2 Goals, 1 Drop

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• “When the well’s dry, we know the worth of water.” – Benjamin Franklin

• “All the water that will ever be is, right now.” – National Geographic

• The Nation that Destroys its soil destroys itself. - Franklin D. Roosevelt

• Despite all our accomplishments We owe our existence to a six-inch layer of topsoil and the fact it rains. - Farm equipment association of Minnesota and South Dakota
Soil Health

• The continued capacity of a soil to function as a vital, living ecosystem that sustains plants, animals, and humans

• Key Soil Health Principles
  • Minimize Disturbance
  • Maximize Soil Cover
  • Maximize Diversity
  • Maximize presence of living roots
Opening Thoughts

- No Till is not about lack of tillage, but about managing soil water, soil structure, soil biology, and carbon compounds in the soil.
- Commonality Among Tillage Tools
  - All Tillage tools destroy soil structure
  - All tillage tools decrease water infiltration
  - All tillage tools reduce organic matter
  - All tillage tools increase weeds
Long Term Benefits of Tilled Soil

• Pros
  • None

• Cons
  • Less Liquid Carbon for microbes
  • Color of soil will lighten
  • Destroys Biological Life
  • Destroys Soil Structure
  • Increased Weed Pressure
  • Increased Disease Pressure
  • Lack of Moisture Retention
  • Increased Erosion and Runoff
  • Decreased Infiltration
  • Increased Compaction
  • Depends on Commercial inputs
Long Term Benefits of No Till

• **Pros**
  - Saves Time, Money, Labor, & Fuel
  - Decreased Erosion and Runoff

• **Cons**
  - Increased Herbicide usage
  - Increased Herbicide Resistant Weeds
  - Fallow Periods intercept flow of Carbon
  - Lack of diversity
  - Increased Disease Pressure
  - Dependent on Pesticides
  - Increased Compaction
Long Term Benefits of No-Till with Covers

• Pros
  • Soil is mellow and resilient
  • Living Plant 24/7 feeding microbes
  • Higher Biological Population
  • Increased formation of soil aggregates
  • Improved Infiltration Rates
  • Decreased Erosion and Runoff
  • Less Compaction
  • Increased Soil Organic Matter
  • Increased Savings on Input cost
  • Increased Pore Space
  • Less use of Herbicides
  • Increased Armor on the soil
  • Mimics nature

• Cons
  • Complex and will make you think harder
  • Managing Biomass
  • Logistics
  • Requires Faith, Patience, Understanding & Commitment
Where does water go?

• 20-30% loss from evaporation
• 70-80% loss from transpiration
  • Moves from soil, through root hairs, to roots, through xylem to leaves and out stomata
  • Moves nutrients into plant through dissolved minerals in soil water
  • Cools the leaves
  • Amount of water leaving is controlled by
    • Atmospheric demand
      • Wind, Temperature, and Humidity
    • Leaf Area Index (LAI)
      • The ratio of leaf cover to soil surface area
      • A leaf area index of 3 is 3 sq inches of leaves for every 1 sq inch soil
Figure 6.6 Average annual pan (= free-water-surface) evaporation (in/yr * 25.4 = mm/yr) for the 48 contiguous United States based on data for 1946–1955 (map provided by US National Weather Service).
Hale County Historical Rainfall

<table>
<thead>
<tr>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.63”</td>
<td>0.62”</td>
<td>0.87”</td>
<td>1.42”</td>
<td>2.92”</td>
<td>2.90”</td>
<td>2.39”</td>
<td>2.07”</td>
<td>2.12”</td>
<td>1.68”</td>
<td>0.68”</td>
<td>0.76”</td>
</tr>
</tbody>
</table>

~12” during the growing season

19.29”
How Effective is our Annual Rainfall

Hale County, TX

1908-2012 6073 Rain Events

<table>
<thead>
<tr>
<th>Rainfall Range</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;0.1&quot;</td>
<td>2471</td>
<td>40%</td>
</tr>
<tr>
<td>0.1-0.25&quot;</td>
<td>1328</td>
<td>22%</td>
</tr>
<tr>
<td>0.25&quot;-0.50&quot;</td>
<td>991</td>
<td>18%</td>
</tr>
<tr>
<td>0.5&quot;-1&quot;</td>
<td>790</td>
<td>13%</td>
</tr>
<tr>
<td>1&quot;-2&quot;</td>
<td>414</td>
<td>7%</td>
</tr>
<tr>
<td>&gt;2&quot;</td>
<td>79</td>
<td>1%</td>
</tr>
</tbody>
</table>
1” of rain in two hours
How much made it into the root zone?

