Analysis of Sprinkler Systems:Comparing Center Pivots, Linears, Wheel lines

Forage Irrigation Workshop

Western Alfalfa and Forage Symposium, "Optimizing Yield and Quality in Irrigated Forages"

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Application Efficiency

- The percentage of applied water that is placed in the crop root zone. Losses include:
  - Droplet evaporation & wind drift
  - Evaporation from plant leaves & bare soil
  - Runoff
  - Deep Percolation
    - Over-application on the entire field
    - Poor water application uniformity (local areas of over-application)

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Irrigation System Application Efficiency

	Application Efficiency, %	Water needed to put 1 inch into the soil
Sprinkler Systems		
Stationary lateral (wheel- or hand-move)	60-75	1.7 - 1.3
Solid set lateral	60-85	1.7 - 1.2
Center-pivot lateral	70-85	1.4 - 1.2
Moving lateral (linear)	80-87	1.2 - 1.1

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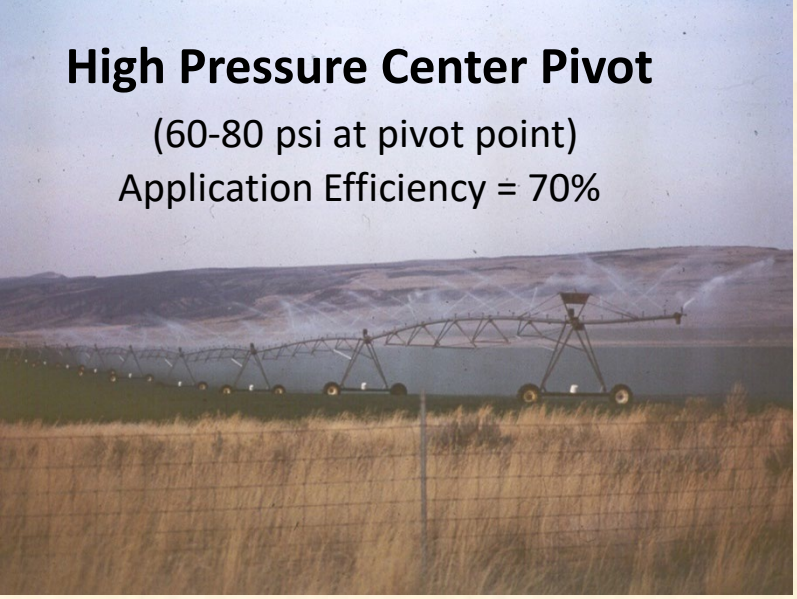
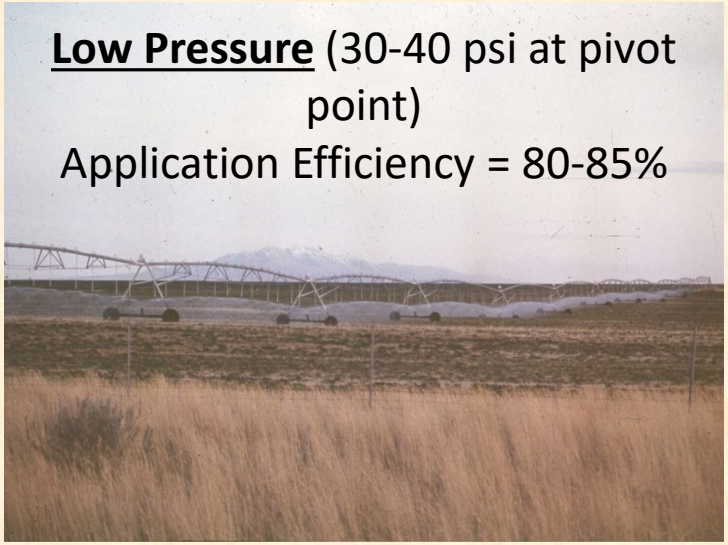
High Pressure Center Pivot

