IRRIGATING ALFALFA

Making the Most of Your Water

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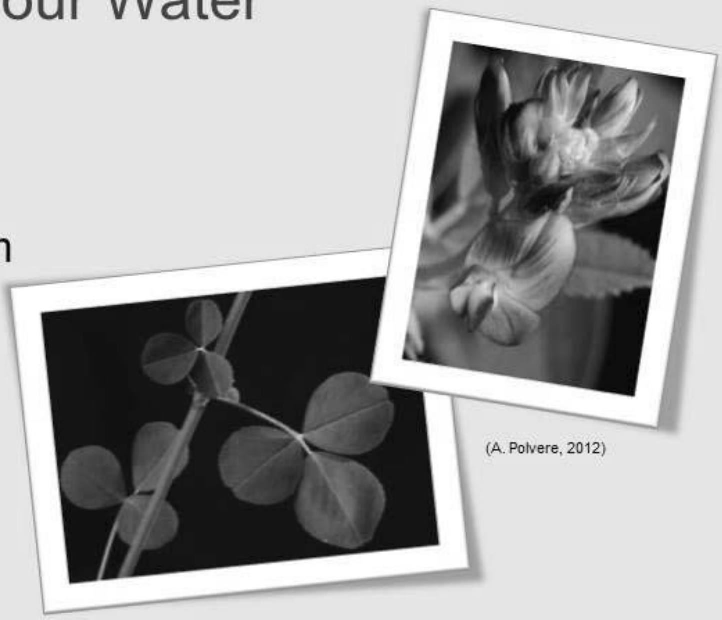


(A. Polvere, 2012)

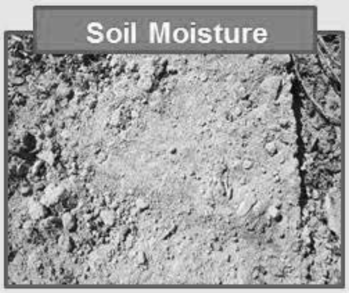
UNIVERSITY OF WYOMING EXTENSION

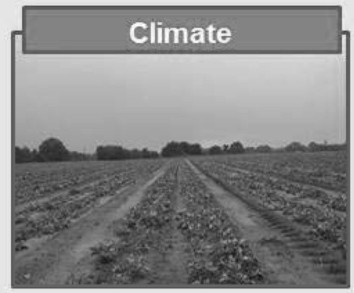
Outline

- Irrigation management
- Terminology
- Soil moisture
- Crop and climate factors
- Determine crop water use (ET_c)
- Irrigation Scheduling

(A. Polvere, 2012)

Irrigation management





Checkbook method

Starting the checkbook

- soil texture
- crop type, rooting depth and water use
- available water-holding capacity of the soil
- minimum allowable balance
- estimate of current soil water balance.

Water use terms

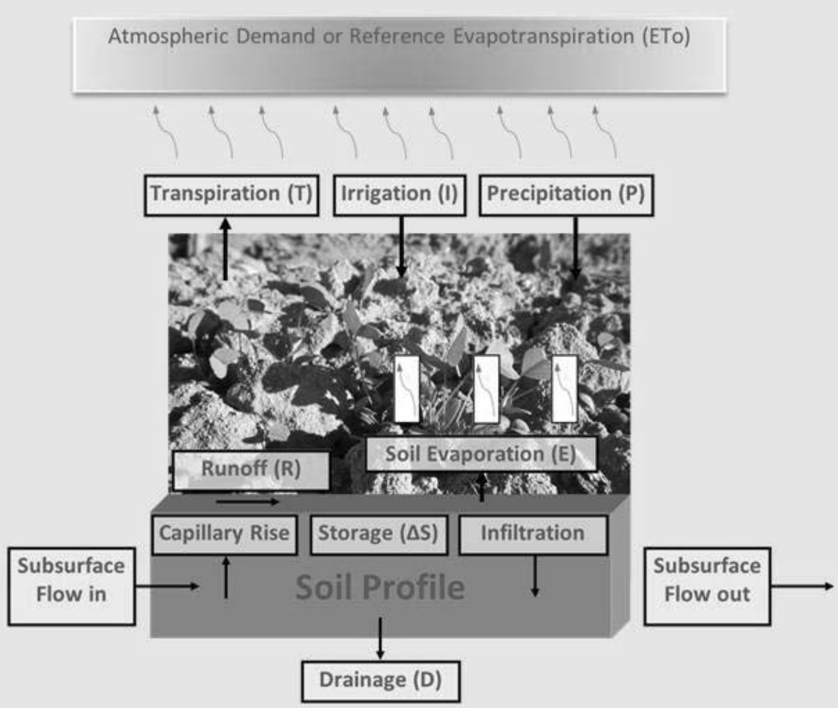
- Evaporation (E) – water loss from the soil.
- Transpiration (T) – water loss from the plant.
- Evapotranspiration (ET_{crop}) – combination of evaporation and transpiration.
- Reference evapotranspiration (ET_o) – tall grass ET.
- Crop coefficient (K_c) – ratio of grass water use (ET_o).

