

Efficient Irrigation

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Agriculture and Water

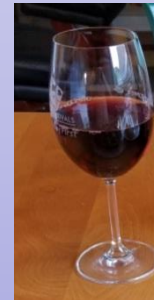
- Livestock



- Crops



- Processing



Importance of water for agriculture

- Life requires water
 - Livestock
 - Plants
 - Value of water
 - What if we don't have it?
- Where do we get our water?
 - Precipitation – rain, snow
 - Streams - rivers, lakes, creeks, springs
 - Groundwater – wells, dugouts

What Right do we have to Water

- First water licences 1864
- *Water Act* – 1909
 - Surface water
- *Water Sustainability Act* – 2016
 - Groundwater
- First in Time - First in Right (FITFIR)
 - Purpose – irrigation, stock-watering, domestic

Why do we Irrigate?

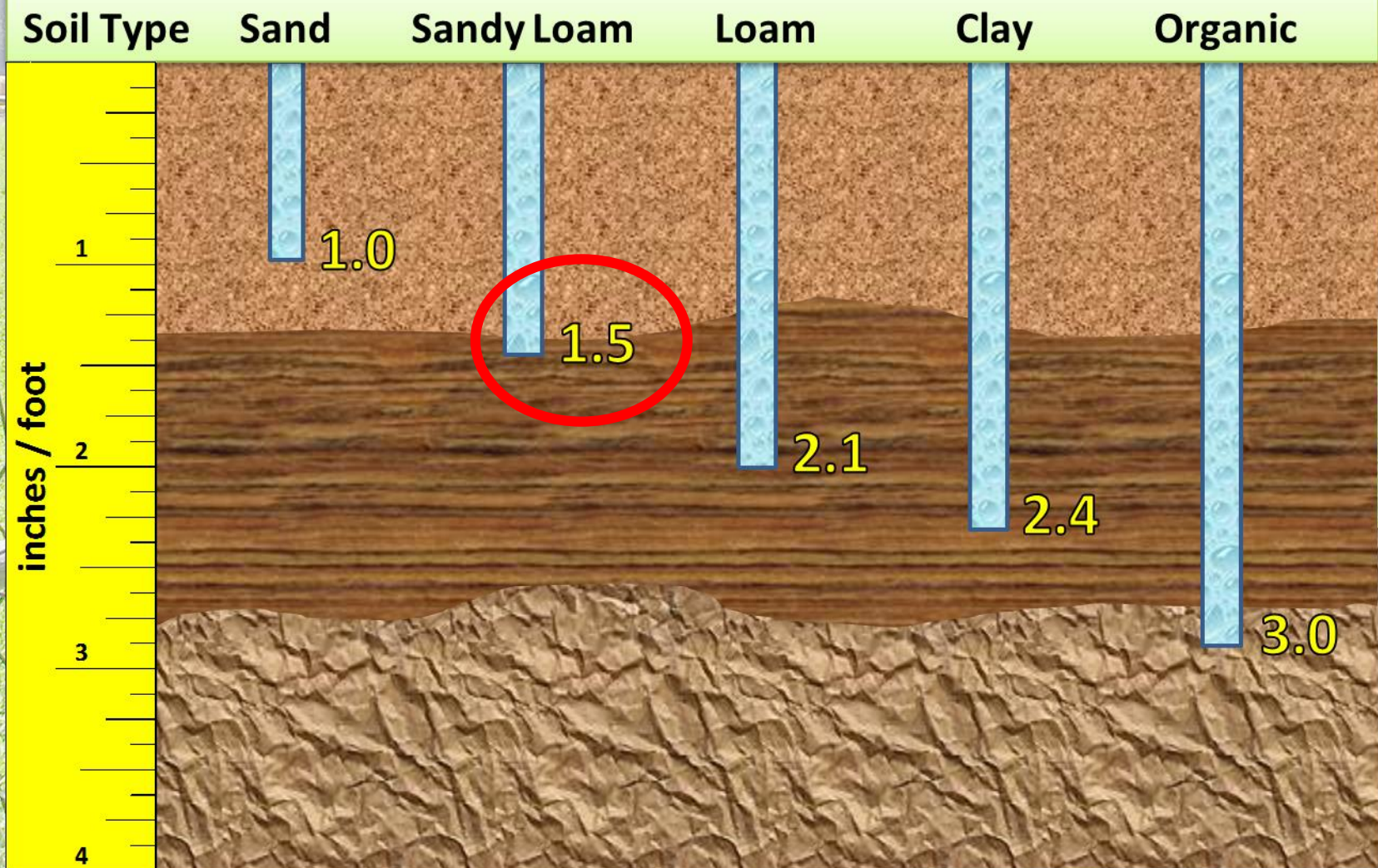
- To grow a productive crop
- To replenish Soil Moisture
- Soil is our storage tank for water
- Soil structure is very important