(60-80 psi at pivot point)
Application Efficiency = 70%



Low Pressure (30-40 psi at pivot point)
Application Efficiency = 80-85%



Hose-drag linear move

Application Efficiency = 80-85%

Center-pump linear move

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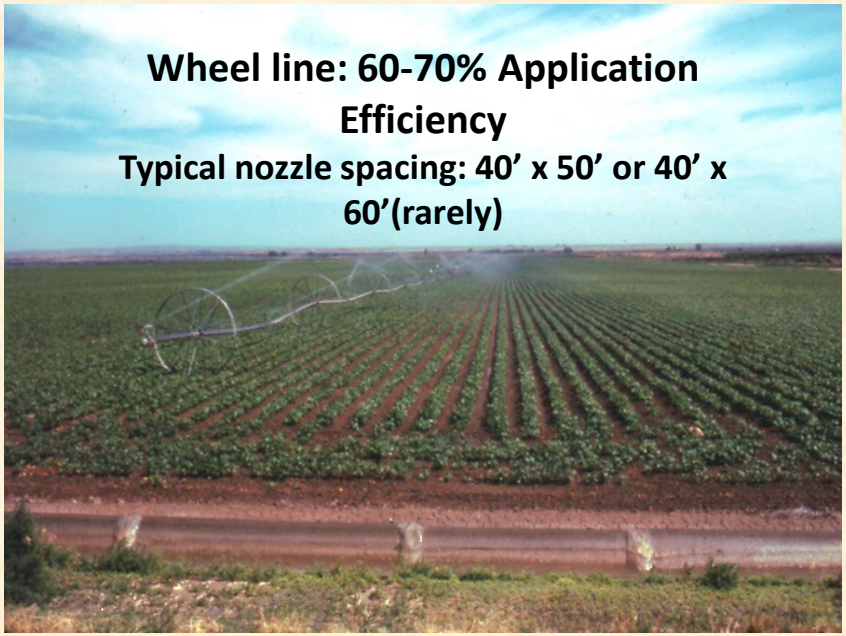

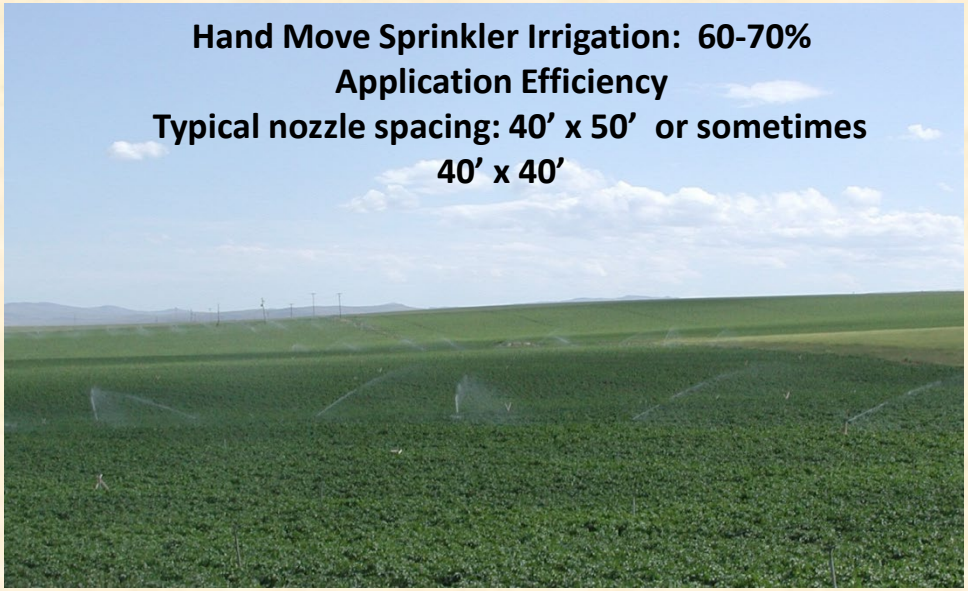

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Approximate Sprinkler System Hardware Cost

- Cost (lateral and mainline):

• Full-circle pivot	$85,000/130 ac =	$654/ac
• Half-circle pivot	$85,000/65 ac =	$1308/ac
• Hand line (4)	$36,000/80 ac =	$450/ac
• Wheel line (4)	$86,000/80 ac =	$1075/ac
• Solid set (53“certa-set”)	$152,500/80 ac =	$1906/ac
• Solid set (53 aluminum)	$230,000/80 ac =	$2875/ac

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System Advantages / Disadvantages

- Pivots
  - + low initial cost, low annual labor cost, high water application uniformity (CU about 85-90%), high application efficiency (80-90%), convenient and easy to remote monitor and control
  - – Corners, runoff on some soils, more difficult to wet deep
- Set systems
  - + Irrigate entire area, apply more water per set without runoff (water deeper)
  - – Higher labor costs, lower water application uniformity (CU 70-80%), lower application efficiency (65-75%), difficult to remote control

Water Use Efficiency (WUE)

WUE = units of crop produced/ inches of water used

water used = water applied + soil water storage used

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To increase Field-Scale WUE:

- Meet crop Et while Reducing surface runoff or deep seepage losses (irrigation scheduling)
- Reduce evaporation (irrigation system modification)
- Reduce losses due to leaks, worn nozzles or “extra” water added due to poor water application uniformity (system maintenance) – most important in set systems

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BPA LEPA Demonstration Project

Double goose-necks and truss-rod hose slings.