<table>
<thead>
<tr>
<th>Texture</th>
<th>0-3% Slope</th>
<th>10% Slope</th>
<th>&gt;15% slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loam</td>
<td>Water</td>
<td>Water</td>
<td>Water</td>
</tr>
<tr>
<td>Sandy Clay</td>
<td>Increase</td>
<td>Increase</td>
<td>Increase</td>
</tr>
<tr>
<td>Clay</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sandy Loam</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium Sand</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clay Loam</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Protecting the Soil Habitat

- Maintain or increase stable soil aggregates and soil organic matter
- Protect the surface of the soil from degrading forces of wind and water
- Buffers against soil temperature fluctuations that not only stress plants but soil organisms
- Reduces evaporation rates
- Increases the amount of water entering the soil profile from rain and irrigation
My Cover Crop Blends

• No Perfect Blend. I use what is cheap, available and adapted to my climate

• Summer Mix – Proso Millet, German Millet, Pearl Millet, Sorghum Sudangrass, Cowpeas, Mungbeans, Sunn Hemp, Radish, Sunflower, Buckwheat

• Winter Mix – Rye, Barley, Oats, Canola (Rapeseed), Winter Pea, Crimson Clover, Radish, Hairy Vetch
Importance of residue cover

The graph shows the percentage of precipitation in relation to soil cover (in tonnes/ha). The bars indicate that as soil cover increases, the percentage of infiltration also increases, while runoff decreases. This highlights the importance of residue cover in managing soil erosion and improving water infiltration.
Crop Residue’s Impact on Water

- Crop residue will *reduce evaporation by 2-3”* during the irrigation season
  - Insulates soil from solar radiation
    - Water is retained in profile
  - This *water can be pushed deeper in the root zone* with next rainfall or irrigation
    - Helps fill the entire profile

**The more often you wet the soil, the more evaporation losses you will have**
Infiltration Rate Comparison

<table>
<thead>
<tr>
<th></th>
<th>Conventional Till Cotton</th>
<th>No Till Cotton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infiltration Rate</td>
<td>18:03</td>
<td>1:44</td>
</tr>
</tbody>
</table>

**Legend:**
- **Full Depression:**
- **Till Management:**
- **Soil Water Content:**
  - 15 Jul: 17.20" ± 0.01"
  - 16 Jul: 17.15" ± 0.01"
  - 17 Jul: 16.74" ± 0.45"
  - 18 Jul: 16.89" ± 0.01"
  - 19 Jul: 16.82" ± 0.32"
  - 20 Jul: 17.17" ± 0.01"
  - 21 Jul: 17.34" ± 0.45"
  - 22 Jul: 17.45" ± 0.05"
Soil Water and Temperature Interactions on Biology

- Microorganisms are most active between 50-75% soil moisture

- Microorganisms are most active between 40-80°F
  - For every 10°F temp increase the activity of the soil will double if adequate moisture is present
  - 1% increase in Oxygen will significantly increase the activity of soil microbes
Water Holding Capacity Comparison

No Till Cotton

Field Capacity = 19.3" Soil Water Content

Conventional Till Cotton

Field Capacity = 18.6" Soil Water Content
Temperature Fluctuation

Temperature

No Till Temperature

2" AVG = 84.65
Min = 70.6
Max = 102.6

6" AVG = 82.41
Min = 75.4
Max = 90.2

Temperature

Conventional Tillage Temperature

2" AVG = 80.95
Min = 62.12
Max = 104.75

6" AVG = 80.87
Min = 68.85
Max = 90.27

CropMetrics
Yield Optimization Technology
Can We Make more Water?

Profile Daily Change

No Till - with multi species cover crop

Conventional Tillage - No Cover Crops

Feb 9 UTC: Diff 0 00 in

Feb 14 UTC: Diff 0 00 in

1"

0.8"

0.8

0.55
Do Cover Crops Use Moisture?

Terminated Wheat/Radish Prior to No-Till Cotton

Profile Daily Change

Profile Sum

Terminated Wheat/Radish prior to no-till cotton

Sensors not included in sum:
- Percentage
- Inches
Feeding the Soil Organisms Inhabiting Soil

• Maximizing diversity above ground increases diversity below ground and stimulates a host of additional benefits
  • Breaking disease cycles
  • Habitat for pollinators
  • Stimulating plant growth

• Maximizing the living root –
  • Reducing fallow periods
  • Diverse crop rotation
  • Diverse mixtures grown over a period of time
Healthy Functioning Soils are able to:

- Cycle nutrients effectively
- Store Carbon and nutrients in organic matter
- Provide good aeration to promote root growth
- Improve farm resiliency and profitability
- Improve yield stability
- Reduce runoff and erosion
- Improve water storage and plant available water while protecting water quality
- Be resilient to drought, heavy rainfall events, and temperature extremes
- Reduce disease and pest problems
A Healthy Soil Moisture/Nutrient Profile
Precision Ag – Sustainable Systems Approach

Which single input has the greatest ability to impact the other two?
What’s happening below the ground?

