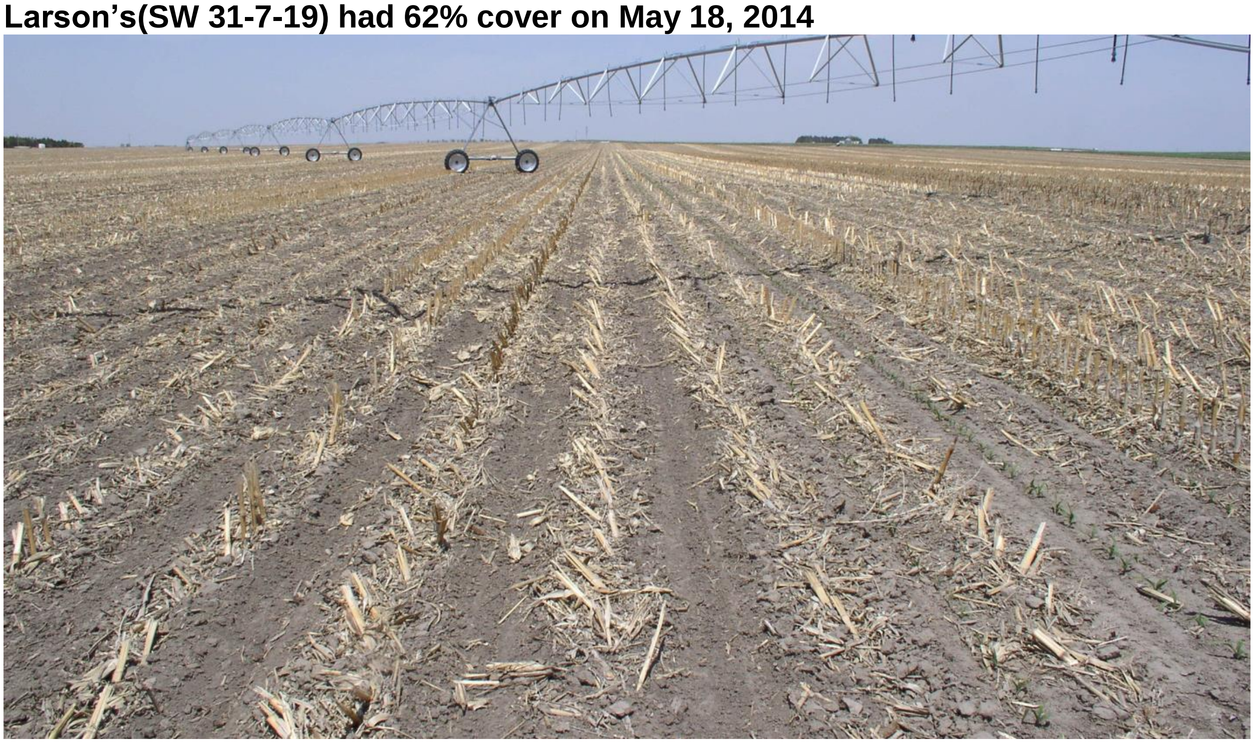
Rod Clough (SW 15-10-33) had 57% cover on May 20, 2014.

Hagan Farms SW 26-10-39) had 66 % cover on May 14, 2014

Hoehn Farms (SW 7-19-54) had 66 % cover on May 7, 2014

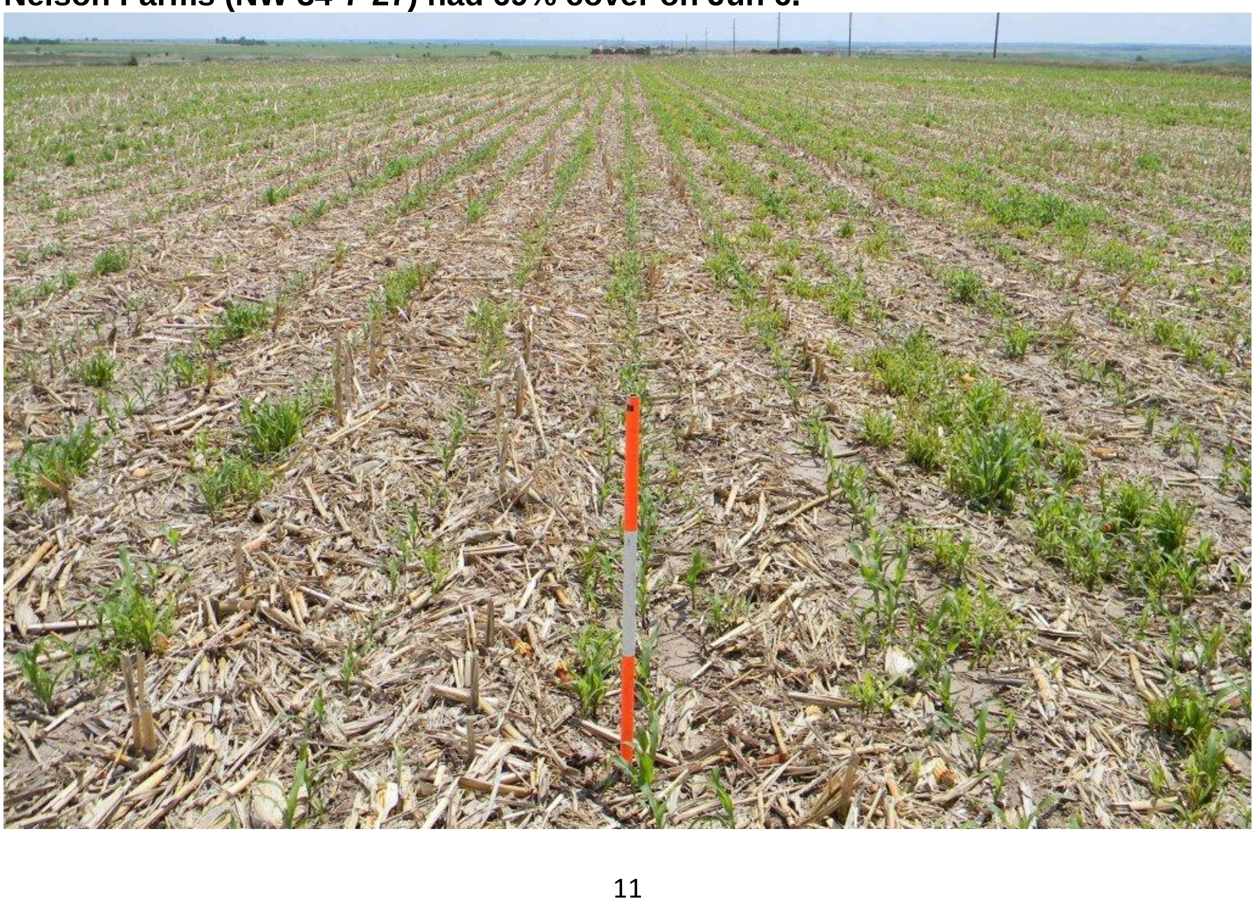
Lapaseotes (SW 29-19-51) had 41% coverage on May 21, 2014