Irrigation terms

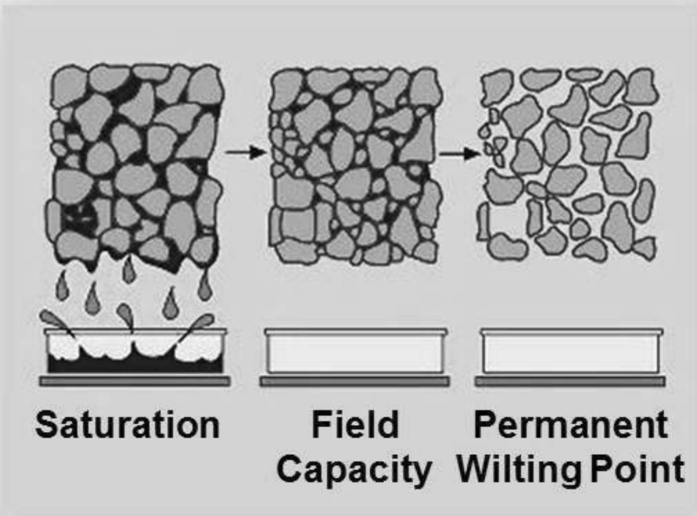
- Irrigation Scheduling – Determining when and how much water to apply.
- Manageable Allowable Depletion (MAD) – amount of water depletion that will trigger an irrigation, alfalfa: 50%.
- Application efficiency (E_a) – amount of water actually available to the crop.
- Field Capacity (FC) –Max water held by soil 12 – 24 hrs after soaking event.
- Permanent wilting point (PWP) –Amount of water held by soil that is not available.

