

Irrigation With Reuse Water: System Design, Operation and Drift Considerations

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To maximize crop yield, quality (& nutrient uptake) while protecting surface & ground water:

- Apply nutrients at agronomic rate
- Supply water to meet crop needs (minimal stress)
 - The right amount of water at the right time
 - Keep up during unusually high ET periods
- Match wetted depth to root extraction pattern (avoid deep percolation)
- Apply water uniformly
- Minimize wheel track rutting and surface runoff

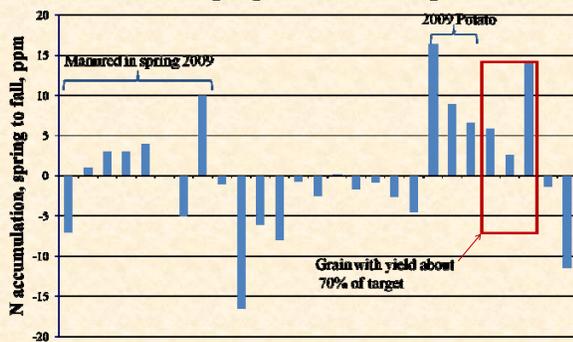
Applying nutrient-rich irrigation water at “agronomic rate” means:

- Nutrients from soil and applied nutrients are sufficient to produce the planned crop yield with little fall nutrient residual
- Agronomic rate based on anticipated yield goal so the crop yield goal must be realistic

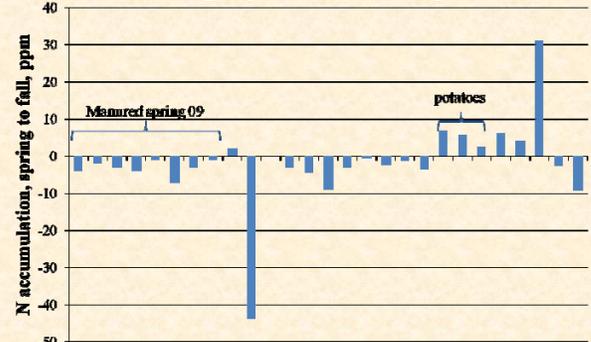
Irrigation Water Management

- Poor water management can reduce yield
 - higher fall soil nutrient levels
 - higher winter leaching potential
- Therefore, proper irrigation system design and in-season water management are essential to achieve crop yield, quality and reuse water goals
- Good in-season water management requires proper system design and maintenance

2009 Fall - Spring Total N, 0-12" Depth, 27 fields



2009 Fall - Spring Total N, 12-24" Depth, 27 fields



Types of Sprinkler Systems

- Set-move
 - Hand line
 - Wheel line
- Solid set
- Center pivot
- Linear Move

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



Hand Move Sprinkler Irrigation: 60-70% Application Efficiency
Typical nozzle spacing: 40' x 50' or sometimes 40' x 40'

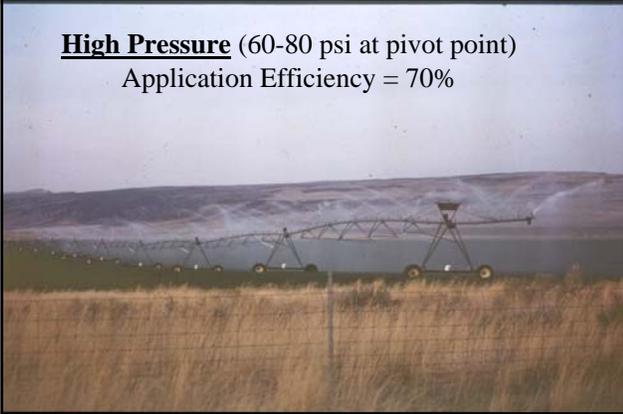


Wheel line: 60-70% Application Efficiency
Typical nozzle spacing: 40' x 50' or 40' x 60'(rarely)

