

Historic Consumptive Use Methodology

- ARM 36.12.1902 -

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Historic Consumptive Use Approach

- **Why?** Historic Consumptive Use (ET) is often less than what is predicted.
- Need for the development of a reasonable method for estimating historic consumptive use,
 - Use best available data,
 - Understandable and easy to use methodology,
 - Public acceptance and final rule making.

Reasons Why Consumptive Use Is Often Below What's Predicted

- Inadequate water supply
- Water application is not uniform
 - topography
 - inadequate system design
 - inconsistent operations
- Infrequent irrigation
- Haying
 - down time
 - windrows covering a large area



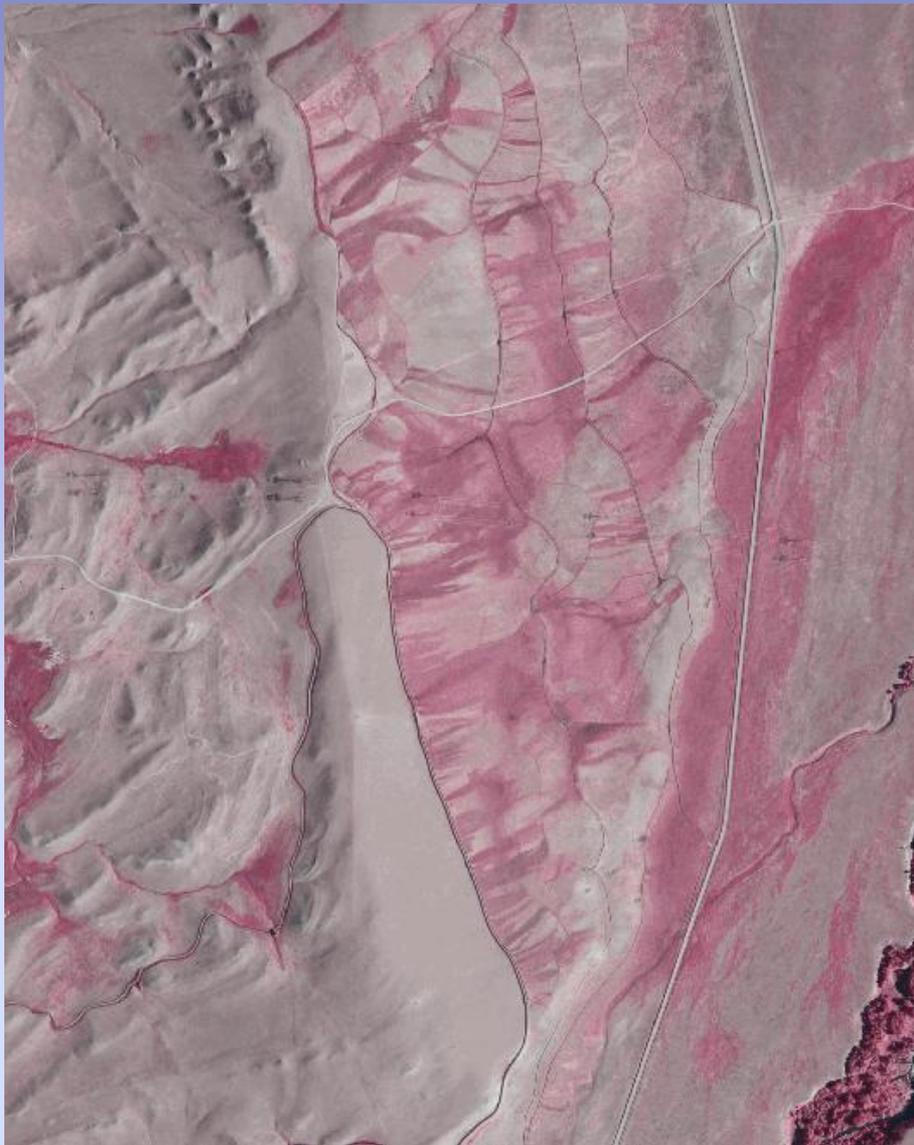


Photo from Scott Irvin

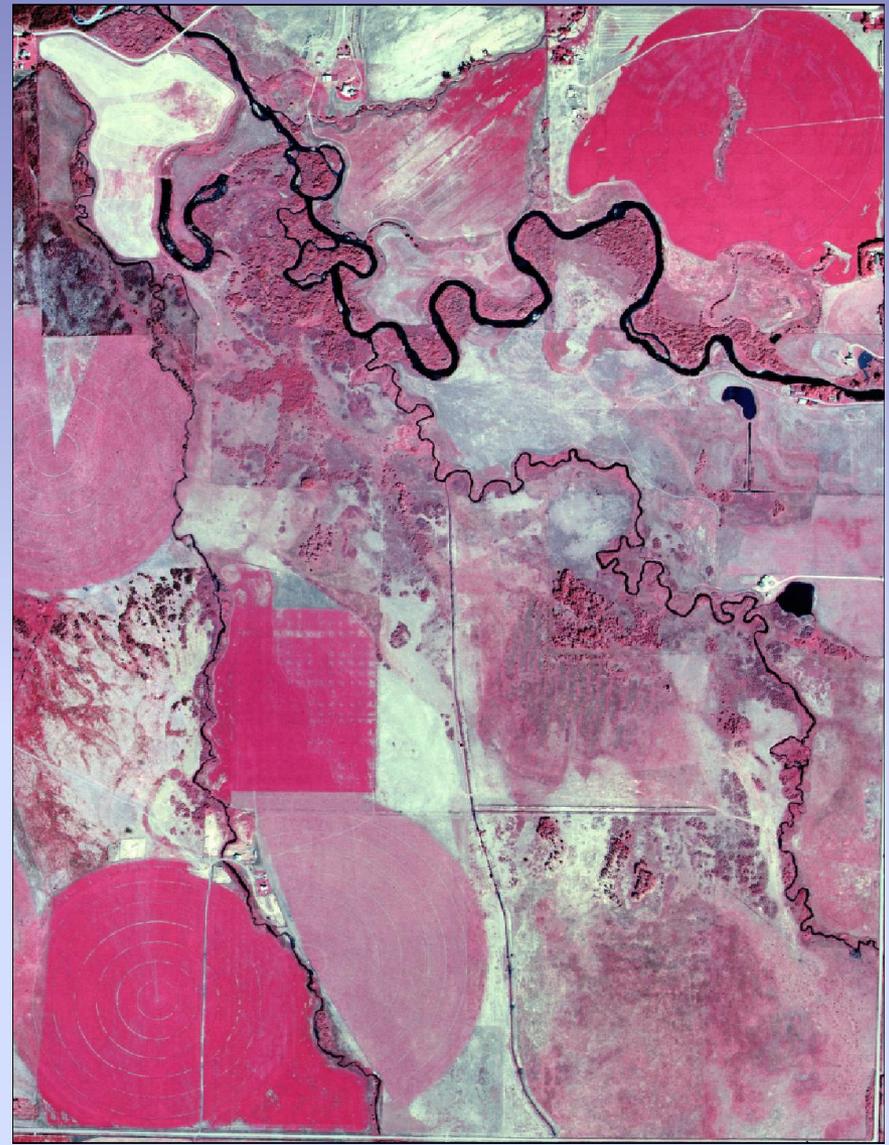


Photo from Gallatin WQD

Need to determine a Management Factor to determine how well producers approach the irrigation requirement.

Common Technical Approaches

- Montana Irrigation Guide
- Irrigation Water Requirements Program (IWR)
- Agriculture statistics