Larson's(SW 31-7-19) had 62% cover on May 18, 2014



LT Farm (E ½ 18-10-38) had 40% cover on May 7, 2014

Nelson Farms (NW 34-7-27) had 69% cover on Jun 6.



Paulman Farm had (SE 28-13-33) 56% cover on May 22, 2014

Paulman Farm had (SE 28-13-33) 69% cover on May 22, 2014

Turn West Farm (SW 8-10-39) had 44% Cover on May 7, 2014

Wahlgren Farms (NE12-11-27) had 57% cover on May 22, 2014

The average residue percentage for all the growers was 54%. Based on Norm Klocke's work this would be an **approximate 14 % water savings.**

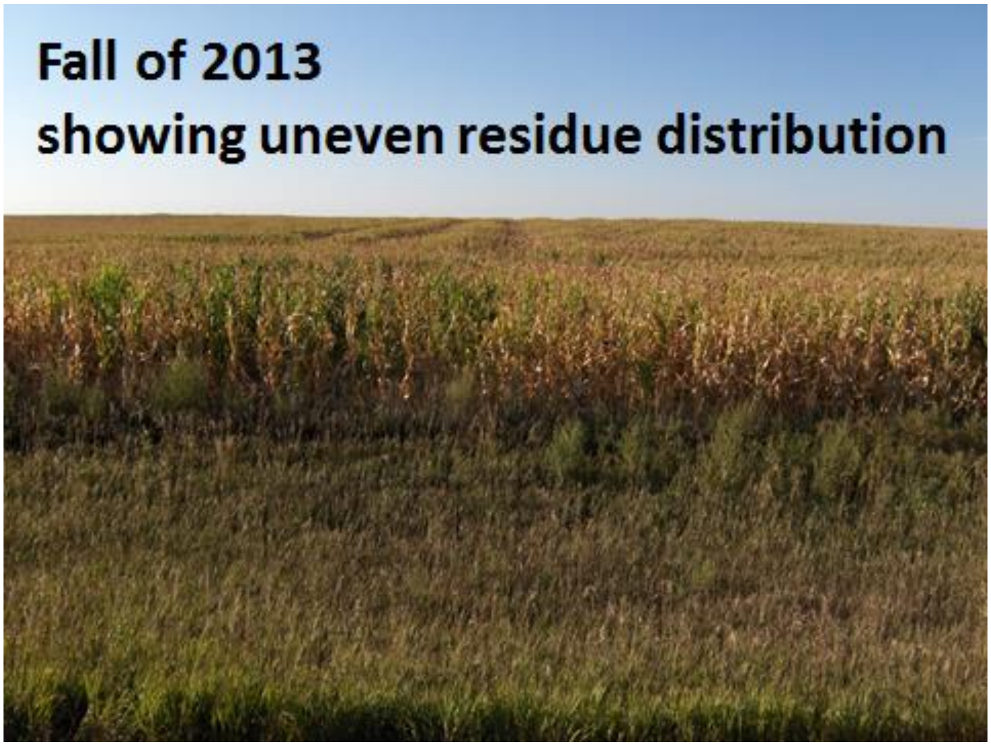
Hoehn Banner 9 and the limitations to residue cover

Killing vegetation in the early stages before it enters into the reproductive stage results in a quick breakdown into organic matter. In the above case the residue had completely decomposed by July 15th. Because the temperature and moisture conditions were ideal decomposition happened very quickly. The decomposed residue released nutrients to the growing crop; however, the residue cover needed to reduce evaporation and water erosion was gone.

Below is a chart showing the value of material with differing carbon nitrogen ratios.

Material	C:N Ratio	Material	C:N Ratio
Rye straw	**82:1**	Mature Alfalfa Hay	**25:1**
Wheat straw	**80:1**	Ideal for Microbes	**24:1**
Oat Straw	**70:1**	Rotting Manure	**20:1**
Corn stalks	**57:1**	Legume Hay	**17:1**
Rye Cover Crop (anthesis)	**37:1**	Beef Manure	**17:1**
Pea straw	**29:1**	Young Alfalfa hay	**13:1**
Rye Cover Crop (vegitative)	**26:1**	Hairy Vetch Cover	**11:1**
		Soil Mcrobes (ave)	**8:1**

The effects of uneven residue distribution behind the combine also have a major impact on crop production.