Soil Structure

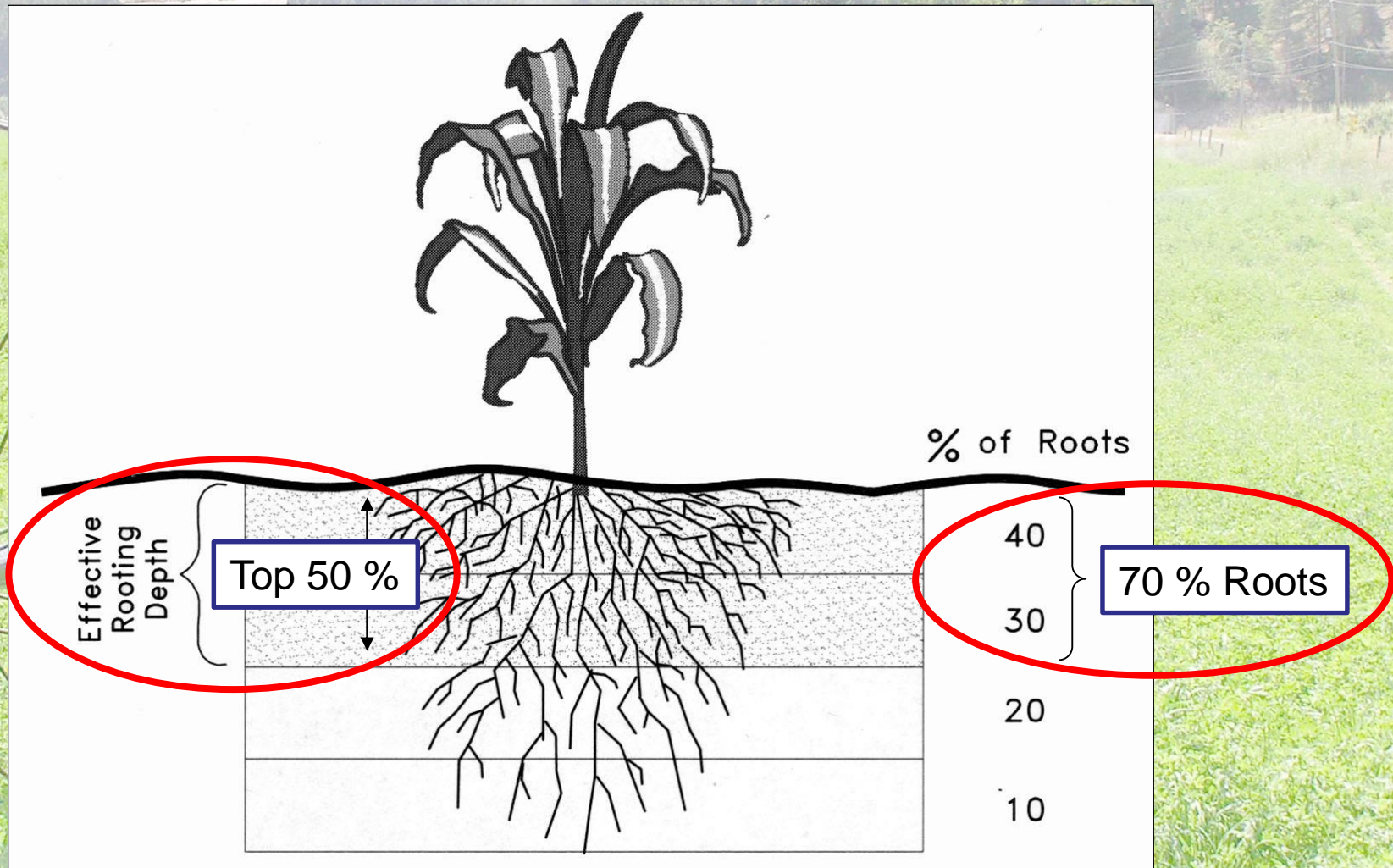


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Available Water Storage Capacity (AWSC)



Effective Rooting Depth



Effective Rooting Depth

Shallow 0.45 m (1.5 ft)	Medium Shallow 0.6 m (2 ft)	Medium Deep 0.9 m (3 ft)	Deep 1.2 m (4 ft)
Cabbages Cauliflowers Cucumbers Lettuce Onions Radishes Turnips Grass Conifer Tree Shallow	Beans Beets Blueberries Broccoli Carrots Celery Peas Potatoes Spinach Strawberries Tomatoes Tree Fruits (3' x 10') Conifer Tree	Brussels Sprouts Cereal Clover (red) Corn (sweet) Eggplant Kiwifruit Peppers Squash Saskatoons Tree Fruits (6' x 12')	Alfalfa Asparagus Blackberries Corn (field) Grapes Loganberries Raspberries Sugar beets Tree Fruits (12' x 18')

How much water can the soil store?

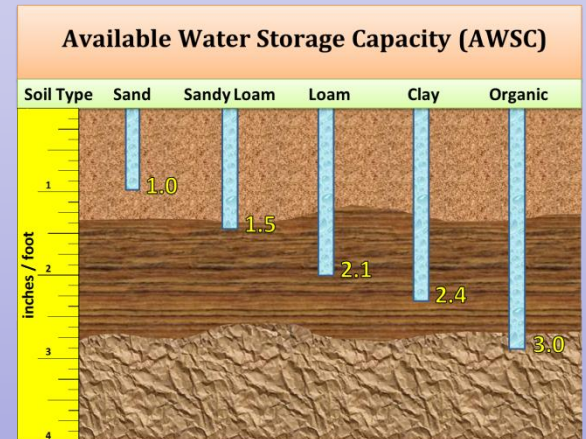
➤ Depends on soil type and tree rooting depth.