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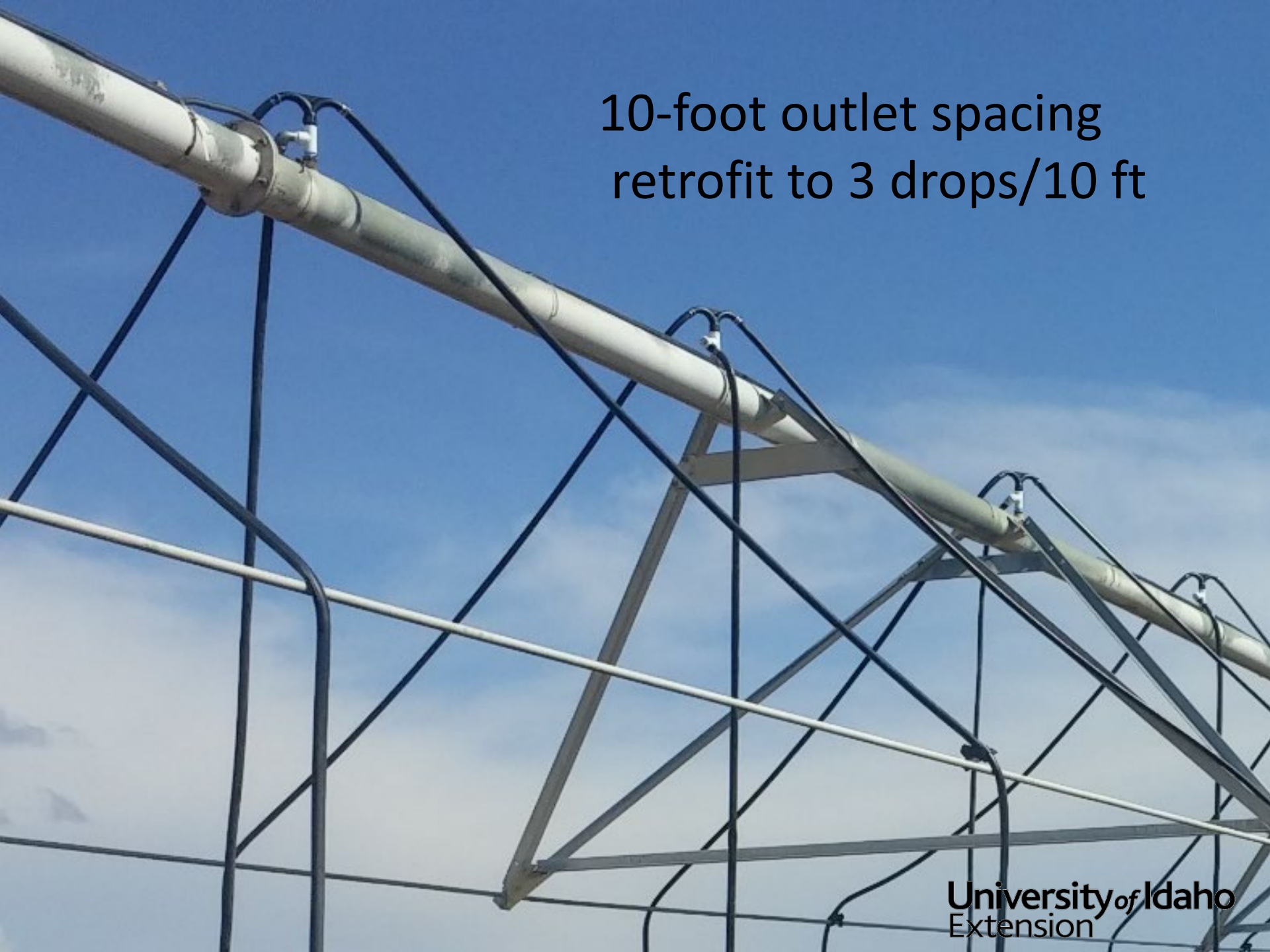
10-foot outlet spacing
retrofit to 3 drops/10 ft
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After 6 yr. work in multiple states on multiple crops:

Potatoes in rotation or more rolling land:

Sprinklers about 40 inches above soil and drops spaced about 5 ft.

Lower cost but less water & power savings

Field has very few humps or ridges, no potatoes, and max water savings desired:

Sprinklers in canopy about 12 -18“ above soil at max. rutting depth. Sprinklers spaced about 5 ft (3 ft for heavy spring grain in rotation) Higher cost but greater water & power savings

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Range of water-saving options:
really a cost-benefit analysis for each site

- Most savings: Dragon-line: **AE**=**98%**, 20K upgrade
- Next: LESA with heads 12-18” above ground, 3-4 ft spacing, **AE=95%**, upgrade, 12K
- Next: LESA with heads 36-42” above ground, 5 ft spacing, **AE= 90%,** upgrade, 8K
- Next: MESA with current spacing, **AE=70-85%,** no upgrade required

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End Gun, Corner Arm, and Corner Irrigation Considerations


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End Guns

- Require booster pumps on low-pressure systems (costly and low reliability)
- High droplet impact energy seals soil, reduces seedling emergence & causes runoff on bare soils
- About 30% of water applied is in a location with insufficient water to produce a crop

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Corner Arms

- Costly (nearly $30,000 to water about 26 acres or about $1150/acre)
- Require VFD. Otherwise, machine pressure is too low when arm fully extended – e.g. “spoking”
- Application rate can be excessive, producing severe runoff and rutting
- Therefore, probably not suitable on silty or clay soils
- A very complex machine – Mr. Murphy is usually quite active!


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The End -- Questions?