The result of poor residue cover from over grazing in the fall of 2012.

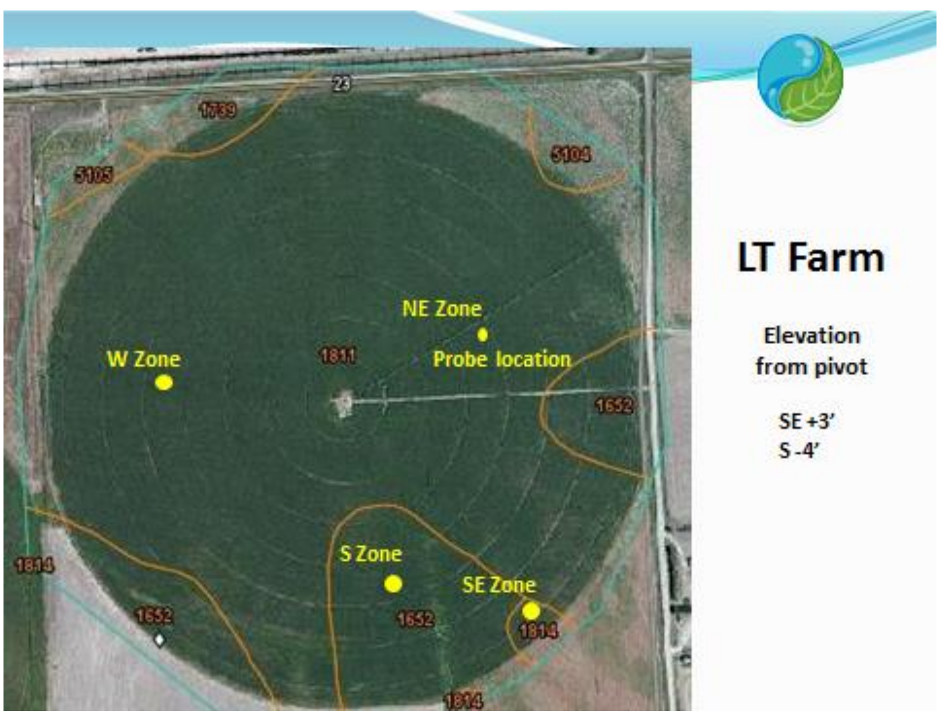
The corn in this quadrant made only 125 bu./A because it only had about 10% residue cover. Most of the water that was applied ran off with very little soaking into the soil profile. The corn in the west quadrant made 216 bu./A

The following table represents 12 inch increments to a depth of 108” or 9 feet.

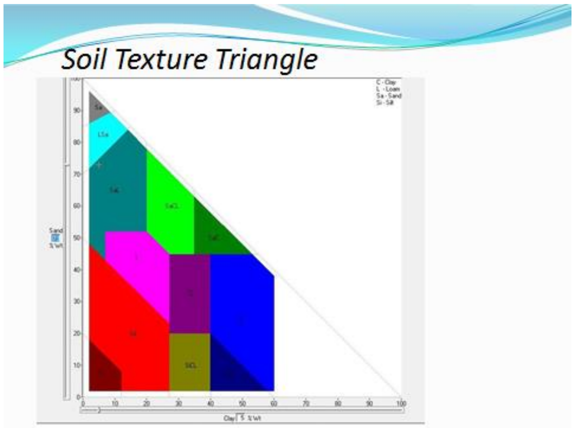
West quadrant of 18-10-38 at probe				SE quadrant of 18-10-38			
9/18/2013 Nitrate-N	**9/18/2013 NH4-N**	**9/18/2013 Summary**	**9/18/2013 WHC**	**9/23/2013 Nitrate-N**	**9/23/2013 NH4-N**	**9/23/2013 Summary**	**9/23/2013 WHC**
35	**11.2**	**46.2**	**50%**	**336**	**32.8**	**368.8**	**Dry**
21	**9.0**	**30.0**	**50%**	**142**	**5.8**	**147.8**	**Dry**
55	**13.3**	**68.3**	**Wet**	**77**	**11.5**	**88.5**	**Dry**
85	**8.6**	**93.6**	**Wet**	**48**	**10.8**	**58.8**	**Dry**
73	**8.3**	**81.3**	**50%**	**35**	**7.2**	**42.2**	**Dry**
45	**5.8**	**50.8**	**50%**	**26**	**10.4**	**36.4**	**Dry**
42	**5.8**	**47.8**	**50%**	**45**	**9.0**	**54.0**	**Dry**
42	**5.8**	**47.8**	**70%**	**42**	**8.3**	**50.3**	**Dry**
36	**9.4**	**45.4**	**70%**	**44**	**3.6**	**47.6**	**Dry**
434	**77.2**	**511.2**		**795**	**99.4**	**894.4**	

Both quadrants were cored for moisture about May 1st. The west quadrant was wet to five feet while the SE quadrant was only wet to 24 inches. They were both sampled around July 1st with adequate moisture down to 36 inches. Even though rain events filled the profile the SE quadrant still required additional irrigation because the deeper soil was still trying to balance its WHC.

Comparing Water Holding Capacity in different parts of the field



Using the Soil Texture Triangle to identify the soil Water Holding Capacity in each zone.