What’s the cost of estimating?

The #1 way to **SAVE** money?

**ELIMINATE WASTE**

The #1 way to **MAKE** money?

**MAXIMIZE ROI**

*Return on INPUT!*
Confidence is found in systems

Measurements

Analytics and Models

Local, trusted advisor

Trust and Confidence
## Precision Irrigation Solutions

### What we don’t know could be influencing our profits

- How much plant available water is in the root zone?
- When is the right time to irrigate after a rain event?
- To what extent would nutrient efficiency improve with precision irrigation?
- How can precision irrigation allow us to optimize the newest seed technologies?

A CropMetrics system helps you irrigate with confidence

### CropMetrics consistently returns $30-60 per acre to the bottom line

- **Reduce irrigation cost:**
  - Typically reduce 2-3 passes per season
- **Secure annual efficiencies:**
  - Optimize root development to optimize nutrient access
  - Improve soil health to improve nutrient uptake
  - Conserve water & nutrients

“I was skeptical, but after 1 year I implemented 80% of my acres and averaged $56/acre increases!”

Dwane Roth  
Western KS corn farmer

### Certified support gives producers the confidence to strive for big results

- Every irrigation program is supported by a Certified Irrigation Strategist
- Irrigation Strategist provide:
  - CropMetrics software and field level hardware support
  - Systems that optimize existing precision programs
  - Weekly precision irrigation recommendations
  - Annual irrigation record keeping and analysis
Precision Irrigation Mindset

- Water needs of the plant
  - Plant available water
  - Active root zone of crop
- Oxygen needs of the crop
  - Plant available oxygen
- Offsetting or optimizing weather
Volumetric Water Management

Irrigation Event
Rain or Mechanical

Little to No Moisture Content Change

Substantial Moisture Content Change

SAFE
Refill / Recharge

Full Profile
Precision Ag’s Most Challenging Input

To reduce the stress of irrigation, most producers will over-irrigate to reduce the “risk” of loss.

Excess early season watering prevents deep root growth requiring more mid - late season irrigation expense.

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**Table I. Average crop water use (ETc) by growth stage for 113-day maturity corn grown in South Central Nebraska.**

<table>
<thead>
<tr>
<th>Growth stage</th>
<th>Average water use rate (in/day)</th>
<th>Duration(^1) (days)</th>
<th>Water needed to reach stage (inches)</th>
<th>Water needed cumulative (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergence (VE)</td>
<td>0.08</td>
<td>0-10</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>4-leaf (V4)</td>
<td>0.10</td>
<td>11-29</td>
<td>1.8</td>
<td>2.6</td>
</tr>
<tr>
<td>8-leaf (V8)</td>
<td>0.18</td>
<td>30-46</td>
<td>2.9</td>
<td>5.5</td>
</tr>
<tr>
<td>12-leaf (V12)</td>
<td>0.26</td>
<td>47-55</td>
<td>1.8</td>
<td>7.3</td>
</tr>
<tr>
<td>Early tassel (R1)</td>
<td>0.32</td>
<td>56-68</td>
<td>3.8</td>
<td>11.1</td>
</tr>
<tr>
<td>Silking (R2)</td>
<td>0.32</td>
<td>69-81</td>
<td>3.8</td>
<td>14.9</td>
</tr>
<tr>
<td>Blister Kernel (R3)</td>
<td>0.32</td>
<td>82-88</td>
<td>1.9</td>
<td>16.8</td>
</tr>
<tr>
<td>Beginning Dent (R4.7)</td>
<td>0.24</td>
<td>89-104</td>
<td>3.8</td>
<td>20.7</td>
</tr>
<tr>
<td>Full Dent (R5.5)</td>
<td>0.20</td>
<td>105-125</td>
<td>3.8</td>
<td>24.5</td>
</tr>
<tr>
<td>Maturity (R6)</td>
<td>0.10</td>
<td>126-140</td>
<td>1.4</td>
<td>25.9</td>
</tr>
</tbody>
</table>

\(^1\)Long-term average number of days since planting required to progress from the previous growth stage to the next. For example, to go from the blister kernel stage to the beginning dent stage requires approximately 15 days (day 89 to day104). Days to each growth stage were determined using the Hybrid-Maize Corn Growth Model for the period 1982-2005 at Clay Center, Neb.
Plant soil water uptake, root development, and uptake distribution.

Average Pivot Application After Evaporation

Not Accounting for Runoff

Precision Irrigation
Only water in the root-zone counts
Don’t Go Here!

Really Good

Good

Don’t Go Here!

Excess or gravitational water
Available water, no plant stress
Available water, plant stress possible
Unavailable water

Water in soil (in./ft.)