➤ Field Corn = 4.0 ft root depth

➤ Sandy loam = 1.5 in water / ft

➤ Total AWSC = 4.0×1.5

➤ = 6.0 in



Shallow Rooted Crop

- If grass is grown instead:
- Grass = 1.5 ft root depth
- Sandy loam = 1.5 in water / foot
- Total AWSC = 1.5×1.5
- = 2.25 in

Availability Coefficient, (AC)

Maximum percentage of the total AWSC that the crop can remove before irrigation should occur again.

Crop	Maximum Percent
Peas	35
Potatoes	35
Tree Fruits	40
Grapes	40
Others	50
Conifer Tree	70

How much water can be applied at one time?

- Maximum Soil Water Deficit is the amount of water that is readily available to the crop.

$$\text{MSWD} = \text{AWSC} \times \text{AC}$$

Example

$$\text{MSWD (Corn)} = 6.0 \times 0.50$$

$$= 3.0 \text{ inch}$$

What if it was shallow rooted crop?

➤ Maximum Soil Water Deficit:

$$\begin{aligned}\text{MSWD (Grass)} &= 2.25 \times 0.50 \\ &= 1.3 \text{ inch}\end{aligned}$$

➤ Same field but need to manage the irrigation system differently.

How do we apply this water?

➤ Irrigation systems types

Application Rates (AR)

- Is the depth of water applied by the irrigation system per hour

Application Efficiency (AE)

- Is an indication of the percentage of water applied by an irrigation system that is actually available to the crop

Stationary Gun



AE = 58%

AR = 0.5 – 0.75 in/hr

Travelling Gun

$AE = 65\%$

$AR = 0.75 - 1.0 \text{ in/hr}$



Hand Line / Wheel Line

AE = 72%

AR = 0.16 – 0.28 in/hr



Micro Sprinkler



AE = 80%

AR = 0.15 – 0.5 in/hr

Drip or Trickle

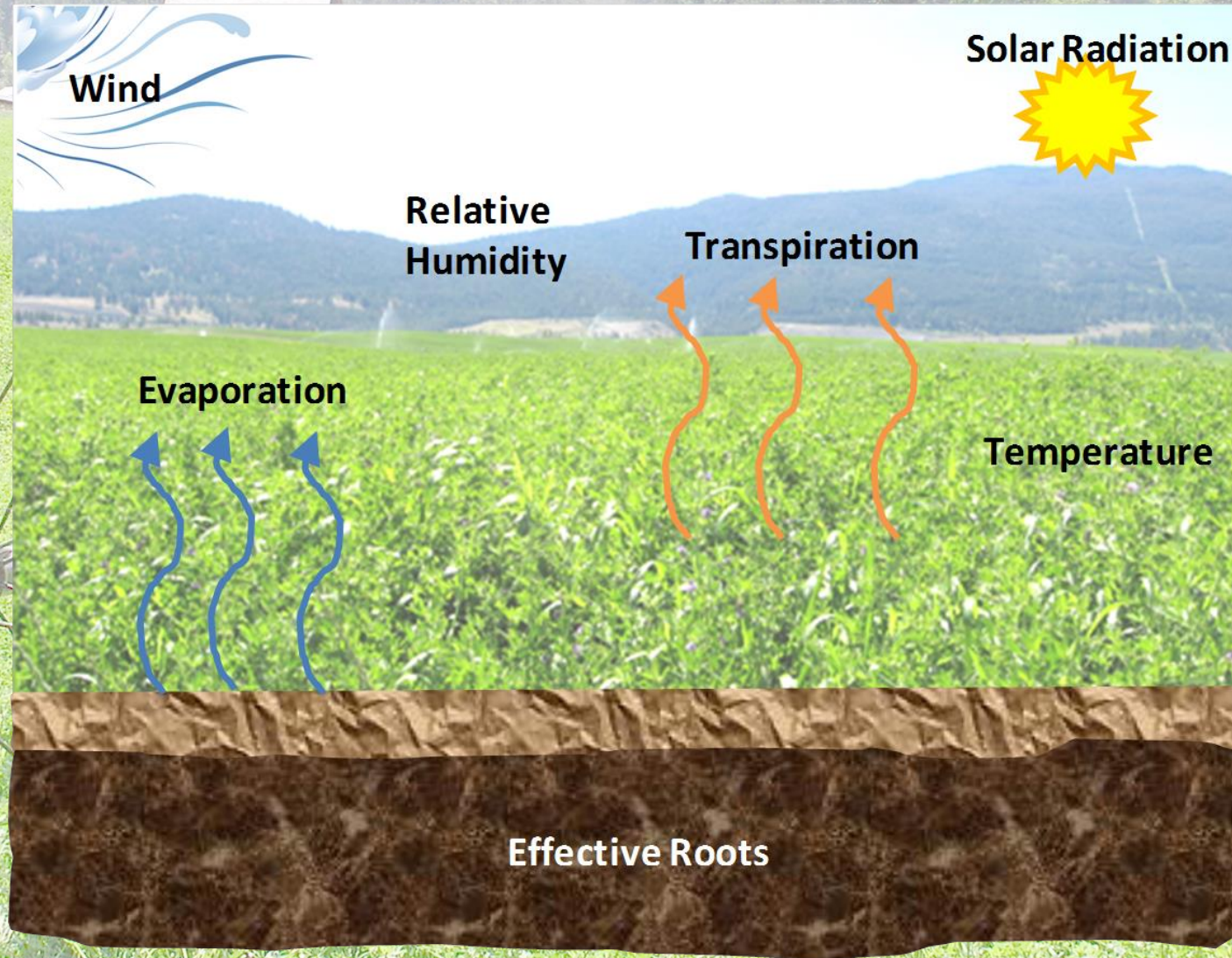


AE = 90%

AR = 0.1 -0.2 in/hr

How is this water consumed?