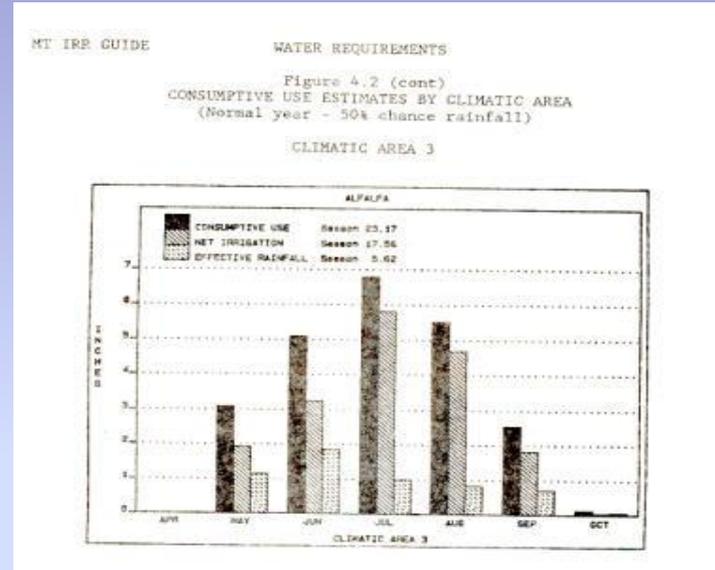
- Plus...Hydraulic and regression equations, METRIC (remote sensing), Agrimet Data, ET Equations (Modified Penman, etc.)

MT Irrigation Guide and IWR (NRCS - Blaney-Criddle)

-Calculations are based on experimentally-derived crop coefficients
mean daily temperature, percent of annual daytime hours

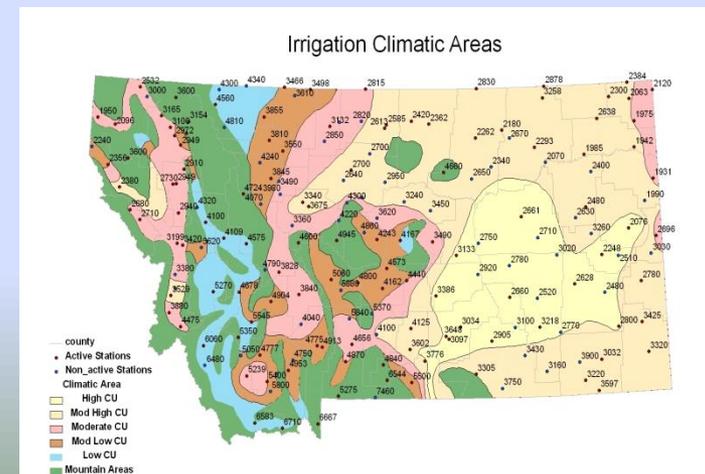
MT Irrigation Guidelines

- estimates seasonal consumptive use, net Irrigation and effective precipitation by climatic area
- not to be confused with the New Appropriations Rules ARM 36.12.115. Reflects diversionary use.



Irrigation Standards

	Climatic Area ¹ Acre Feet per Acre				
	I	II	III	IV	V
Sprinkler Irrigation 70% Efficiency	2.63 - 3.04	2.30 - 2.69	2.08 - 2.41	1.76 - 2.07	1.26 - 1.48
Level Border 60% Efficiency Design Slope Level	3.07 - 3.55	2.69 - 3.15	2.43 - 2.81	2.06 - 2.41	1.47 - 1.73
Graded Border 70% Efficiency Slope Group					
Design Slope .10%	2.63 - 3.04	2.30 - 2.69	2.08 - 2.41	1.76 - 2.07	1.26 - 1.48
Design Slope .20%					
Design Slope .40%					



Irrigation Water Requirements (IWR)

- Estimates net monthly and seasonal irrigation requirements based on crop needs, and effective precipitation (total requirement to meet demand)
- Uses historical weather station records (1970-2000) from statewide network
- Based on 1967 Soil Conservation Service TR-21 and NRCS Irrigation Water Requirements handbook dated 1983,
- Computer program released in 2003.