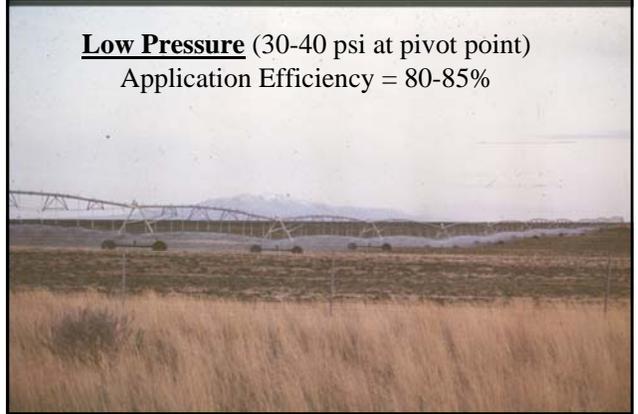


Solid Set Sprinkler Irrigation 60-70% Application Efficiency, Typical nozzle spacing: 40' x 40'

High Pressure (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 (about \$700/ac)



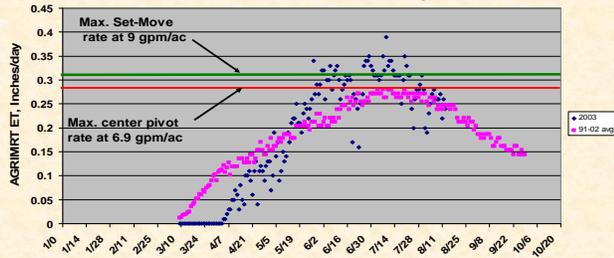


Sprinkler System Design

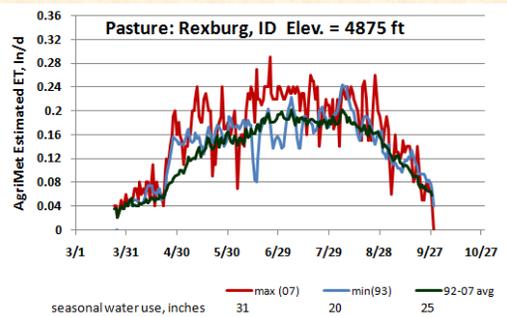
What should the irrigation system do?

- Apply nutrients at agronomic rate
- **Supply water to meet crop needs (minimal stress)**
 - The right amount of water at the right time
 - Keep up during unusually high ET periods
- Match wetted depth to root extraction pattern (avoid deep percolation)
- Apply water uniformly
- Minimize wheel track rutting and surface runoff

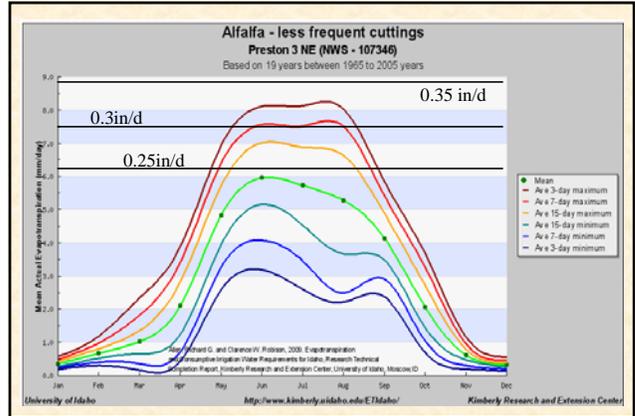
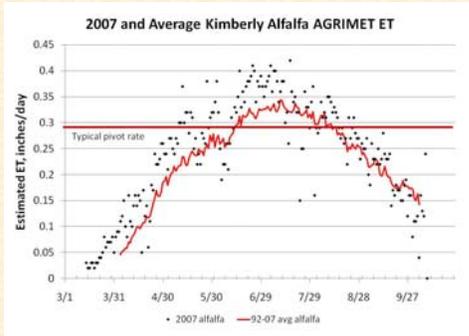
Mean Alfalfa ET - Kimberly