- Evapotranspiration: (ET)



Evapotranspiration

Peak Evapotranspiration Rates for Various B.C. Locations

Location	MSWD		Location	MSWD		Location	MSWD		
	2 in In/d	3 in in/d		2 in In/d	3 in in/d		2 in In/d	3 in in/d	
Abbotsford	0.16	0.15	Golden	0.15	0.15	Oliver	0.26	0.24	
Agassiz	0.16	0.15	Grand Forks	0.19	0.19	100 Mile House	0.24	0.23	
Alexis Creek	0.16	0.15	Grandview Flats	0.27	0.25	Osoyoos	0.3	0.28	
Armstrong	0.23	0.21	Grasmere	0.23	0.22	Oyster River	0.13	0.12	
Ashcroft	Location		MSWD						0.16
Aspen Grove									0.13
Barriere			2 in		3 in				0.2
Baynes Lake			In/d		in/d				0.15
Campbell River									0.25
Canal Flats									0.26
Castlegar									0.2
Cawston			Golden		0.15		0.15		0.28
Chase									0.16
Cherryville			Grand Forks		0.19		0.19		0.17
Chilliwack							0.15		
Clinton							0.19		
Cloverdale	Grandview Flats		0.27		0.25		0.17		
Comox							0.26		
Creston							0.3		
Dawson Creek	Grasmere		0.23		0.22		0.18		
Douglas Lake							0.2		
Duncan	Grindrod		0.16		0.14		0.22		
Ellison							0.29		
Fort Fraser	0.2	0.19	Natal	0.19	0.18	Westwold	0.28	0.27	
Fort Steele	0.23	0.22	Notch Hill	0.21	0.2	Williams Lake	0.29	0.28	
Fort St. John	0.19	0.19	Oliver	0.26	0.24				

Irrigation Interval, II

$$\text{Irrigation Interval} = \text{MSWD} / \text{ET}$$

For crops in Grand Forks ($\text{ET} = 0.19 \text{ in/day}$)

- II (Corn) $= 3.0 / 0.19 = 16 \text{ days}$
- II (Grass) $= 1.3 / 0.19 = 7 \text{ days}$

For crops in Osoyoos ($\text{ET} = 0.3 \text{ in/day}$)

- II (Deep RD) $= 3.0 / 0.3 = 10 \text{ days}$
- II (Shallow RD) $= 1.3 / 0.3 = 4 \text{ days}$