To download go to:

<http://www.mt.nrcs.usda.gov/technical/eng/software.html>



Comparison of Kimberly Penman (Agrimet) and Blaney-Criddle (IWR)
 (based on similar growth periods from May through September, 2000, 2009, 2010)

	1982 Kimberly Penman <u>(Agrimet)</u>	Blaney-Criddle <u>IWR*</u>	<u>% difference</u>
<u>Climatic Area 1</u>			
Buffalo Rapids-Glendive	29.1	32.47	10.4
Buffalo Rapids – Terry	29.6	28.7	-3.1
<u>Climatic Area 2</u>			
Glasgow	29.09	30.3	4.0
Corvallis	25.4	25.1	-1.2
<u>Climatic Area 3</u>			
Helena	26.6	26.03	-2.2
Broken O	23.8	23.95	0.6
<u>Climatic Area 4</u>			
Bozeman	27.7	26.26	-5.5
<u>Climatic Area 5</u>			
Deer Lodge**	21.2	17.85	-18.8

*IWR results use Total ET to provide accurate comparison to Agrimet values.

**Deer Lodge is located on the boundary between Climatic Area 4 and Climatic Area 5.

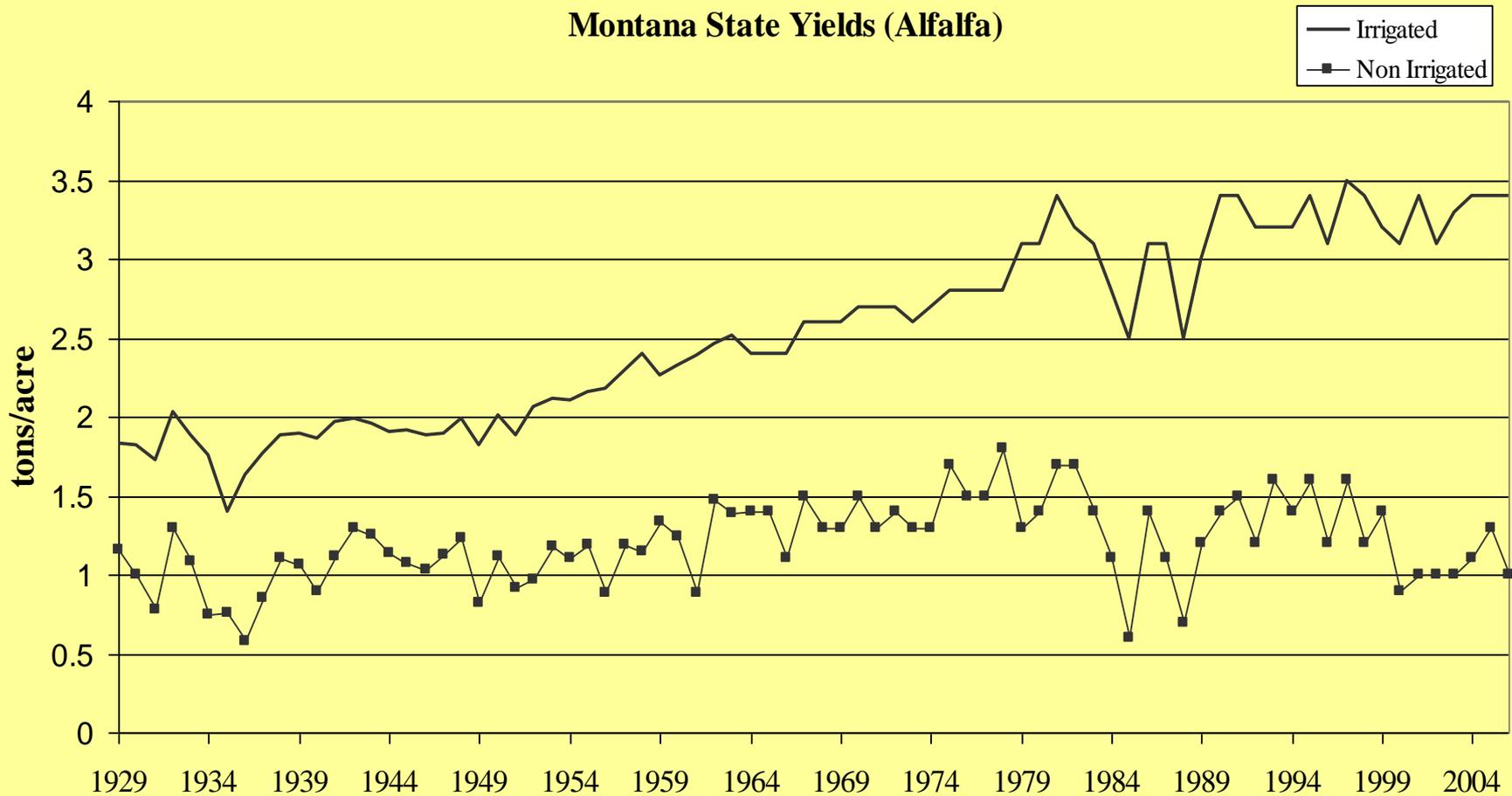
Montana Agriculture Statistics

- Alfalfa hay yields statewide → 1929-present
county → 1964-present
- appx. 80% hay producers report (>100 ac)
- pre-survey questionnaire, follow-up phone call field interviews