SOIL MOISTURE

The water balance

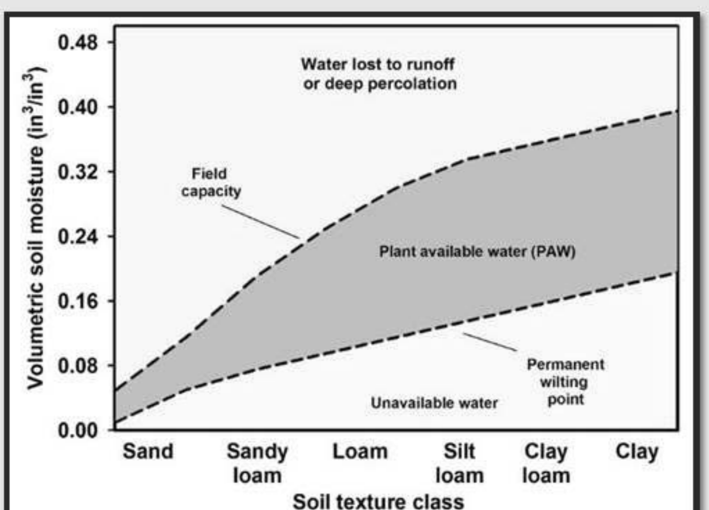


Field capacity vs. wilting point



- Texture
- Rocks
- Organic matter
- Bulk density
- Structure
- Rooting depth

Available soil moisture



- Field Capacity
- MAD: 50% Available Water
- Permanent Wilting Point

http://edis.ifas.ufl.edu/ae460

Soil Texture

Can be easily estimated in the field using the ribbon test

Or

http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

Category	Textures	AWHC (in/12 in soil)	"Ribbon" length (in)
Coarse	S / LS	0.6 – 1.2	None. Ball only.
Sandy	LS / SL / L	1.2 – 1.8	04 – 1
Medium	L / SCL	1.4 – 2.2	1 – 2
Fine	SiL / SiCL / CL / SiC	1.7 – 2.4	>2

Soil Available Water Capacity (AWC)

	Texture	Soil Textural Class	Estimated Average Plant AWC (in/ft^2)
Sandy Soils	Coarse	Sands	0.5
		Loamy sands	1.0
		Loamy fine sands	1.25
		Loamy very fine sands	1.25
		Fine sands	1.25
		Very fine sands	1.25
Loamy Soils	Moderately coarse	Sandy loam	1.5
		Fine sandy loam	1.5
	Medium	Very fine sandy loam	2.0
		Loam	2.0
		Silt loam	2.0
		Silt	2.0
	Moderately fine	Clay loam	2.2
		Sandy clay loam	2.2
		Silty clay loam	2.2
Clayey Soils	Fine	Sandy clay	2.0
		Silty clay	2.0
		Clay	2.0

WATERMARK Sensors, Irrometer

- Model 200SS WATERMARK Sensor and WATERMARK Meter

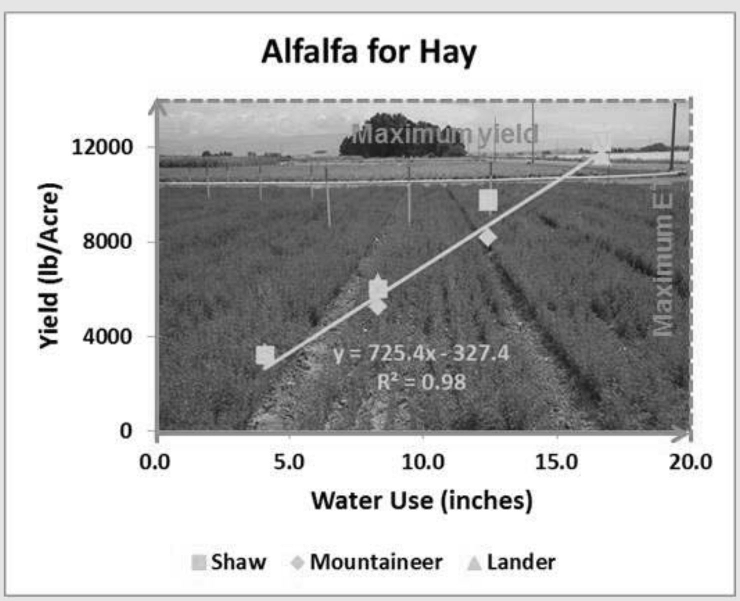
- Measures soil electric conductivity (EC), relates to the matric potential of the soil

CROP AND CLIMATE

Special considerations

- Perennial deep rooted crop, to 4 ft
- 7 to 10 day gaps in irrigation due top harvests
- Soil compaction can decrease infiltration rates
- Over-irrigation can quickly injure alfalfa plants and encourage weed invasion, especially right after harvest.
- Water use efficiency greatest during cool to moderate temperatures, especially during spring.