Yearly Water Use Patterns are Quite Variable

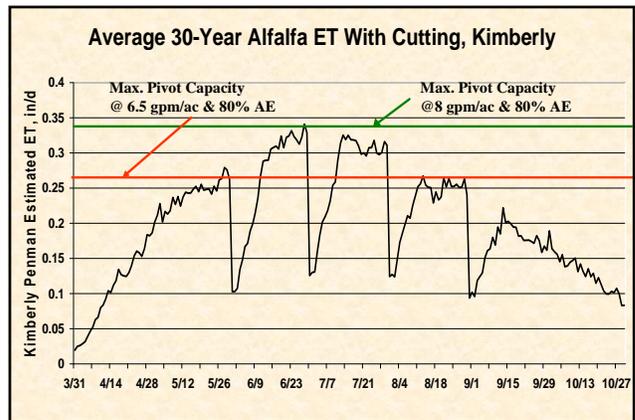


Pivot design should accommodate some uncertainty in peak ET



What do we want the irrigation system to do??

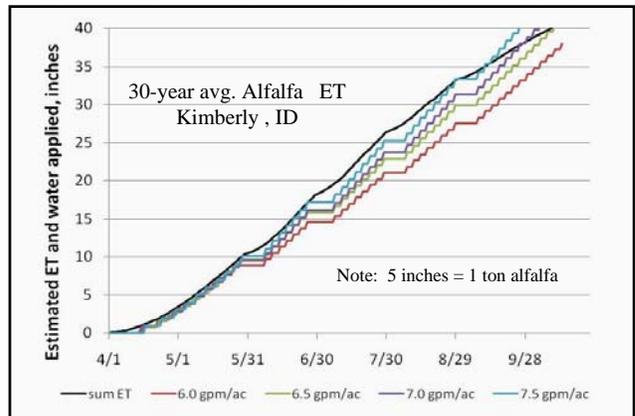
- Supply water to meet crop needs (minimal stress)
 - The right amount of water at the right time
 - **Keep up**
- Match wetted depth to root extraction pattern
- Apply water uniformly
- Minimize runoff and rutting



Water use during period when pivot is off for harvest

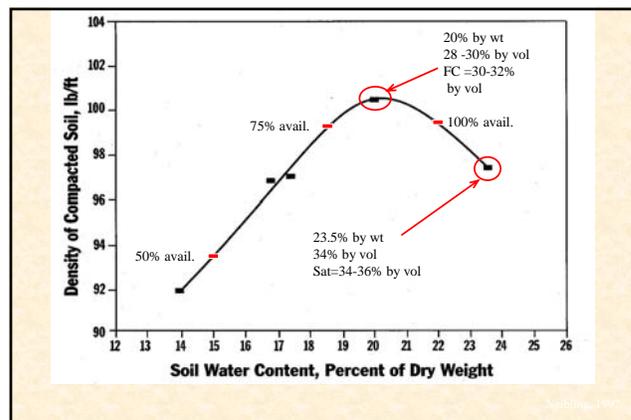
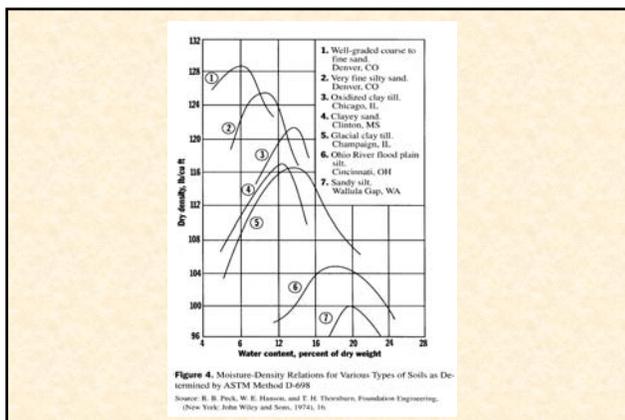
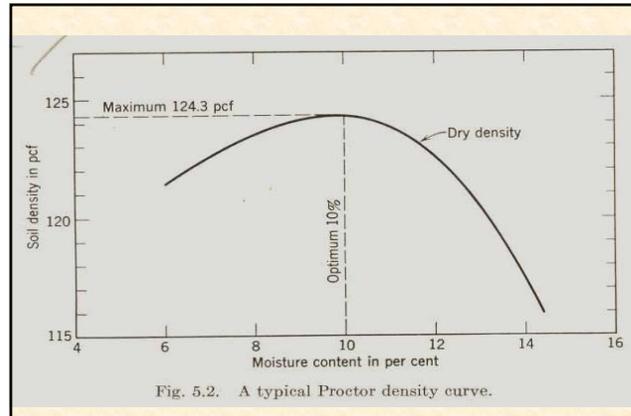
Cut #	Silt loam (2.4 in/ft)			Sandy loam (1.8 in/ft)			Sandy (1.0 in/ft)		
	ET and days before cut ()	ET drying	Total	ET and days before cut ()	ET drying	Total	ET and days before cut ()	ET drying	Total
1	0.6 (4)	0.9	1.5	0.45 (3)	0.9	1.35	0.25 (2)	0.9	1.15
2	0.6 (3)	1.1	1.7	0.45 (3)	1.1	1.55	0.25 (2)	1.1	1.35
3	0.6 (3)	1.1	1.7	0.45 (3)	1.1	1.55	0.25 (2)	1.1	1.35
4	0.6 (4)	0.8	1.4	0.45 (3)	0.8	1.25	0.25 (2)	0.8	1.05