The screenshot shows the USDA National Agricultural Statistics Service website for Montana. The header includes the USDA logo and the text "United States Department of Agriculture National Agricultural Statistics Service". Below the header is a navigation bar with links for Home, About NASS, Newsroom, Publications, Data and Statistics, Census, Surveys, Help, and Contact Us. The main content area is titled "Montana office of USDA's NASS" and features a "Search NASS" box, a "Browse NASS by Subject" menu, and a "Statistics by State" dropdown. The "Montana Statistics" section includes "Quick Stats" and "Montana Publications". The "Ag Statistics by Commodity" section lists Crops, Livestock, Economics/Prices, and County Estimates. The footer contains links for NASS Home, USDA.gov, FEDSTATS, Economics Statistics System (ESS), Site Map, Translate, USA.gov, White House, FOIA, Accessibility Statement, Privacy Policy, Non-Discrimination Statement, Information Quality, and Guidance Documents.

Montana Agriculture Statistics

Montana State Yields (Alfalfa)



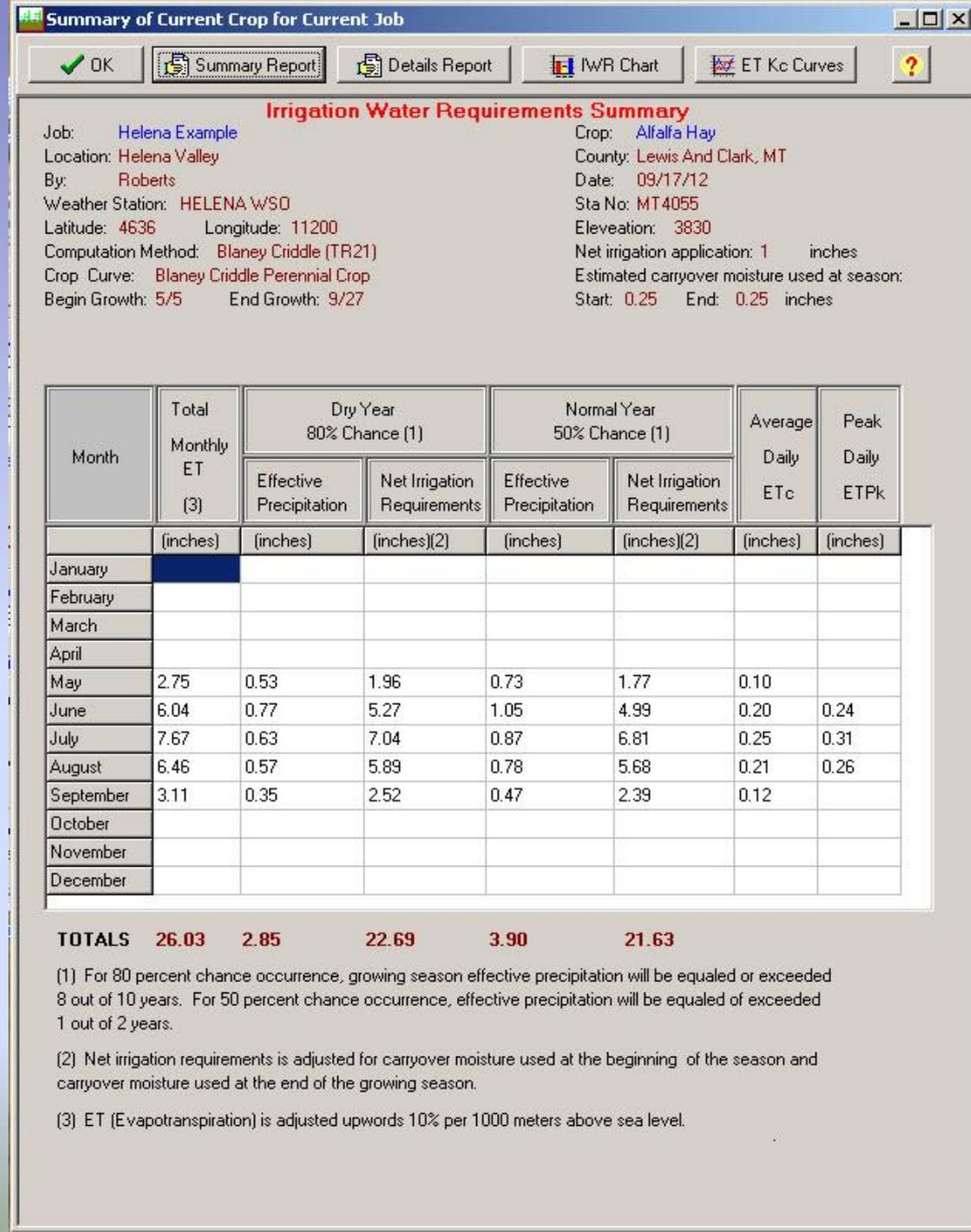
Increasing Trend: sprinkler irrigation improvements
flood irrigation improvements (gated pipe, land leveling, etc.)
improvements in genetics and fertilizers