Alfalfa Water Use



Determining ET_o

- Wyoming Ag Weather Network:
  - www.wawn.net; Axel Garcia (307) 754-2223
  - Powell, Sheridan, Worland
- Nebraska Ag Water Management Network (NAWMN)
  - http://water.unl.edu/cropswater/nawmdn
  - SAREC, Torrington, Albin
  - Smart phone APP
- Literature: statewide estimates
  - Consumptive use and consumptive irrigation requirements in Wyoming. Larry Pochop, 1992

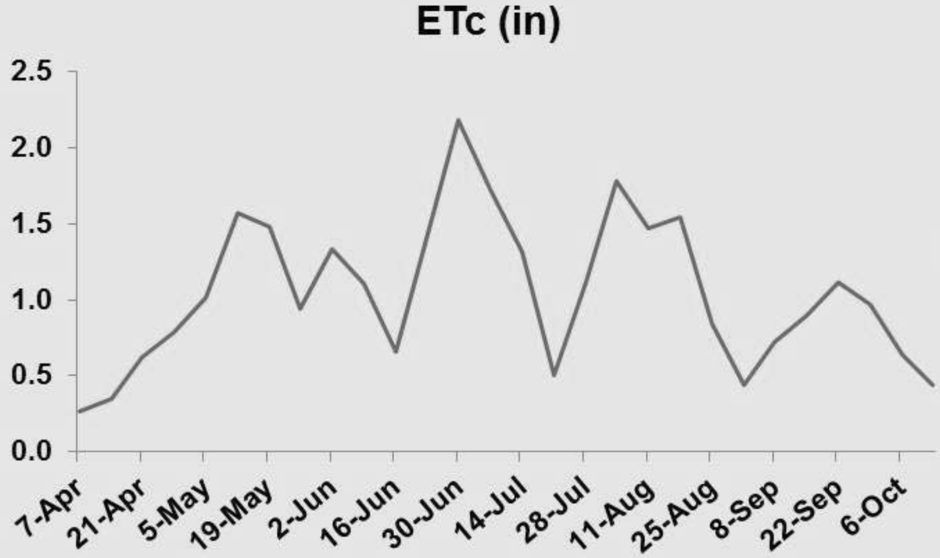
Determining K_c

- Ratio of actual crop water use to ET_o
- Based on growth stage of the plant
- Can generally be simplified to 0.95

Casper

	Kc
Apr	0.92
May	1.08
Jun	1.09
Jul	1.08
Aug	0.98
Sep	0.80
Oct	0.65
average	0.94

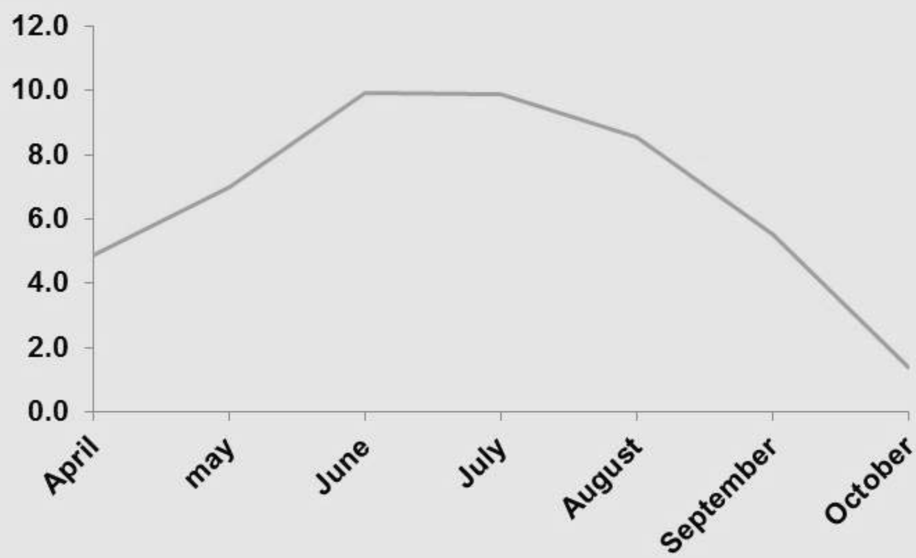
Determining ET_{crop} - variable K_c



<u>2012</u>
Powell
alfalfa ET_c

$$ET_o \times K_c = ET_{crop}$$

Determining ET_{crop} – constant K_c



<u>2012</u>
Casper
alfalfa ET_c

Pochop, L., T. Teegarden, G. Kerr, R. Delaney, and V. Hasfurther. 1992. Consumptive use and consumptive irrigation requirements in wyoming. Wyoming Water Resources Center, University of Wyoming, Laramie, WY, WWRC Publication #92-06. Laramie, WY.