The Soil Texture Triangle should be used to calculate and fill in the missing columns in the charts below to determine how much water could be applied based on 50% refill in the top 24 inches. Most probe manufactures recommend the refill line be set at 50 to 60% of field capacity before starting to irrigate.

Soil Texture Triangle Calculations

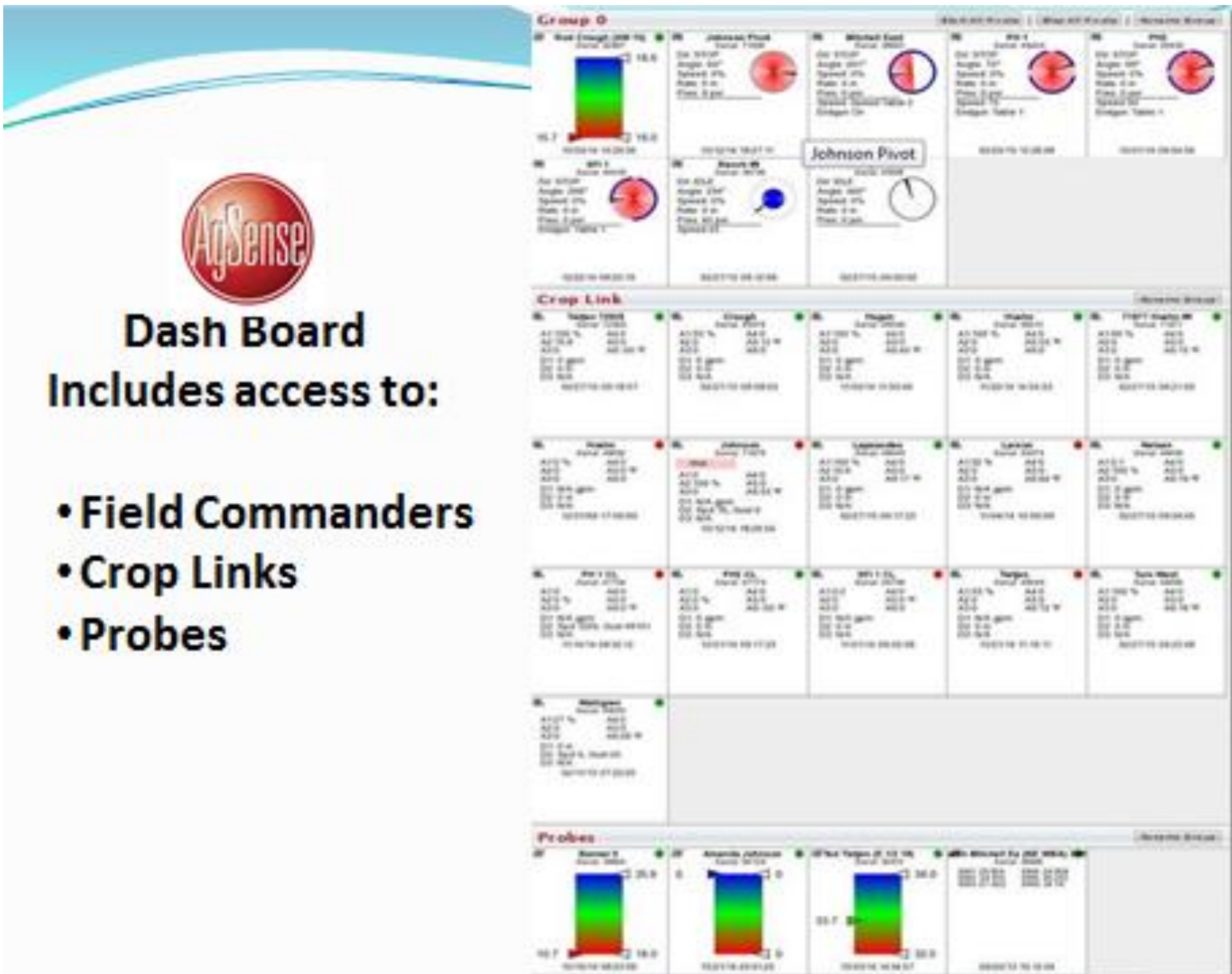
Zone Result 0-12"	Sand	Silt	Clay	Soil Class	Organic Matter	Maximum Intake Rate
NE Zone	30	50	20	Loam	1.9	
SE Zone	41	40	19	Loam	1.6	
S Zone	35	42	23	Loam	1.9	
W Zone	35	46	19	Loam	2.0	
0-12"	**% Field Capacity**	**% Wilting Point**	**% Water Available**	**Inches Available**	**At 50% Refill**	**Maximum Application**
NE Zone						
SE Zone						
S Zone						
W Zone						