1964-73 = 2.51 tons/ac, 1973-2006 = 3.03 tons/ac, 1997-2006 = 3.22 tons/ac

Historic Consumptive Use:

f { Irrigation Water Requirements Program
Montana Agriculture Statistics

IWR Center Pivot Output for Helena Valley



IWR Settings

- Growing season start 50 degrees, growing season end 28 degrees,
- Net irrigation application center pivot = 1 inch
Flood/sprinkler = 4 inches,
- Carryover moisture 25% of net irrigation application,
- Climate set to arid with moderate wind.

Basic IWR approach

- Calculate total and irrigation consumptive use for alfalfa using IWR and 180 weather stations,
- Use 6 in. water per ton of alfalfa to calculate obtainable yield for each site,
- **Management Factor** calculated by dividing the Ag Stats yield by the obtainable yield (% of full service irrigation)

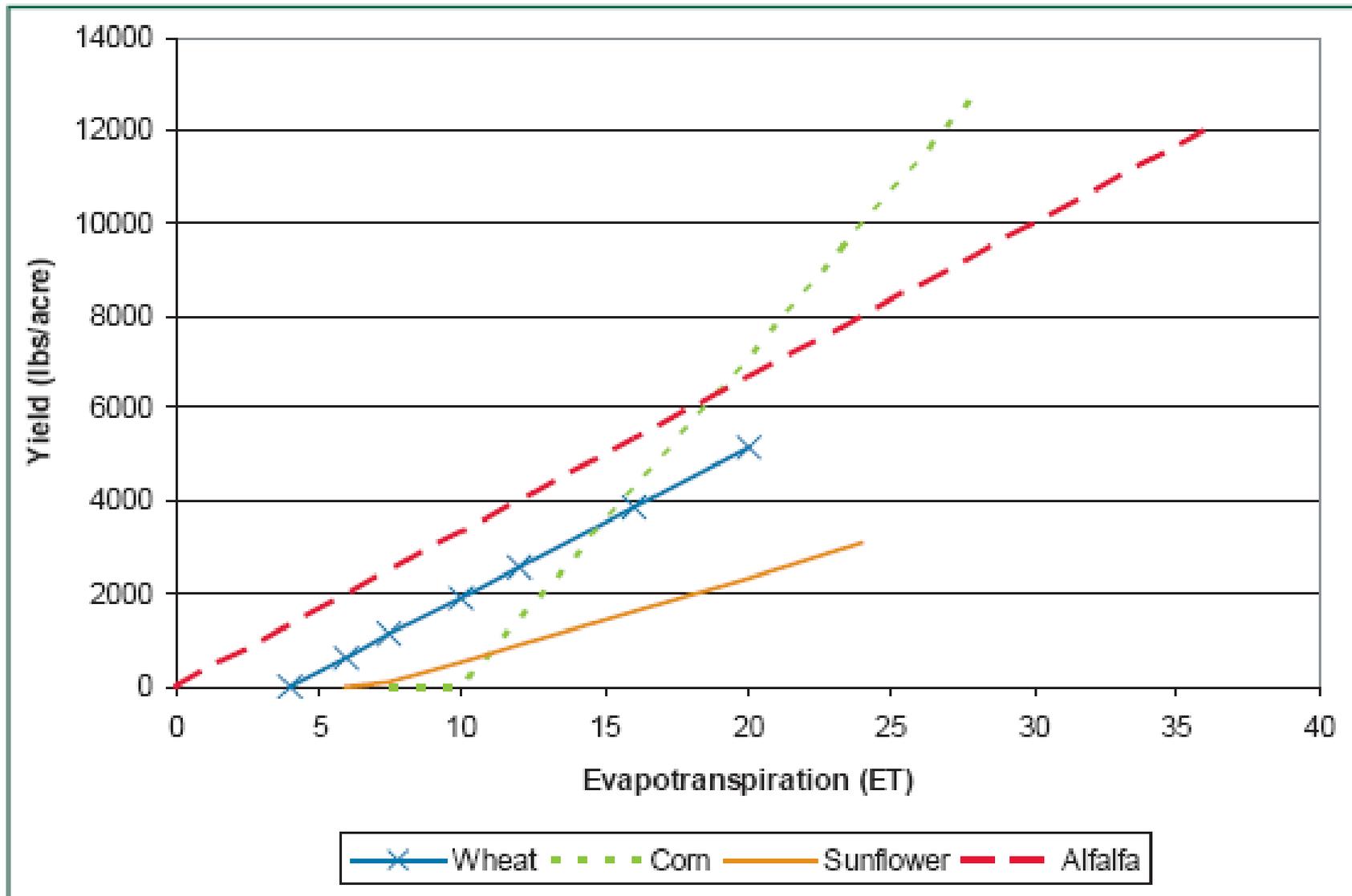


Figure 1. Crop yield and seasonal evapotranspiration relationships.

County Management Factor

- GIS group identified average elevation of irrigated ground in each county,
- Identify most representative weather station based on county elevation and centroid of irrigated land,