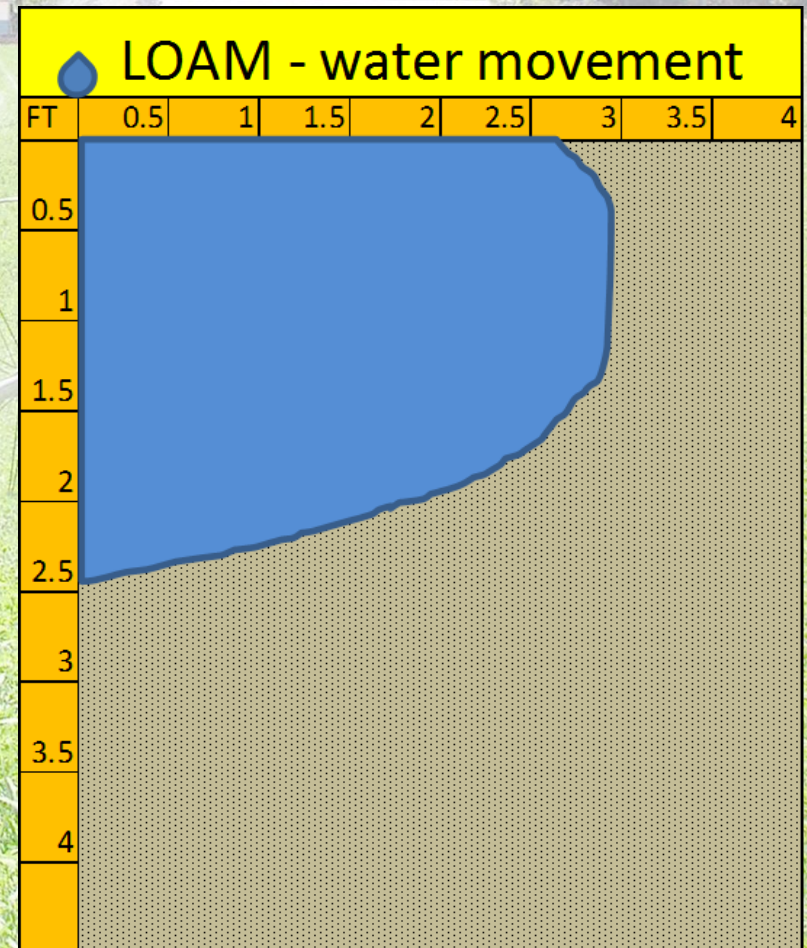
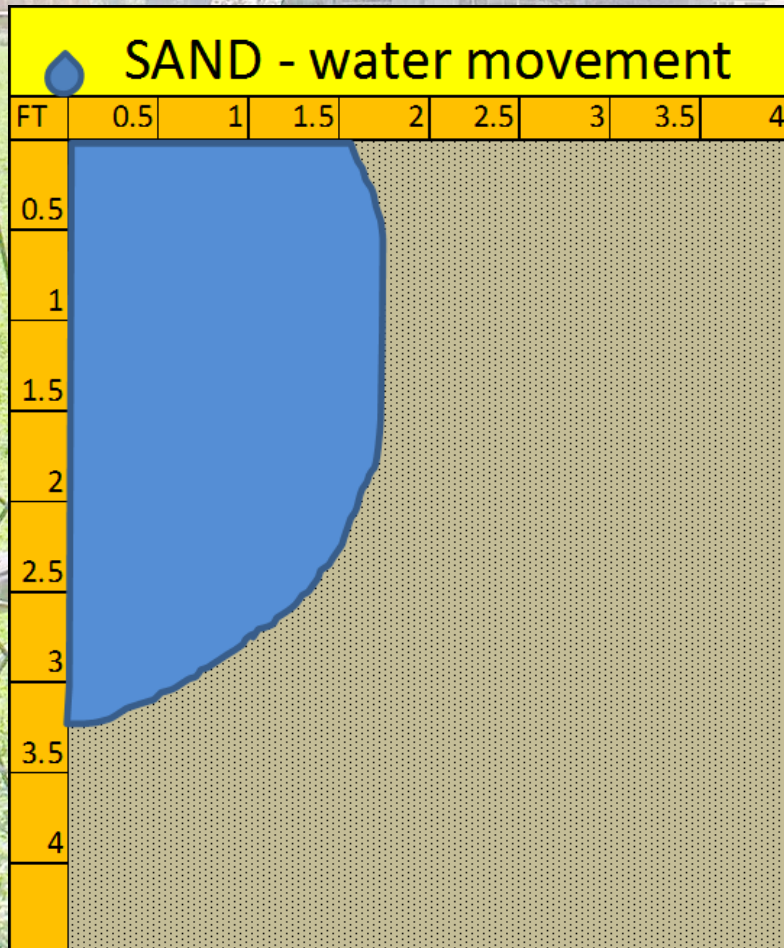
Drip Irrigation



For Drip Systems

- For **point source** trickle systems
 - water requirement is calculated per plant
 - US Gallons or Litres per Plant per Day
- For **linear tape** systems
 - water requirement is calculated per row
 - US Gallons or Litres per Row per Day

Lateral Movement of Water in Soil



Plant Water Requirement

$$G/P/D = 0.623 \times ET \times S \times A \times K$$

ET - Peak evapotranspiration

S - Soil water storage factor

A - Area per plant

K - Crop coefficient factor

Drip Irrigation Design

Example

➤ Tree Fruit Orchard

➤ Spacing $7.5' \times 15'$

➤ Area = 112.5'

➤ Sandy Loam Soil

➤ MSWD = 3.0 inch

Evapotranspiration, ET

Location	MSWD	
	2 in In/d	3 in in/d
Golden	0.15	0.15
Grand Forks	0.19	0.19
Grandview Flats	0.27	0.25
Grasmere	0.23	0.22
Grindrod	0.16	0.14

Soil Water Storage Factor, S

Effective Soil Water Storage Factor

MSWD	Peak ET (in/day)	S Factor
3.0 inches +	0.3	0.8
	0.25	0.75
	0.2	0.75
2.0 inches	0.3	0.85
	0.25	0.8
	0.2	0.75
1.0 inches	0.3	0.95
	0.25	0.9
	0.2	0.85

Crop Coefficient Factor, K

Crop Coefficient Factor (K)			
Crop	Crop Coefficient	Approximate Spacing	
Apples	0.9	Grapes	0.7
Apricots	0.8	Blueberries	0.8
Cherries	0.9	Blackberries	0.6
Peaches	0.8	Kiwi Fruit	1
Pears	0.8	Logan Berries	0.6
Plums	0.8	Raspberries	0.7
Tree Fruits – High Density	1	Strawberries	0.75
		Tomatoes	0.9
		Vegetables	0.75

Plant Water Requirement

- Gallons per Plant per Day (G/P/D)
- $$\begin{aligned} \text{G/P/D} &= 0.623 \times \text{ET} \times \text{S} \times \text{A} \times \text{K} \\ &= 0.623 \times 0.19 \times 0.75 \times 112.5 \times 0.9 \\ &= 9.0 \text{ USgpd (daily)} \end{aligned}$$

Trickle System Design Capacity

$$TC = \frac{G/P/D \times L}{E \times Eu}$$

- GPD - gallons per plant per day
- L - leaching factor
- E - application efficiency
- Eu - emission uniformity

Leaching Factor, L

Leaching Factors for Trickle Irrigation System Design

Region	Rooting Depth	Leaching Factor
Okanagan, Kootneys, Thompson	Less than 2 ft	1.05
	Greater than 2 ft	1.10
South Coastal	All	1.00
Fertigation System	All	1.10