Soil Texture Triangle Calculations

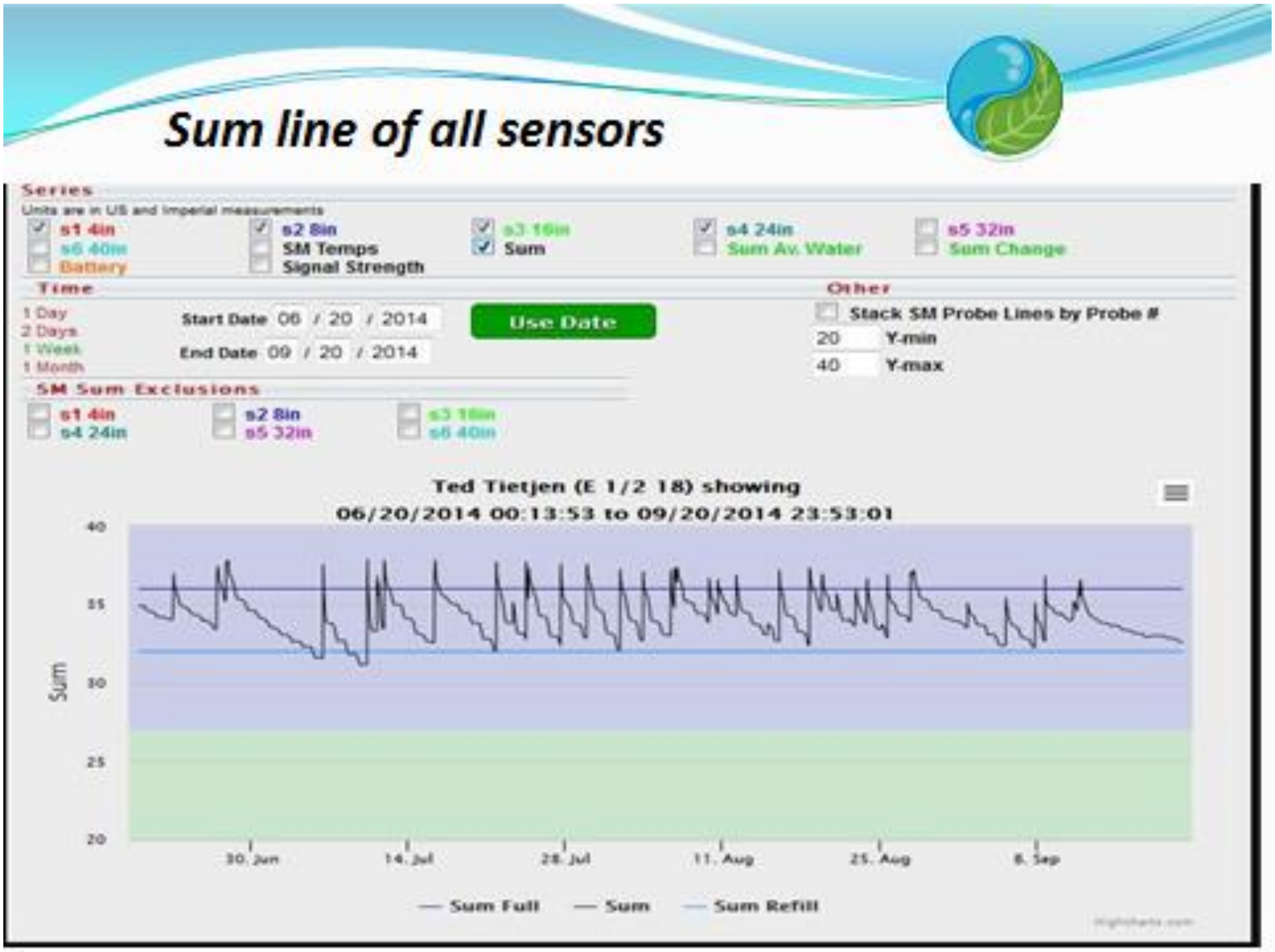
Zone Result 12-24"	Sand	Silt	Clay	Soil Class	% Organic Matter	Maximum Intake Rate
NE Zone	67	16	17	Sandy Loam	1.8	
SE Zone	31	48	21	Loam	1.7	
S Zone	31	30	39	Clay Loam	1.4	
W Zone	31	40	29	Loam	1.6	
12-24"	**% Field Capacity**	**% Wilting Point**	**% Water Available**	**Inches Available**	**At 50 % Refill**	**Maximum Application**
NE Zone						
SE Zone						
S Zone						
W Zone						

It generally takes from 3 to 4 days to apply an inch of water and a growing crop such as corn uses about .35inches per day during the reproductive stage. This needs to be considered when planning to irrigate. Also over irrigation will leach nutrients out of the root zone.

