Mobile Drip Irrigation (MDI)
What we know so far

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My Background:
Philippine Agriculture

Avg. Annual Rainfall = 7.3 ft (±5 ft)
Avg. No. of Typhoons/yr = 21
No. of Islands = 7,107 (7,641 as of 2016)
US/Kansas Agriculture

**Average Annual Rainfall** = 16 in (12 – 48 in)

**Average No. of Tornadoes/yr** = 92

No. of Lakes = 106
Total irrigated area, sprinkler systems, and flood irrigation system in Kansas
The Race for 100% Efficiency

The diagram compares various irrigation methods based on their efficiency. The methods include:

- Average surface irrigation
- Surface with surge valve
- Surface with tail water recovery
- Surface with surge valve and tail water recovery
- CP with heads on top of mainline
- CP with heads at top of canopy
- CP with heads in canopy
- Mobile Drip Irrigation
- LEPA
- Subsurface Drip Irrigation

Each method is represented by a bar, with different segments indicating varying percentages of efficiency. The Mobile Drip Irrigation method is highlighted.
Sources of Losses on Center Pivots

**Air Loss**
- a. drift
- b. droplet evaporation

**Canopy Loss**
- c. canopy evaporation
- d. foliage interception

**Surface Loss**
- e. surface water evaporation
- f. surface runoff
- g. soil evaporation

**Deep Loss**
- h. deep percolation

Diagram showing various sources of losses including impact sprinkler, above-canopy nozzles, in-canopy spray, and MDI and LEPA with corresponding losses a, b, c, d, e, f, g, h.
MDI and LEPA

Soil Storage
Our Story Started BECAUSE...

Farmers Asked

1. Is MDI more efficient compared to nozzles?
2. Do you get more yield with MDI?
3. At what well capacity should I consider MDI?
4. Water productivity?
5. Germination in dry years?
6. Effect of variable well capacity?
7. Herbicide incorporation?
8. Longevity of drip lines?
9. Economics: cost-benefit analysis?
10. Others.

We Proposed

Partners Responded
Earlier work on Mobile Drip Irrigation (MDI)

Howell and Phene, 1983 in Fresno California

Helweg (1989) in Saudi Arabia

Sourcel (2003) in Germany

Olson and Rogers (2008) in NW Kansas
Mobile Drip Irrigation Research at SWREC

Installed and started 5 months after advisory meeting
Mobile Drip Irrigation Research at SWREC

- Spray stem for germination, and fertilizer and herbicide incorporation
- Guide wires tied to UV PVC drops
- Flexible tube to help with reversing
- 1/4 gauge wire anchored at wheel tower and between truss rods
- Two emitter rates (1 & 2 gph) pc (pressure compensating)
Questions about MDI from producers in SW Kansas

1. Is MDI more efficient compared to sprinklers?
2. Do you get more yield with MDI?
3. At what well capacity should I consider MDI?
4. Water productivity?
5. Germination in dry years?
6. Effect of variable well capacity?
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8. Longevity of drip lines?
9. Economics: cost-benefit analysis?
10. Others.
Center pivot Spinkler and Drip Irrigation Experiment for Corn (2016)

KEY
Numbering Code: R-S-T-N (Replication/Span/Drip or Sprinkler/Number)

Total tubes installed = 66

Note: Tubes NOT in exact straight line as depicted in drawing

- Drip (code 1)
- Sprinkler (code 2)
- 3 tubes installed (Sprinkler)
- 5 tubes installed (Drip)

- Always on

600 gpm
300 gpm
150 gpm
2019 Network of Water Technology Farms

[farm locations marked on a map of Kansas]
What we know so far...

- Application and Water Use Efficiencies
- Management
- Suitability
- Cost
- Longevity
Better than Spray (LESA and MESA)
BUT not as good as Subsurface Drip Irrigation (SDI)

Evaporation under MDI and Sprinklers

Limited wetting of the soil surfaces reduces soil water evaporation losses.
Soil water evaporation under LESA and MDI

Percent difference in soil water evaporation ~35%

Before the canopy closes
**Soil water redistribution under MDI**

- Drip line spacing 60 inches
- Corn spacing 30 inches
End of season soil water under 0.12 in d^{-1}

P-value<0.05, \alpha=5%

Volumetric soil water content

Depth (feet)

- Drip
- Spray
- 50% Depletion
- Field Capacity
- Wilting Point

Drip Profile SW: 5.5 inches
PAW: 1.8 inches

Sprinkler: 4.6 inches
PAW: 0.9 inches
## MDI 2016 Results

<table>
<thead>
<tr>
<th>Simulated well gpm on 125 ac</th>
<th>600</th>
<th>300</th>
<th>150</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drip 2 gpm</td>
<td>245 b</td>
<td>271 a</td>
<td>243 ab</td>
</tr>
<tr>
<td>Drip 1 gpm</td>
<td>294 ab</td>
<td>263 a</td>
<td>268 a</td>
</tr>
<tr>
<td>Bubbler</td>
<td>275 ab</td>
<td>256 a</td>
<td>239 ab</td>
</tr>
<tr>
<td>Spray</td>
<td>265 a</td>
<td>240 a</td>
<td>212 b</td>
</tr>
<tr>
<td>Irrigation (in)</td>
<td>11</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>

Rainfall May to October: 14.8 inches

At very low well capacity, highly efficient irrigation systems are inevitable
### 2018 ILS/WaterPACK Farm Data