The pivot needs adequate capacity to “catch up” during the reduced ET period following harvest



Minimize soil compaction

- Compaction reduces infiltration rate (increases surface runoff)
- Compaction is most severe when soil water content is near field capacity (1-3 days after irrigation)
- Therefore, on established grass or alfalfa stands, cut off water at least 3-4 days before harvest on silt loam soils (2-3 days on sandy soils)

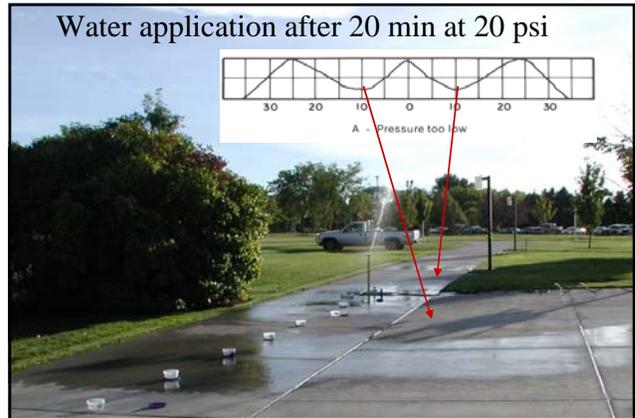
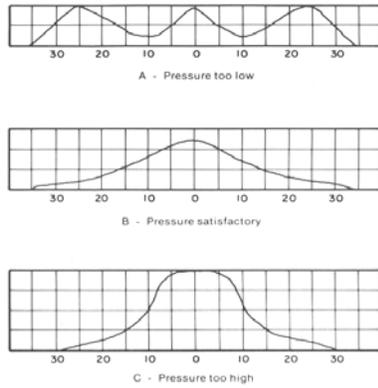


Sprinkler System Maintenance

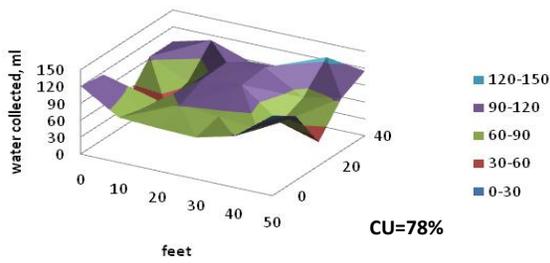
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- Supply water to meet crop needs (minimal stress)
 - The right amount of water at the right time
 - Keep up
- Match wetted depth to root extraction pattern
- **Apply water uniformly**
- Minimize runoff and rutting