Saturation
Field Capacity
Wilting Point

Sand
Loam
Silty Clay Loam

5.2
5.8
4.4
3.5

3.8
2.8
3.5

2.1
1.8
2.6

1.6
1.1

CropMetrics Yield Optimization Technology
Precision Ag Seed Technology

SAME YIELD

2 Different Crops
2 Different Hybrids/Varieties
Different Irrigation Demand!
Same Soil Type
Same Farmers

Source: University of Illinois, 1999
TX Panhandle Cotton – Spearman, TX
Optimize Every Acre In Every Field Every Time!
Lloyd Arthur
- Ralls, TX

Cotton Planted multiple times due to weather, finally got a good stand the first of June.

Split in half VRI vs Flat Rate of 1”

Flat Rate needed one more irrigation to finish out
<table>
<thead>
<tr>
<th>Irrigation Scheme</th>
<th>Avg Application/Pass</th>
<th>Total inches applied inseason</th>
</tr>
</thead>
<tbody>
<tr>
<td>VRI</td>
<td>0.985</td>
<td>9.59</td>
</tr>
<tr>
<td>Flat Rate</td>
<td>1.000</td>
<td>10.37</td>
</tr>
</tbody>
</table>

**10.37” applied**  **17.24” rainfall**
Flat Rate vs VRI Yield Comparison
2 yr – Arthur Farms

- Flat Rate: 801.22 lbs of Lint/A
- VRI: 150.3 lbs of Lint/A
Flat Rate vs VRI Loan Rate Comparisons 2yr– Arthur Farms

- **Flat Rate**: $0.5000
- **VRI**: $0.5244

**$0.024/lb advantage**
<table>
<thead>
<tr>
<th>Sector</th>
<th>Yield</th>
<th>Lint</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat Rate</td>
<td>801.2</td>
<td>.50001</td>
<td>$400.62</td>
</tr>
<tr>
<td>VRI</td>
<td>951.5</td>
<td>.5244</td>
<td>$498.97</td>
</tr>
<tr>
<td>VRI Advantage</td>
<td>150.3</td>
<td>$.0244</td>
<td>$98.35</td>
</tr>
<tr>
<td>Probe Cost</td>
<td></td>
<td></td>
<td>-$13.3/A</td>
</tr>
<tr>
<td>VRI Cost</td>
<td></td>
<td></td>
<td>-$6/A</td>
</tr>
<tr>
<td>Controller Cost</td>
<td></td>
<td></td>
<td>-$10.83/A</td>
</tr>
<tr>
<td>Water savings of 0.52” @ $8/inch</td>
<td></td>
<td>$4.16</td>
<td>$72.38</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Nozzle Spacing Differences

80” drop spacing

40” drop spacing
# Nozzle Spacing Comparison

<table>
<thead>
<tr>
<th>Irrigation Type</th>
<th>Yield</th>
<th>Loan</th>
<th>$/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>40” Drop Spacing</td>
<td>793.7</td>
<td>$0.5339</td>
<td>$423.74</td>
</tr>
<tr>
<td>80” Drop Spacing</td>
<td>548.3</td>
<td>$0.5049</td>
<td>$276.81</td>
</tr>
</tbody>
</table>

11.86” of irrigation in season
17.24” of rainfall
Corn – 1” applications early then switched to 1.5” applications

Cotton – 0.5” application early then switched to 1” applications

Corn planted at 23K, chopped for silage and made 19 tons
Very consistent plant height, ear size and yield across all regions

Cotton had very even emergence across all zones, 1554lbs/a $0.56 loan
Variable Rate Irrigation to address Wiper or Split Pivots

For wiper pivots or pivots that reverse, VRI prescriptions can be smartly adjusted to speed into and out of each field edge. These prescriptions help ensure more uniformly managed application depths at the field edges while preventing irrigation and slower overall windshield wipes.

- **Constant Speed at 1.5”**
- **26 bu/Ac yield difference between N side and S side**
My Field is Flat
Variable Rate Irrigation

For wind stress, VRI prescriptions can be easily programmed to increase irrigation to any edge of the field that shows crop damage or potential yield loss as determined by visual observation.

Wind VRI Rx - Real-Time Spatial Irrigation Management that Targets Wind Stressed Areas of the Field
For optional Variable Rate Seeding prescriptions, VRI prescriptions can more precisely match irrigation to increased or decreased seed densities to further optimize yields.
What about Sub Surface Drip?
Sub Surface Drip Monitoring
Sub Surface Drip Monitoring

- Dripper Line
- Roots active below tape down to 36"
- Deep roots reactivated late in the season
Technology is **NOT** the Solution

The **ADOPTION** of Technology is the Solution
Upcoming Events

• No Till on the Plains – 1/28-1/29 – Wichita, KS
• High Plains No Till Conference – 2/4-2/5 – Burlington, CO
• TX Soil Health Symposium – 2/11-2/12 – Overton Hotel, Lubbock, TX
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