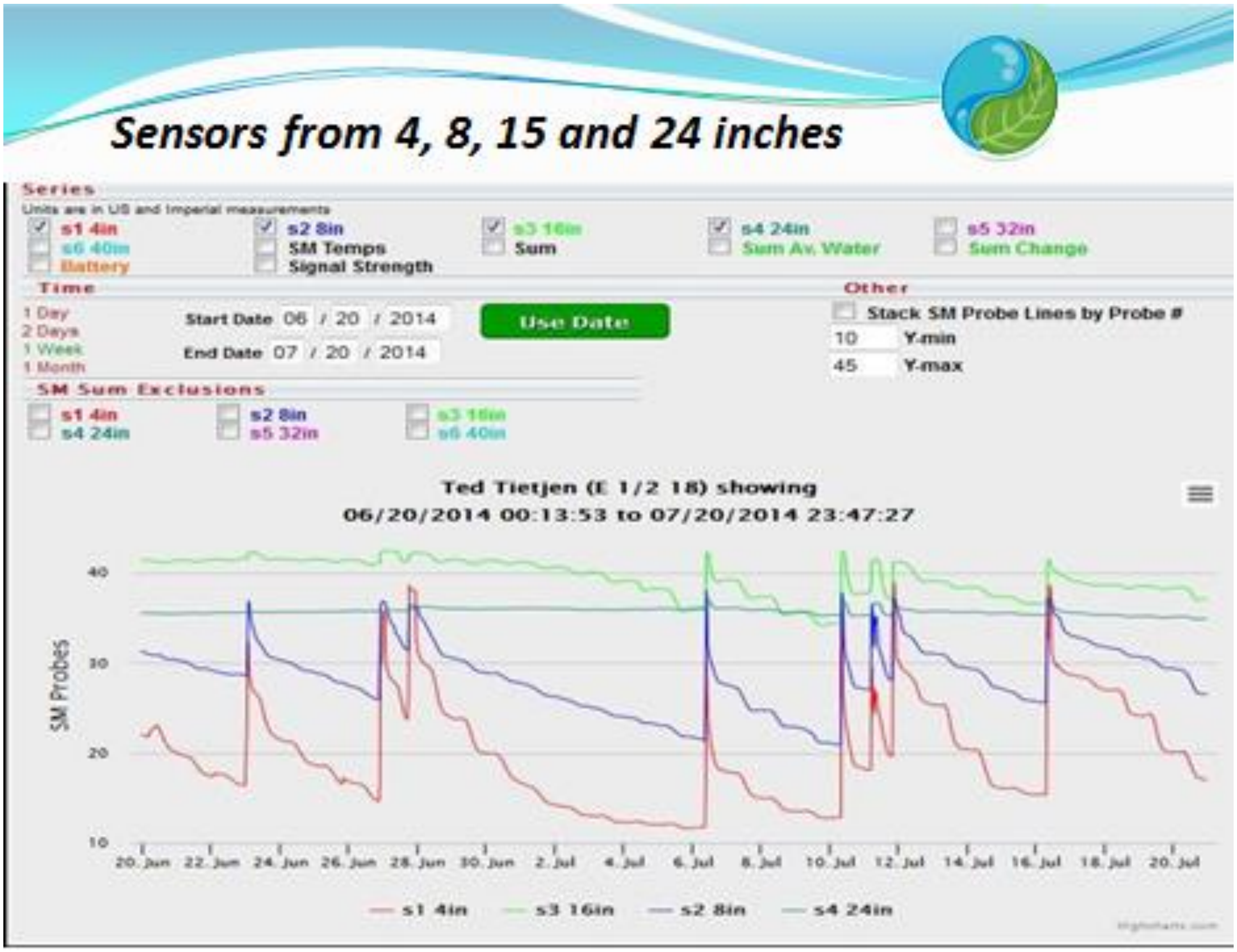
Below is the dashboard that was available to us in 2014 showing Field Commanders, Crop Links and probes if the software was compatible. The Crop Links were used to measure in real time how much water was being pumped and applied.



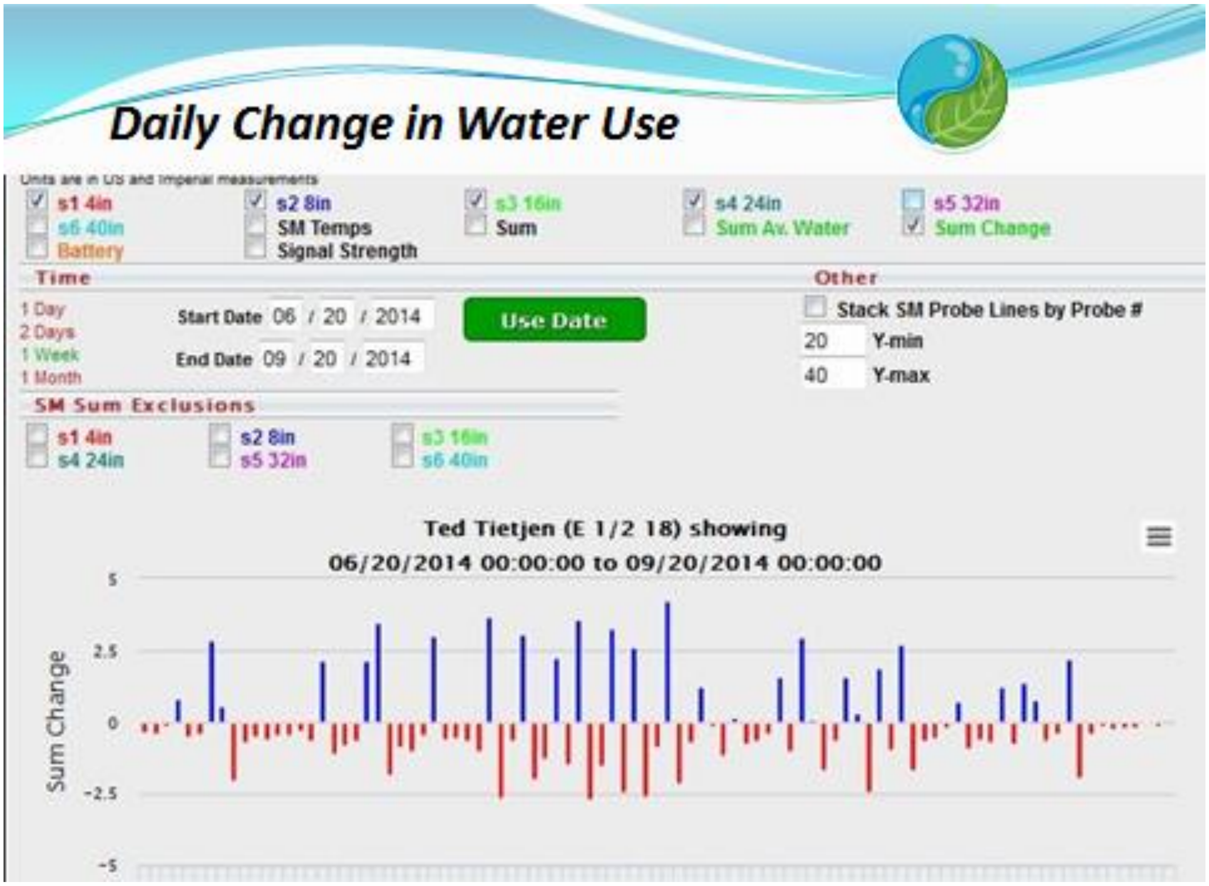
Below is a picture of what the sum line looks like and is normally used as a quick reference by the grower to see what the water status is before moving to the next probe



This picture shows the moisture status in the active root zone that is helpful in determining when to start irrigating.