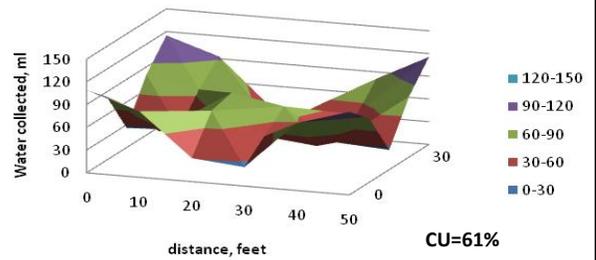
Pressure Effects on Sprinkler Water Distribution



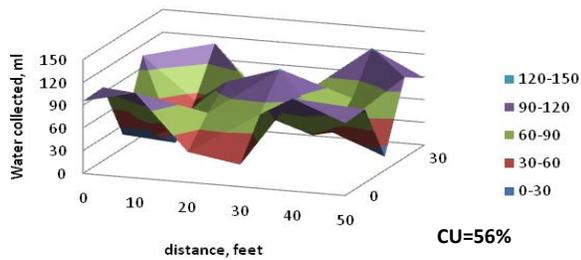
Impact sprinkler 7a, 50 psi, <2mph wind



Impact sprinkler 7a, 40 psi, <2mph wind

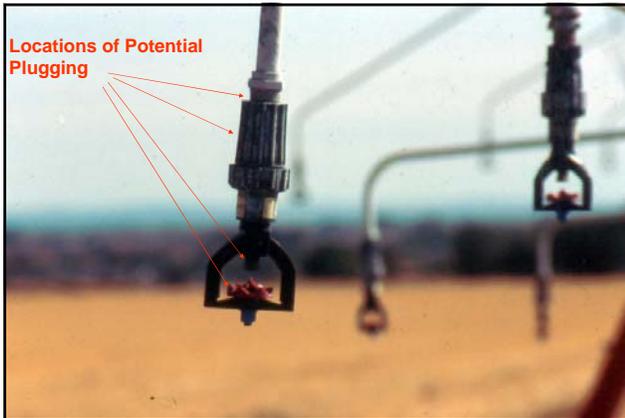


Impact sprinkler 7a, 30 psi, <2mph wind



Replace pressure regulators & nozzles every 5 years (wear and mineral deposits cause pressure to be too high or low & lower uniformity)





Irrigation Water Management

Adequate Early-season Water Is Important for Alfalfa Production!

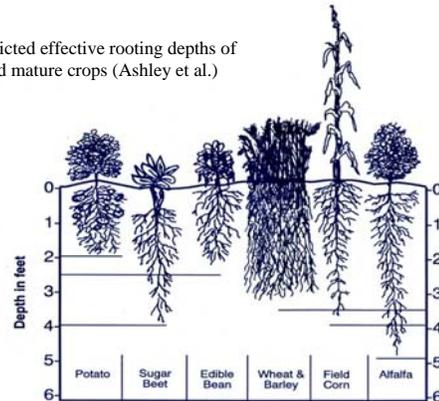
What is an inch of water worth?

- Early season: about 510 lb
- Remaining season: 400 lb

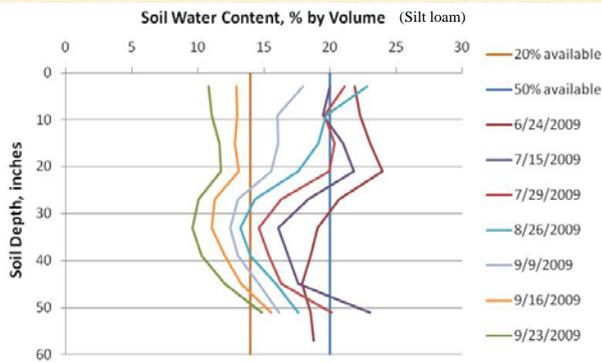
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Unrestricted effective rooting depths of Selected mature crops (Ashley et al.)