Trickle System Design Capacity, TC

- For orchard in Grand Forks

$$TC = \frac{G/P/D \times L}{E \times Eu}$$

$$= \frac{9.0 \times 1.1}{0.92 \times 0.9}$$

$$= 12 \text{ USgpd}$$

(adds about 1/3 more water)

Water Storage

- How big does it need to be?
 - Total storage for season
 - Partial storage with recharge
- $\text{Storage} = \text{Duty} \times \text{Field Area}$
 - Depth of Duty
 - How many acres

Licenced Water Duty

➤ Grand Forks	=	18 inch
➤ Creston	=	24 inch
➤ Malakwa	=	12 inch
➤ Invermere	=	24 inch

Field Size



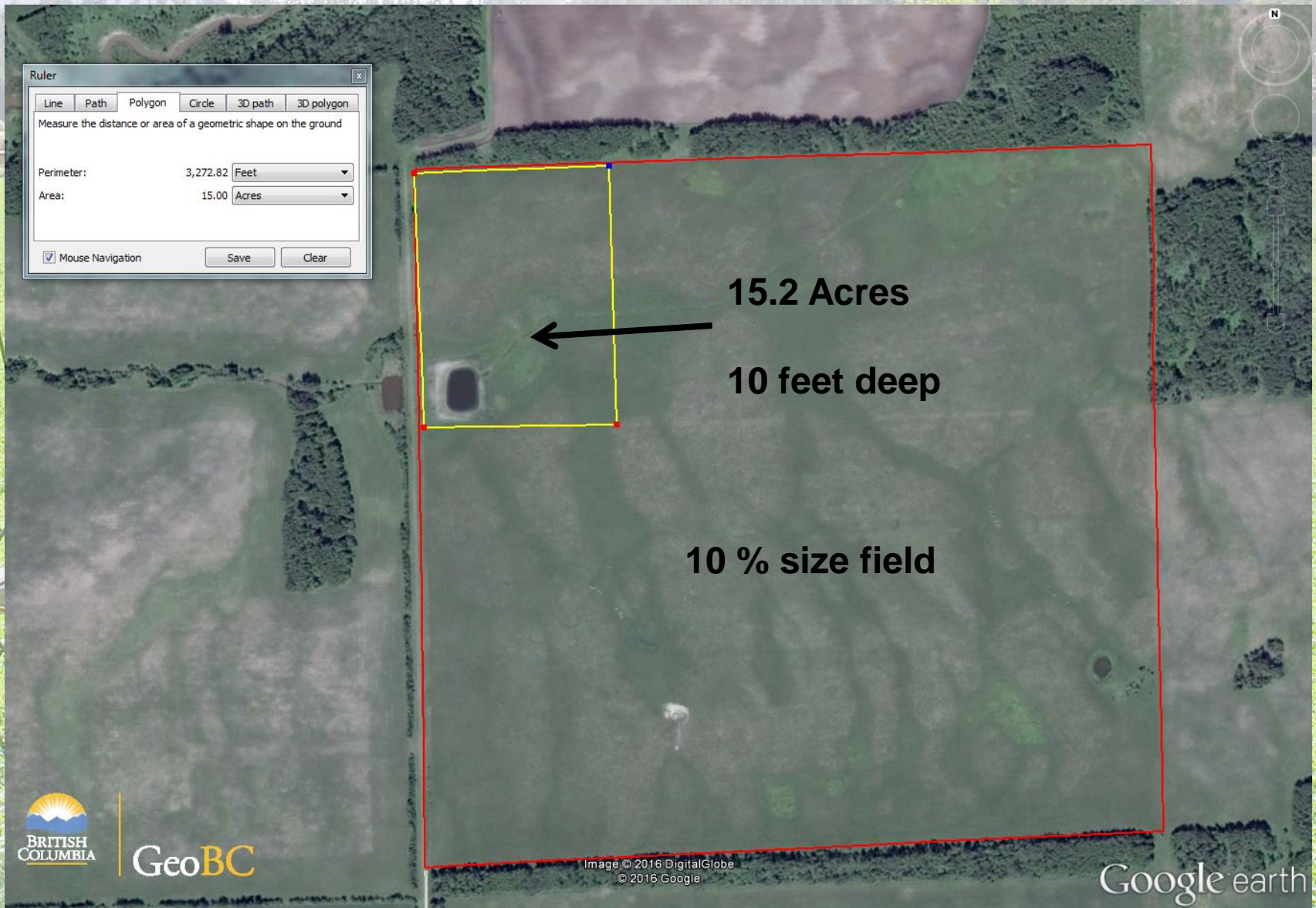
Irrigation Water Required

- Storage = Duty x Field Area
 - Duty = 12 inch or 1 foot
 - Area = 152 acres
 - Storage = 1 x 152 = 152 acre feet
 - Dugout 10 feet deep = 15 acres

Dugout Size - Irrigation



Required dugout size



Stockwatering Dugout



Stock Watering

TABLE 1 **ESTIMATED AVERAGE DAILY WATER CONSUMPTION FOR LIVESTOCK**
(US GALLONS PER DAY)