This chart shows when the field received rainfall or an irrigation application.

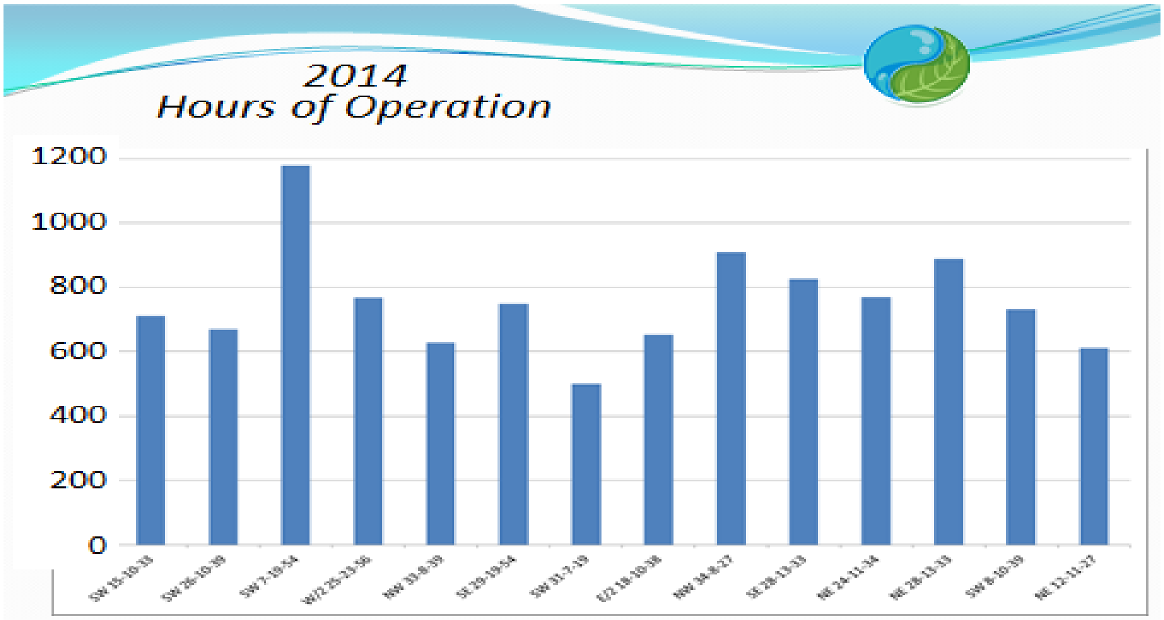


Below is a chart showing the in season rainfall and *Evapotranspiration from each growers weather station.