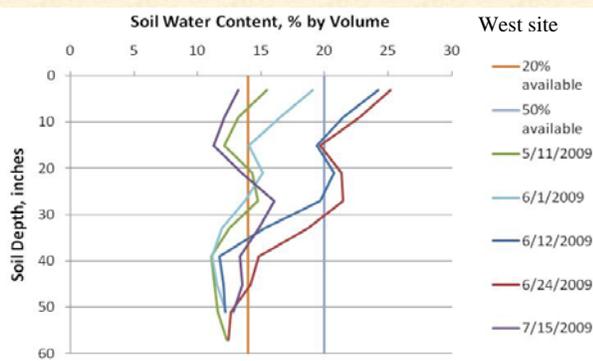
2009 Alfalfa Soil Profile Water Content Declo, ID



Depth Penetrated by a 1-inch Net Water Application (assuming uniform soil properties and uniform initial soil moisture with depth)

	Sand	Sandy Loam	Silt Loam	Clay
Average Water Holding Capacity (in/ft)	1.0	1.7	2.1-2.4	2.2
Moisture Content (% depleted)	Soil Depth (inches)			
25	48	28	20	22
35	34	20	14	16
50	24	14	10	11
75	16	9	7	7
100	12	7	5	5

2009 Alfalfa Soil Profile Water Content Declo, ID

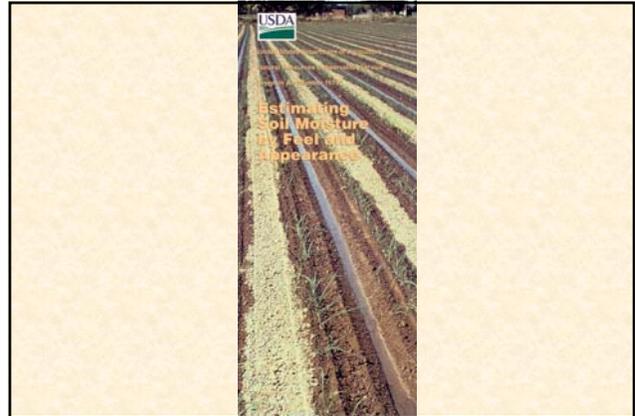


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35	34	20	14	16
50	24	14	10	11
75	16	9	7	7
100	12	7	5	5

On set systems:

- Apply water to re-fill active root zone (match set time and nozzle size to water needed to re-fill)
- Design system so return time occurs before water stress begins (e.g. keep root zone available water > 50%)
- Irrigation scheduling tools can help

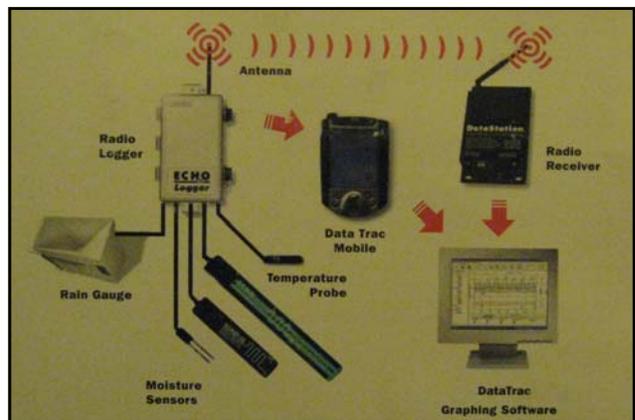
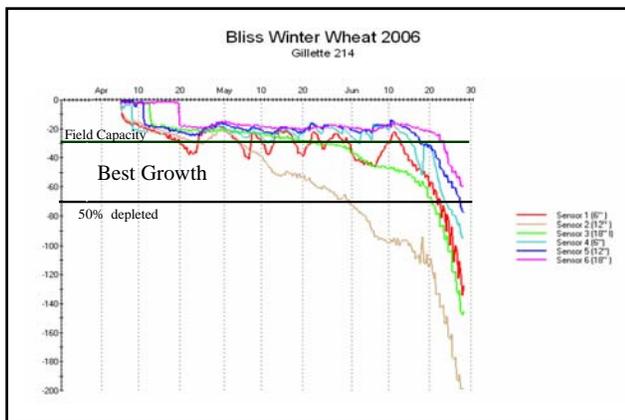