- Run IWR and determine obtainable yield,
- Use Ag-Stats to find management factor.

County Management Factor

Obtainable Yield =

Total ET Requirement (in.) / 6 inches/ton water

County Management Factor =

County Ag Stats (tns/ac) / Obtainable Yield (tns/ac) x 100

County Stats-Final Table

<u>County</u>	<u>Mean Elevation</u> <u>Irrigated Lands</u>	<u>Mean</u> <u>Latitude</u>	<u>Mean</u> <u>Longitude</u>	<u>Obtainable</u> <u>Yield</u>	<u>County Ag-stats</u> <u>1964-1973 (ton/ac)</u>	<u>Management</u> <u>Factor</u> <u>1964-1973</u>
Beaverhead	5710	45.24	-112.66	4.0	2.54	63.7
Big Horn	3142	45.66	-107.59	4.4	2.45	55.4
Blaine	2512	48.54	-108.97	4.7	2.76	58.7
Broadwater	4051	46.24	-111.49	4.6	3.15	69.2
Carbon	4198	45.39	-108.99	4.9	2.84	58.3
Carter	3362	45.65	-104.40	4.5	1.74	38.4
Cascade	3651	47.37	-111.40	4.5	2.56	57.3
Chouteau	2791	47.88	-110.32	4.8	2.53	52.5
Custer	2447	46.43	-105.83	5.1	2.80	54.5
Dawson	2122	47.23	-104.87	5.7	3.21	56.8
Fallon	2818	46.42	-104.47	5.0	2.37	47.6
Statewide	3448			4.46	2.51	57.2