<table>
<thead>
<tr>
<th>FIELD</th>
<th>TREATMENT</th>
<th>YIELD (Combine) (BU/AC)</th>
<th>YIELD (Hand) (BU/AC)</th>
<th>IRRGN APPLIED (IN)</th>
<th>WATER USE EFFICIENCY (BU/AC-IN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORTH 16</td>
<td>ALL</td>
<td>234</td>
<td>244</td>
<td>13.1</td>
<td>18.62</td>
</tr>
<tr>
<td></td>
<td>MDI (70%)</td>
<td>231</td>
<td>243</td>
<td>9.8</td>
<td>24.8</td>
</tr>
<tr>
<td></td>
<td>MDI (80%)</td>
<td>231</td>
<td>243</td>
<td>11.2</td>
<td>21.2</td>
</tr>
<tr>
<td></td>
<td>SPRAY (100%)</td>
<td>249</td>
<td>259</td>
<td>14.0</td>
<td>18.5</td>
</tr>
<tr>
<td>SOUTH 15</td>
<td>SPRAY</td>
<td>232</td>
<td>237</td>
<td>15.3</td>
<td>15.5</td>
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</tbody>
</table>
Roth/GC Co Farm Data

Average of Adj. Yield

Average of plants

YIELD (BU/AC)

PLANT NUMBER

bubbler hose iwob mdi bubbler hose iwob mdi

2017 2018

Roth/GC Co Farm Data
Long WTFarm

Average of Adj. Yield
Average of plants

YIELD (BU/AC)

LEPA
mdi
Spray
LEPA
mdi
Spray

250gpm
500gpm

2018
Less critical than SDI
BUT more involved
than Spray (MESA/LESA)

MDI vs Spray on
Circular vs
Straight Planting
Corn
MDI Filtration System

Disc Filter 2 Inch
Mesh 200
Flow up to 200 gpm

Combination of cyclone and disc filters

This is Drip, so clogging can be a major problem
May have an advantage in some:

- locations (e.g. flat)
- conditions (e.g. limited capacity, improve inside two towers)
- situations (e.g. preventing wheel track rutting, avoiding salt on leaves)
- crops (e.g. better for low profile crops)
Structural Static and Dynamic Forces

Typical Spray Nozzle Center Pivot System
Mobile drip irrigation system

Structural Static and Dynamic Forces
Low height crop MDI system
More expensive than spray but a lot cheaper than SDI

> Other conditions may help justify the cost

<table>
<thead>
<tr>
<th>MODE</th>
<th>TOTAL COST</th>
<th>AVERAGE COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPRAY (6 circles)</td>
<td>$4,596.00</td>
<td>$766.00</td>
</tr>
<tr>
<td>MDI (4 circles)</td>
<td>$180.00</td>
<td>$45.00</td>
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</table>

**Repair Cost at T&O WTFarm**

**2016 Partial Budgets**

<table>
<thead>
<tr>
<th>Pivot Designation</th>
<th>NE20</th>
<th>SW20</th>
<th>SE20</th>
<th>NW20</th>
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<tbody>
<tr>
<td>Technology</td>
<td>MDI</td>
<td>Spray</td>
<td>MDI</td>
<td>Spray</td>
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<tr>
<td>Crop</td>
<td>Alfalfa</td>
<td>Alfalfa</td>
<td>Sorghum</td>
<td>Sorghum</td>
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<tr>
<td>Income</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Acres</td>
<td>123</td>
<td>123</td>
<td>123</td>
<td>122</td>
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<tr>
<td>Yield per Acre</td>
<td>2.97</td>
<td>3.13</td>
<td>140.04</td>
<td>145.25</td>
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<tr>
<td>Price</td>
<td>$161.48</td>
<td>$161.48</td>
<td>$4.46</td>
<td>$4.46</td>
</tr>
<tr>
<td>Gross Profit ($/ac)</td>
<td>$479.19</td>
<td>$505.45</td>
<td>$624.58</td>
<td>$647.80</td>
</tr>
<tr>
<td>Expenses</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Seed</td>
<td>$74.63</td>
<td>$96.59</td>
<td>$8.45</td>
<td>$9.00</td>
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<tr>
<td>Herbicide</td>
<td>$13.18</td>
<td>$13.18</td>
<td>$60.68</td>
<td>$59.37</td>
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<tr>
<td>Fertilizer</td>
<td>$25.06</td>
<td>$40.88</td>
<td>$77.69</td>
<td>$91.69</td>
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<tr>
<td>Drive Train Repairs</td>
<td>$0.00</td>
<td>$3.86</td>
<td>$0.00</td>
<td>$12.88</td>
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<tr>
<td>Variable Expenses</td>
<td>$112.87</td>
<td>$154.51</td>
<td>$146.82</td>
<td>$172.94</td>
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<tr>
<td>Profit Above</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Variable Expenses</td>
<td>$366.31</td>
<td>$350.94</td>
<td>$477.76</td>
<td>$474.86</td>
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<tr>
<td>Water Use (ac-in/ac)</td>
<td>4.46</td>
<td>3.77</td>
<td>9.65</td>
<td>9.36</td>
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<tr>
<td>Profit per ac-in/ac</td>
<td>$82.14</td>
<td>$93.10</td>
<td>$49.53</td>
<td>$50.71</td>
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<tr>
<td>Yield per ac-in/ac</td>
<td>0.67</td>
<td>0.83</td>
<td>14.52</td>
<td>15.51</td>
</tr>
</tbody>
</table>
Longevity depends on

- management (e.g. circular planting, grazing on field)
- field (e.g. better on flat than undulating field)
- crop (e.g. better on short crops)
- who you ask
Future Research on MDI / Other unanswered questions

- How will fertigation affect the management and crop performance?
- How do we capitalize on the reduced soil water evaporation?
- Are there other benefits and improvements that we could still identify on this technology?
THANK YOU

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