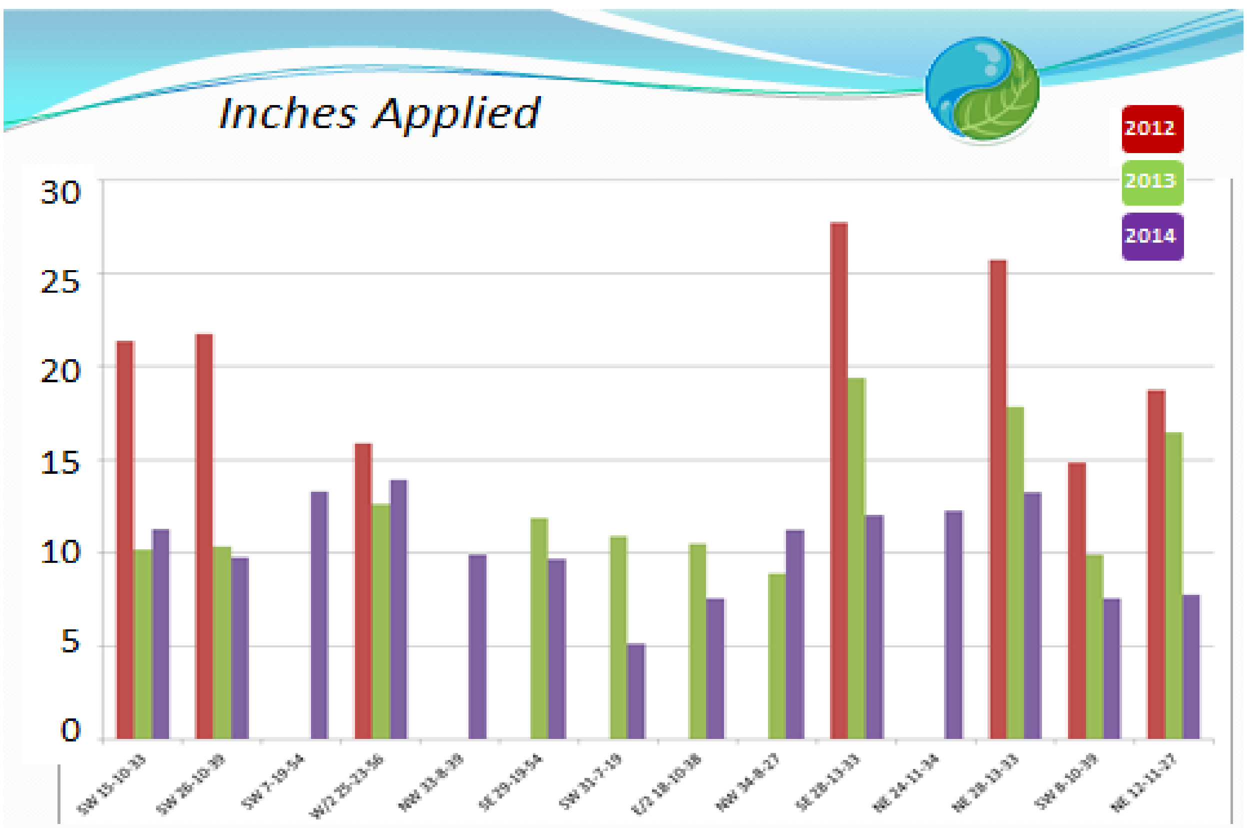
Growing Season Rainfall and ET in 2014

	Clough	Hagan	Hoehn	Johnson	Lapaseotes	Larson	LT Farm
Rainfall	12.84	16.96	14.48	15.89	12.79	14.27	18.46
*ET	26.54	25.76	24.87	23.31	24.27	25.15	24.50
	Nelsen	Paulman	Paulman	Paulman	Turn West	Wahlgren	Average
Rainfall	12.85	11.47	15.36	13.25	7.57	7.74	13.38
*ET	28.90	29.48	20.02	20.50	24.93	24.05	24.79

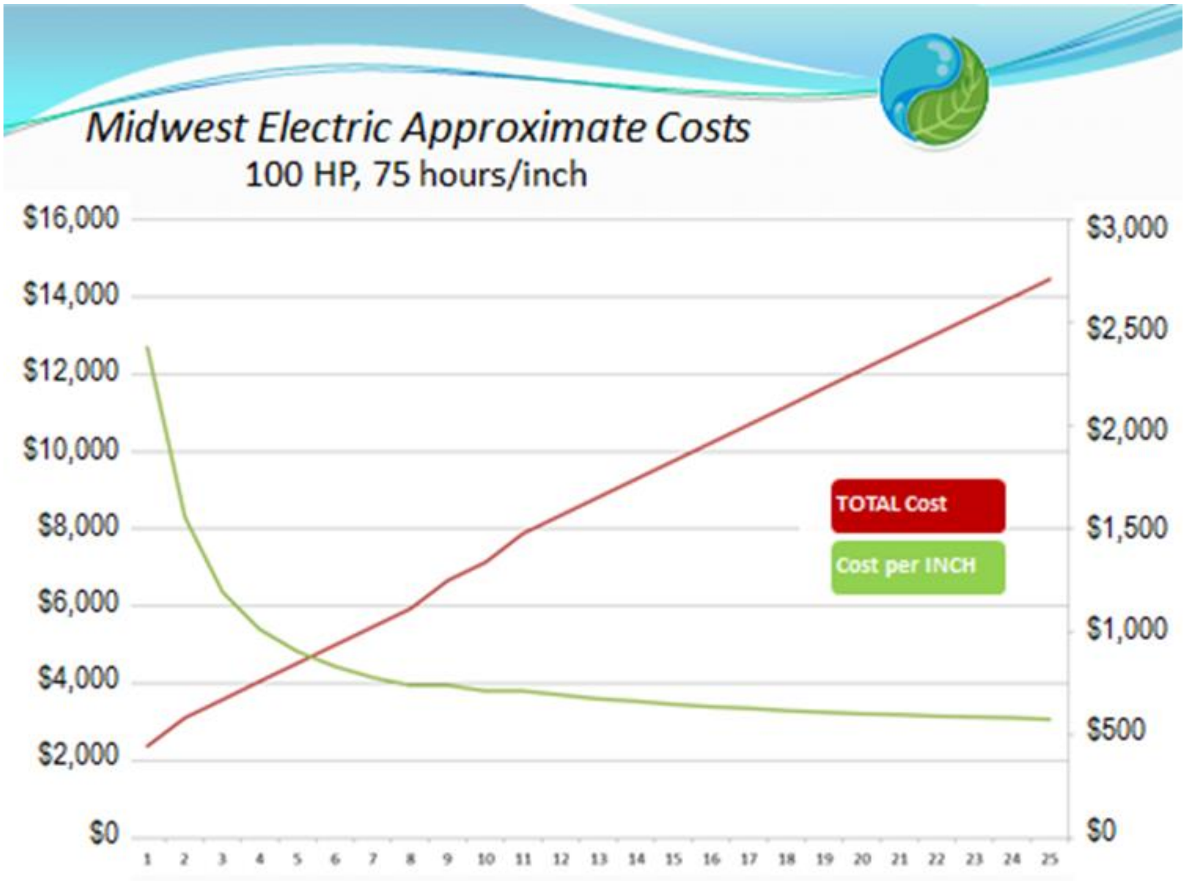
Below is a chart showing the hours of operation by the participating growers in 2014



Inches of water applied from 2012 through 2014 by participating growers



Most power companies have a horse power charge, which makes the first inch very expensive. As the user applies more water the lower the cost per inch.



There is no doubt that we learned a lot from the participating growers in the last year and hope they will share what they learned with their neighbors and others to make us more efficient with water management in the future.

The Nebraska Water Balance Demonstration Project Team.
Ted Tietjen, Coordinator
Larry Umberger, Administration
Lorre McKeone, Administrative and support.
Marcia Trompke, Project Assistant
Andrew Hock, Project Assistant
PJ Hoehn, Project Assistant