PUTTING IT ALL TOGETHER

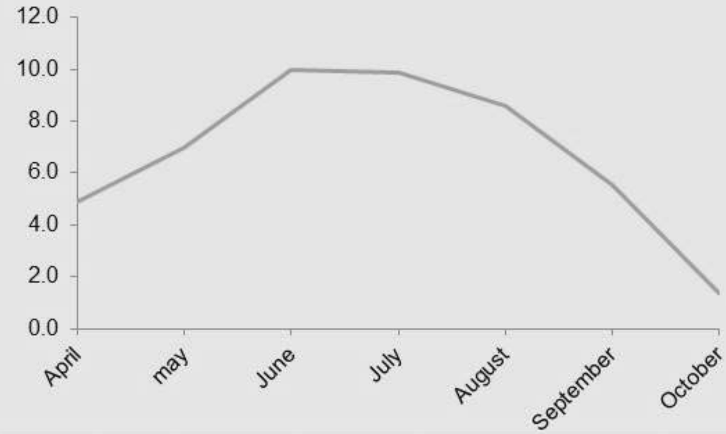
Irrigation scheduling: checkbook method

Pivot System capacity

- Acres: 140
- Hp: 60
- Psi: 45
- Gpm: 1050
- gpm/ac:
  - 1050/140 = 7.5
- in/day:
  - 7.5/0.05303 = 0.397725
- Efficiency: 80%
  - 0.39 *0.80 = 0.32 in/day (AE)

- Daily water balance will include:
  - Water in from irrigation and effective precip
  - Water out as ET_{crop}
  - balanced just like a checkbook

Checkbook method Example



$ET_o \times K_c = ET_{crop}$

Kc	
Apr	0.92
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average	0.94

		April	May	June	July	August	September	October	total
max	CU	3.23	5.31	7.38	8.72	7.51	4.46	1.02	37.62
	CIR	1.79	3.31	5.95	7.54	6.84	3.55	0.36	29.33
mean	CU	4.89	7.00	9.95	9.88	8.56	5.52	1.39	43.46
	CIR	4.54	8.70	9.14	9.48	9.40	5.34	1.38	39.66
min	CU	2.08	4.00	5.42	6.81	6.02	2.86	0.47	31.82
	CIR	0.00	0.00	1.42	5.85	3.36	0.00	0.00	19.21

Checkbook method example

- Rooting depth: 4 ft
- Soil type: fine sand
- Monthly water use: 9.88 in, July
- MAD: 50%
- Current soil moisture: field capacity
- Rainfall

- AWC:
  - 1.25 in/ft^2 x 4 ft = 5 in
- Daily water use:
  - 9.95/30 = 0.33 in/day
- Current soil moisture:
  - must be estimated or measured.
- Effective rainfall
  - Runoff during rainfall event?

Checkbook method example

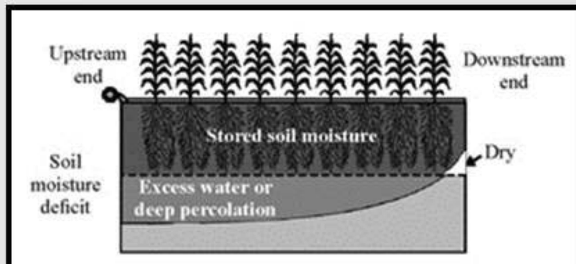
- AWC = 5 in
- MAD = 50%
- RAW = 5 x .5 = 2.5 in
- ET_c in June = 0.33 in/day
- RAW depletion:
  - 2.5/0.33 = 7.58 days
- Shows importance of maintaining soil moisture
- In order to avoid stress during max ET

FLOOD IRRIGATION

Improving efficiency

Flood irrigation

- Furrows
  - 30 to 60 in spacing
- Corrugations
  - 15 to 30 inches
  - Shorter field length
- Efficient flood irrigation
  - Almost filling root zone
  - Utilizing or minimizing runoff



1a. Poor uniformity — adjust stream size and set time.