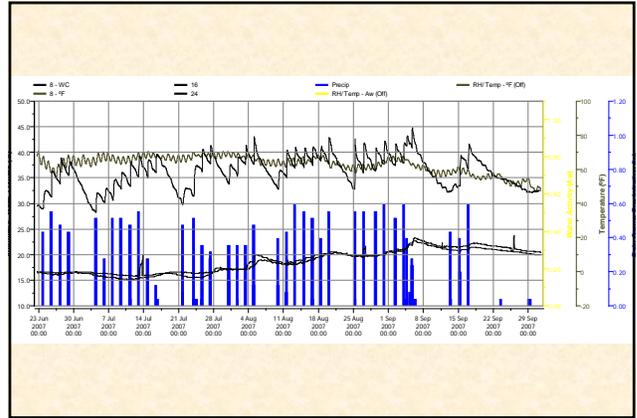
25-50 percent available
1.8-0.8 in./ft. depleted

Slightly moist, forms a weak ball, very few soil aggregations break away, no water stains, clods flatten with applied pressure.

Hansen AM 400 Data Logger

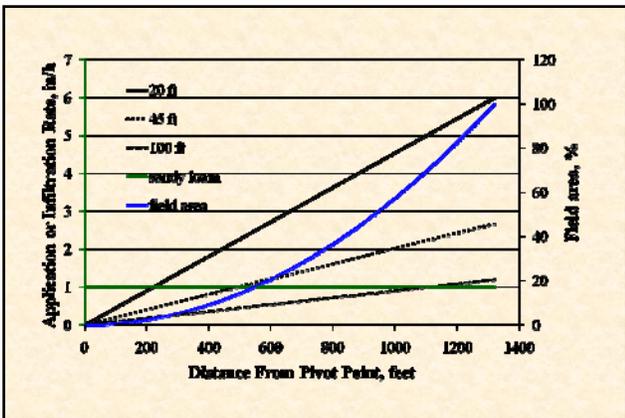
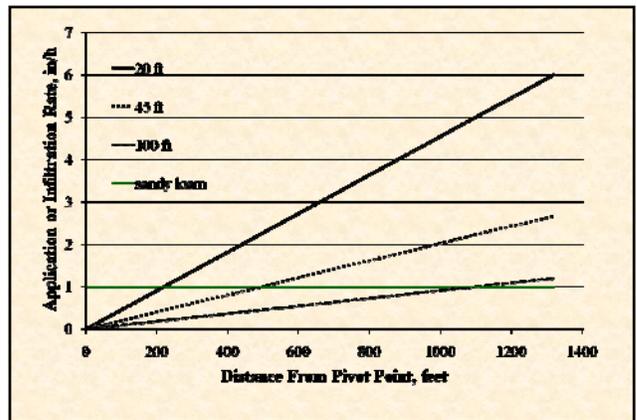
- Cost: about \$375+\$200 for wire and 6 sensors
- Records data from 6 sensors every 8 hours
- Single button display shows 5 weeks data for each sensor
- Weatherproof and can be used in the winter
- Memory stores entire season of data without downloading
- Can download at any time
- Shows change in moisture with time at selected depths
- Can be set up to show leaching events