Example

Estimate historic consumptive use for an acre of flood irrigation near Bozeman, MT (Gallatin County),

- Most representative weather station is Bozeman MT State, flood irrigation water requirement is 18.42 inches (ARM 36.12.1902, Table 1),
- Gallatin County management factor = 73.5% of the obtainable yield,
- $0.735 * 18.42 \text{ inches} = 13.54 \text{ in.}$
or 1.13 af/acre,

Column A	Column B	Column C	Column D	Column E	Column F
County	Weather Station	Elevation	IWR Flood Irrigation, Wheeline & Handline Seasonal ET (inches)	IWR Center Pivot Irrigation Seasonal ET (inches)	Management Factor Percentage 1964 - 1973
	Whitefish	3100	15.74	18.61	
Gallatin	Bozeman Exp Farm	4775	16.84	19.55	73.5%
	Bozeman MT State	4913	18.42	21.39	
	Hebgen Dam	6667	10.09	12.77	
Garfield	Cohagen	2710	22.36	24.99	43.4%
	Jordan	2661	23.58	26.32	
	Mosby	2750	24.51	27.34	
Glacier	Babb	4300	12.12	14.87	59.7%
	Cut Bank	3855	16.01	18.60	
	Del Bonita	4340	14.61	17.30	
	East Glacier	4810	10.60	13.26	
	St Mary	4560	13.64	16.60	
Golden Valley	Ryegate	4440	17.60	20.17	62.6%

Permit Applications Historic Use

1973-2006

County	Weather Station	Elevation	IWR Flood Irrigation, Wheeline & Handline Seasonal ET (inches)	IWR Center Pivot Irrigation Seasonal ET (inches)	Management Factor Percentage 1964 - 1973	Management Factor Percentage 1973 - 2006
	Trident	4040	20.64	23.31		
Carbon	Joliet	3776	22.41	25.12	58.3%	66.8%
	Red Lodge	5500	15.57	18.41		
Carter	Ekalaka	3425	20.13	23.14	38.4%	54.7%
	Ridgeway	3320	20.28	23.01		
Cascade	Cascade 20	4600	14.12	16.63	57.3%	70.0%
	Cascade 5	3360	17.90	20.75		
	Great Falls	3675	19.78	22.55		
	Neihart	4945	12.17	15.08		
	Sun River	3340	18.10	20.65		
Chouteau	Big Sandy	2700	21.52	24.37	52.5%	65.3%
	Fort Benton	2640	21.98	24.75		
	Geraldine	3130	20.30	23.27		
	Iliad	2950	21.55	24.27		
	Loma	2700	22.64	25.37		
	Shonkin	4300	13.32	16.70		
Custer	Miles City	2628	26.68	29.55	54.5%	72%
	Mizpah	2480	23.80	26.57		
	Powderville	2800	24.83	27.68		
Dawson	Glendive	2076	26.01	28.99	56.8%	63.6%
Deer Lodge	No weather station				See appropriate adjacent county	
Fallon	Plevna	2780	22.48	25.34	47.6%	47.8%
Fergus	Denton	3620	15.39	18.12	48.8%	65.8%
	Grass Range	3490	18.93	21.93		
	Lewistown	4167	15.54	18.44		
	Roy	3450	19.94	22.78		
	Winifred	3240	17.86	20.75		
Flathead	Creston	2949	14.97	17.81	87.6%	94.5%
	Hungry Horse Dam	3160	14.66	18.06		
	Kalispell	2972	16.45	19.03		
	Olney	3165	12.50	15.16		
	Polebridge	3600	10.20	12.50		
	West Glacier	3154	13.74	16.78		
	Whitefish	3100	15.74	18.61		

Conclusions

- IWR and Ag-Stats will be used to determine a management factor for quantifying historical consumptive use.
- Methodology: simple and consistent
- Applicants can argue for larger amount, but must present evidence/proof, such as diversion records matched to hay-harvests, or justification for tweaking input parameters.
- Helps standardize DNRC review of applications.