Mobile Drip Irrigation & Variable Rate Irrigation: A review of Existing Research

Behnaz Molaei
Troy Peters, Ph.D., P.E.

Irrigated Agriculture Research and Extension Center, Prosser
Washington State University
What is MDI?

Spray heads (MESA)  Drip Lines, MDI

MDI Trial, Alfalfa Field, Umapine, Oregon
• **Applications:** Center pivot and Linear

• **Companies producers:** Netafim, Dragon Lines

• **Designing:** Based on soil type and crop

• **Space between driplines:**
  
  Soil type & crop need (between 20 to 40 inches)

• **Emitters:** 1 or 2 gal/hr

• **Costs:**
  
  • $150-$200 /acre (Yost et al., 2019)
  
  • $250-$280 /acre, converting LESA to MDI (O’Shaughnessy, 2017)
MDI Mounting Methods

Based on Crop types (crop height) & Row orientation

**Tall crops:**
Manifold attached to the truss rods or driplines attached directly to the pivot using rigid or flexible drops (Netafim)
Short crops: manifold 3-4 ft from the ground
Water Savings with MDI??

- MDI saves water compared to MESA and LESA
- Surface evaporation from MDI is 35% less than LESA
- 30.6% water savings by MDI (Jones in 2015)
- Improved yields when water is limiting

**Average Application Efficiency \( (E_a) \)**

MESA = 80%  
LESA = 97%  
\( E_a \) of MDI > LESA

![MESA](image1.png)  
![LESA](image2.png)  

Spearmint, Toppenish, 2017 to 2019
Energy Savings with MDI??

- More water reaches the soil surface per gallon pumped
- Pumps and pivot can be shut off more often
- MDI does not need the same pressures as sprinklers
  Lower pressure & less run time sig. power savings

A few research studies reported energy savings:

- 20-70% (Lamede et al., 2017)
- 40-50% (Derbala, 2003)
- 70% (Hezarjaribi, 2008)
Other Benefits of MDI

- Significant (!) wheel track reduction
- Better infiltration compared to LEPA/LESA
  - Less runoff
  - Can handle tighter soils and steeper slopes
- Canopy stays dry. Reduces disease pressure and salt contamination when irrigating with high salt irrigation water
- MDI is ideally adapted to forages and small grains
Barriers for MDI

- Cost!
  - Lots of drip tubing, fittings, and hose
  - Very tight filtration requirements
- Drags on ground damages the hoses (less robust than sprinklers that don’t touch the ground/crop)
- Damage due to animals
- Tangling and Reversing
- Limited ability to chemigate crop foliage
- Tall crops (corn) can be difficult
- Planting in circles is better
MDI can save at least 20% of water compared to MESA.

Electric power savings depends on the particular pump, and water source, operating condition before converting.

Because of higher cost, growers will only be motivated to convert if:
- Water is limiting
- Growing higher value crops
- They have runoff issues
Variable Rate Irrigation

Applying different amounts of water to different areas of the field
Variable Speed Irrigation

- Uses a sophisticated control panel: slow down or speed up the pivot to apply more or less water in different areas of the field
- Many newer pivot control panels have speed control ability

Costs: $2,000 - $4,000

Colors indicate areas with different amounts of water applied
Variable Zone Irrigation

Wide variety of irrigation depths to different areas

- Variations in application rate along the pivot lateral
- Variation the speed of pivot as it moves in a circle

Costs: $15,000 - $25,000

Different application rate along lateral is due to pulsing sprinklers on/off for various amounts of time
Does not always conserve water

Ambiguous water saving, or yield improvement

**Studies in New Zealand, Missouri and Mississippi**

- Large in-season rainfall & large differences in WHC allow
  - To "mine" the soil water
  - Reduce deep percolation
- Saved 4-7%, 9-19%, and 22-26% in different studies
- Reduction in drainage losses of 45%
- 25% less water with VRI (Sui and Haijun, 2017)
Thinking about VRI

Variable Rate Irrigation?
Different Amounts of Water to Different Areas

Deep Silt

Deep Sand

Shallow Silt

Shallow Sand

Most problems can be mostly solved through “precision” uniform irrigation management
Thinking about VRI

Starting from full, after a few days of water use
Managed Irrigation Based On the Silt Soils

Shallow Sandy/Rocky Soils

Deep Silt Soils
Managed for Sandy/Rocky Soils

Shallow Sandy/Rocky Soils

Deep Silt Soils
Thinking about VRI

Managing to Maintain Space for Significant in-season rainfall

Low WHC. Shallow Sandy/Rocky Soils
Thinking about VRI

Managing to Maintain Space for Significant in-season rainfall

Requires very close water management in time and space
Greatest Profit Potential for VRI

- Consistent prescription maps
- No irrigation to non-cropped surfaces
- Crops getting consistent amounts of water from alternative sources

- May be necessary if injecting chemicals that can’t legally be applied to non-cropped areas
Benefits of VRI

- Potential to save water and energy is certain situations!
- Simple water and energy conservation opportunities when using VRI to avoid irrigating non-cropped areas of the field
  - % savings = % of field that is non-cropped
- Can save water when crops are getting water from other sources

Fields with non-cropped surfaces
Summary about VRI

- VRI can save water and energy to avoid irrigating non-cropped surfaces.
- VRI can save water in other instances, but currently it is so complicated to manage so the savings cannot be relied upon.
- Growers may choose to use VRI to increase yields in high-value crops and to alleviate water-logging that can theoretically be avoided using “precision uniform irrigation”.
- Large variations in WHC in the field = > Savings water.
- Climates with significant in-season rainfall helps = > greater water savings.
Thanks for your attention