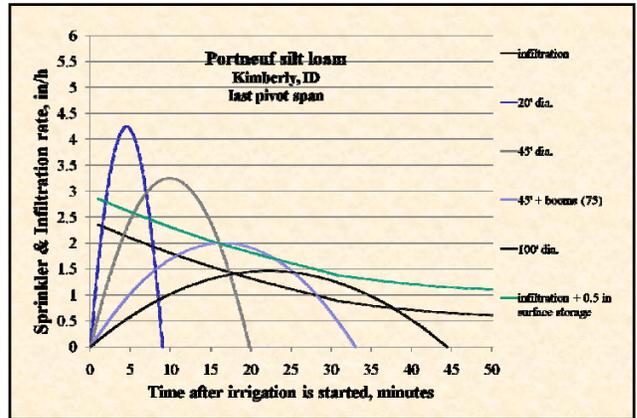
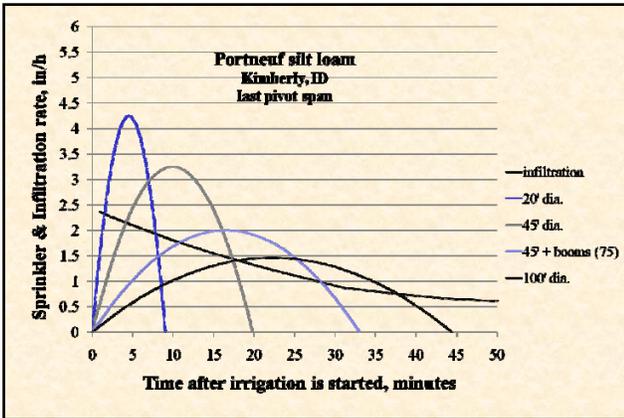
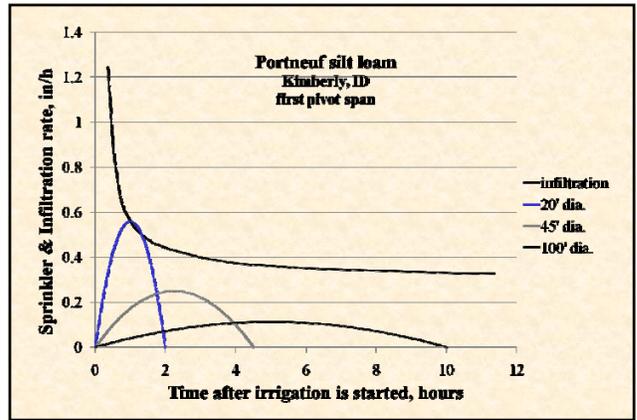
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 - The right amount of water at the right time
 - Keep up
- Match wetted depth to root extraction pattern
- Apply water uniformly
- **Minimize runoff and rutting**



Dual Nozzle Applications

- Low rate for early season or new alfalfa seeding - maintains adequate infiltration rate on bare soil
- Nozzle clip holds alternate nozzle in place at each drop for easy changing
- Cost: clip (about \$110) nozzle chart (about \$50) and nozzles (about \$110)



Reduce Pivot & linear Runoff Losses By:

- Choose proper application pack
- Use fore & aft booms to spread application pattern
- Limit application per revolution
- Aerate ?
- Consider multiple or wider tires

Fore and Aft Booms Spread the Application Pattern & Reduce Runoff



Summary

- For best irrigation water management, the system must be properly designed and well maintained
- Assure adequate system capacity to meet mid-season ET demand (considering appropriate soil water storage)
- Yield proportional to water added (5 inches per ton of hay)
- Irrigate young stands frequently to develop adequate root depth
- Assure adequate early-season soil water
- Fill root zone before peak water use period, while water is available, system has sufficient capacity, and evaporation rates are low.

Summary, Cont.

- Roots will develop to 4 ft + if soil and irrigation management allow – slow pivot to water deeper (with no runoff though !!)
- Irrigate right after harvest to enhance re-growth
- Center pivots typically barely “keep” up in an average” year
- Light-textured soils can usually accept up to 1 inch of net irrigation per revolution without runoff
 - This will wet about 16-24 inches deep
 - Return time is about 3 days in mid-season

Summary, Cont.

- Silt loam soils can usually accept up to about 0.7 inch per revolution to avoid runoff
 - This will wet about 12-16 inches deep
 - Return time is about 2 -2.5 days in mid-season
- To minimize drift
 - reduce system pressure
 - apply water closer to the crop canopy

The End -- Questions ??