TYPE OF ANIMAL	DESCRIPTION	US GPD	TYPE OF ANIMAL	DESCRIPTION	US GPD
BEEF			SWINE (with wash water)		
cow with calf *	1,300 lb	12	farrow - finish	--	24 / sow
dry cow/mature cow *	1,300 lb	10	farrow - late wean	50 lb	8 / sow
calf *	250 lb	3	farrow - early wean	15 lb	6.5 / sow
feeder – growing **	400-800 lb	6 - 9	feeder	50 - 250 lb	2 / pig
feeder – finishing **	600-1,200 lb	9 - 12	weaner	15 - 50 lb	0.6 / pig
bull	--	12	POULTRY		
DAIRY			broiler	per 100	4.2
milking * (with wash water)	holstein	36	roaster/pullet	per 100	4.8
dry cow/replacement	holstein	12	layer	per 100	6.5
calf	to 550 lb	3.5	breeder	per 100	8.5
SHEEP AND GOATS			turkey - grower	per 100	15.5
ewe/doe	--	2.5	turkey - heavy	per 100	19
milking ewe/doe	--	3.5	OSTRICH	--	1.2
feeder lamb/kid	--	2	DEER, LLAMA, ALPACA	--	2.5
BISON, HORSE, MULE	--	12	ELK, DONKEY	--	6

Livestock Water Storage

- Beef – 100 Cows
 - 12 US gpd
 - $100 \times 12 = 1200$ US gpd
- Dairy – 100 Cows
 - 36 US gpd
 - $100 \times 36 = 3600$ US gpd
- Poultry – 10,000 Layers
 - 6.5 US gpd / 100 birds
 - $6.5 \times 100 = 650$ US gpd

Livestock Water Storage

➤ Dairy Example

$$\begin{aligned}\text{➤ Annual water use} &= 3600 \text{ USgpd} \times 365 \text{ day/yr} \\ &= 1.3 \text{ million USG} \\ &= 4 \text{ acft}\end{aligned}$$