Yonts, C.D., D.E. Eisenhauer, and D.L. Varner. 2007. Managing Furrow Irrigation Systems. University of Nebraska-Lincoln Extension. Lincoln, NB.

Flood irrigation management

$$stream\ size = \frac{pump\ discharge\ (gpm)}{number\ of\ furrows\ flowing}$$

$$gross\ depth = \frac{1{,}155\ x\ stream\ size\ (gpm)\ x\ time\ water\ applied\ (hrs)}{furrow\ length\ (ft)\ x\ wetted\ furrow\ spacing\ (in)}$$

Soil Texture	Ideal Gross Application
Sandy	1.5 – 2 inches
Medium to Fine	2.5 – 3 inches

Flood irrigation management

$$cutoff\ ratio = \frac{average\ advance\ time}{set\ time}$$

Target cutoff ratio based on soil and system considerations.			
	Sandy Soils	Loamy Soils	Clayey Soils
Without Reuse	0.5	0.70	0.9
With Reuse	0.20	0.40	0.5
Blocked Ends	0.7	0.85	0.95

Example

- Soil = sandy
- Pump discharge = 760 gpm
- Furrow length = 2,600 ft.
- Set time = 24 hours
- System = no reuse
- Set size = 80 gates flowing
- Watered furrow spacing = 30 inches
- Observed advance time = 15 hours

Example (cont.)

- $cutoff\ ratio = \frac{15\ hrs}{24\ hrs} = 0.63$
- $stream\ size = \frac{760\ gpm}{80\ furrows} = 9.5\ gpm\ per\ furrow$
- $Gross\ application = \frac{1{,}155\ x\ 9.5\ gpm\ x\ 24\ hrs}{2{,}600\ ft\ x\ 30\ in} = 3.4\ in$

- Cutoff time: 0.63 > 0.5
- Gross application: 3.4 inches, high for sandy soil

Example (cont.)

Parameter	Calculation Method	Example
Desired cutoff ratio	*Table 1*	0.5
New Advance Time	Desired Cutoff Ratio x New set time	0.50 x 12 hrs = 6.0 hrs
Advance Time Ratio	New Advance Time ÷ Original advance time	6 hrs ÷ 15 hrs = 0.40
Furrow Ratio	*Figure 2*	0.6
New Number of Gates	Original Number of Gates x Furrow Ratio	80 x 0.60 = 48 gates
New Stream Size	Equation 1	760 ÷ 48 = 15.6 gpm
New Gross Application	Equation 2	(1155 x 15.6 x 12) ÷ (2600 x 30) = 2.8 in

Yonts, C.D., D.E. Eisenhauer, and D.L. Varner. 2007. Managing Furrow Irrigation Systems. University of Nebraska-Lincoln Extension. Lincoln, NB.

PIVOT IRRIGATION

Flood to pivot

Why?

- Make better use of a limited water supply
- Save time/labor
- Potential yield/forage quality increase
- Improve water quality/quantity down stream
- Irrigation scheduling

Questions

- Owner operator or hire out help to irrigate?
- Decreased labor costs cover increased energy needs?
- Expect to see an increase in yield?
- Water quality?
- Hydrology effects?

The Bottom Line

- What will it cost me?
- Can I recoup the cost in increased production and decreased expenses?

Trial and error

How to implement new recommendations

Contact Information

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Web: www.uwextension.org/highplainscropsite

- Irrigation resources

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