Current Dugout - Livestock



Irrigation Scheduling Methods

Soil Method



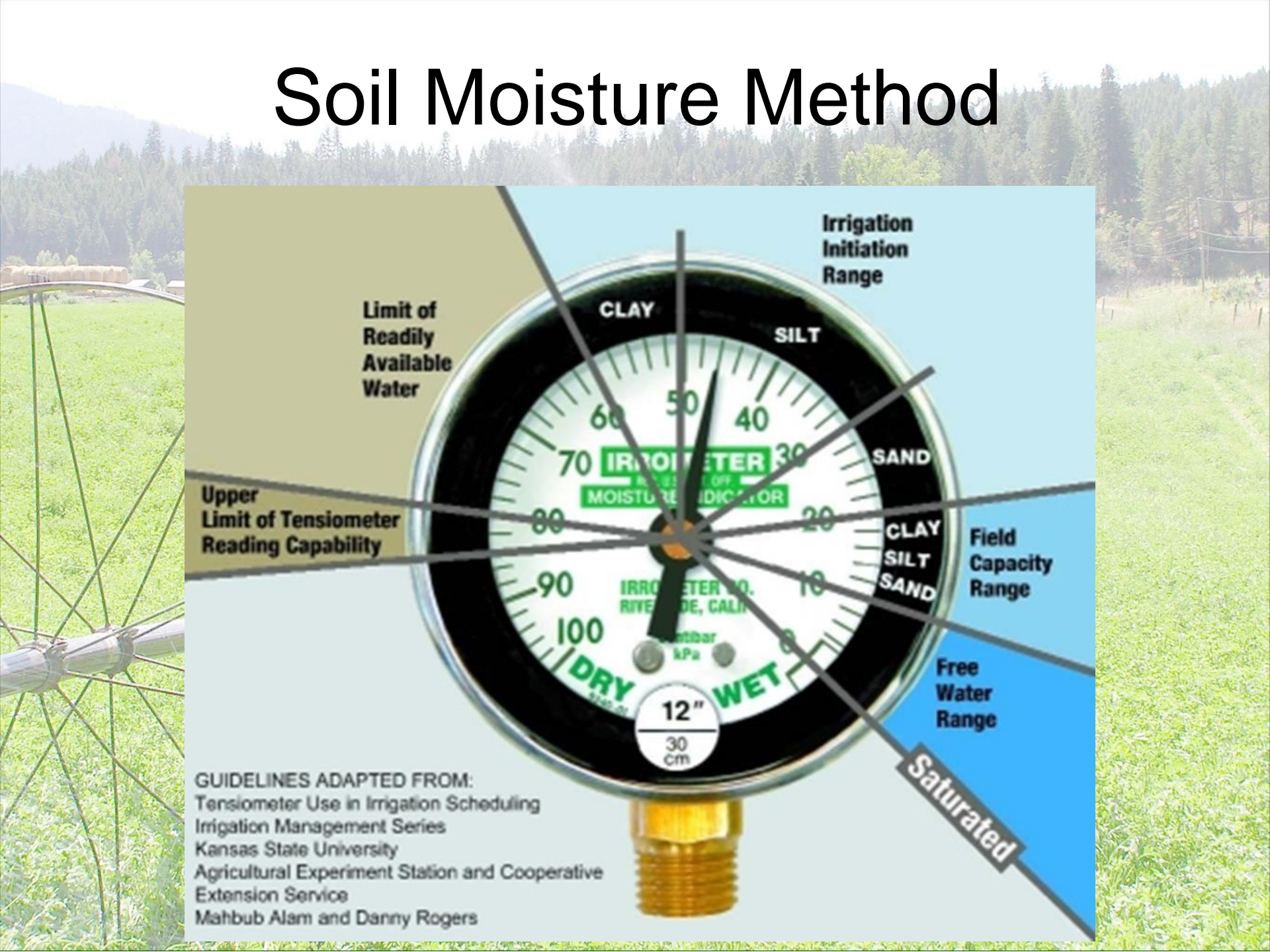
Climatic Method



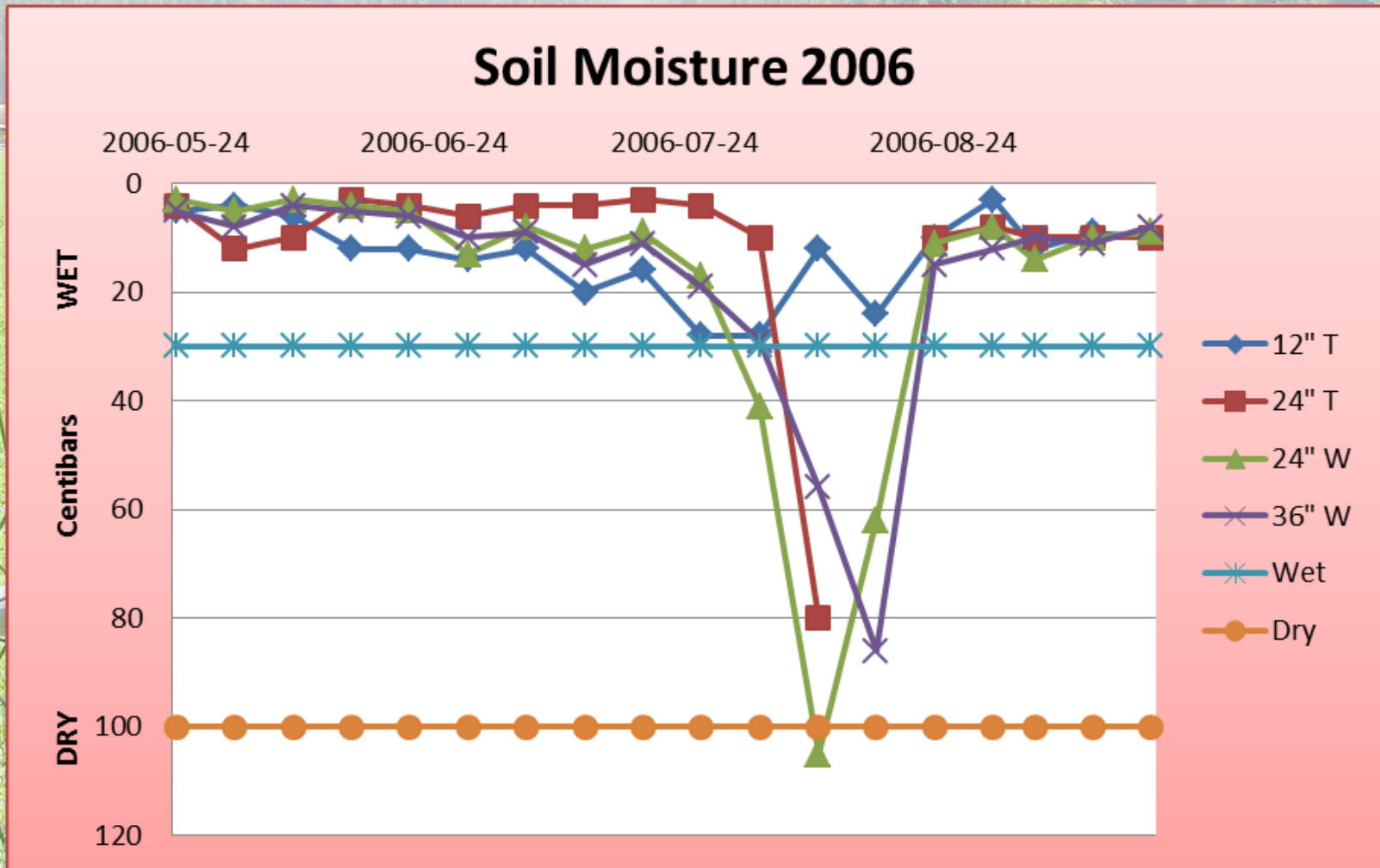
Soil Moisture Method

The diagram shows a circular tensiometer gauge with a black face and white markings. The gauge is labeled "IRROMETER MOISTURE INDICATOR" and "IRROMETER NO. RIVERIDE, CALIF.". It features a scale from 0 to 100, with "0" at the top and "100" at the bottom. The scale is divided into three main sections: "CLAY" (0-30), "SILT" (30-60), and "SAND" (60-100). The gauge is also labeled with "Limit of Readily Available Water" (0-30), "Irrigation Initiation Range" (30-60), "Field Capacity Range" (60-80), "Free Water Range" (80-100), and "Saturated" (100). The gauge has a yellow needle pointing to approximately 45. Below the gauge, there is a yellow label that reads "12\"/>

GUIDELINES ADAPTED FROM:
Tensiometer Use in Irrigation Scheduling
Irrigation Management Series
Kansas State University
Agricultural Experiment Station and Cooperative
Extension Service
Mahbub Alam and Danny Rogers

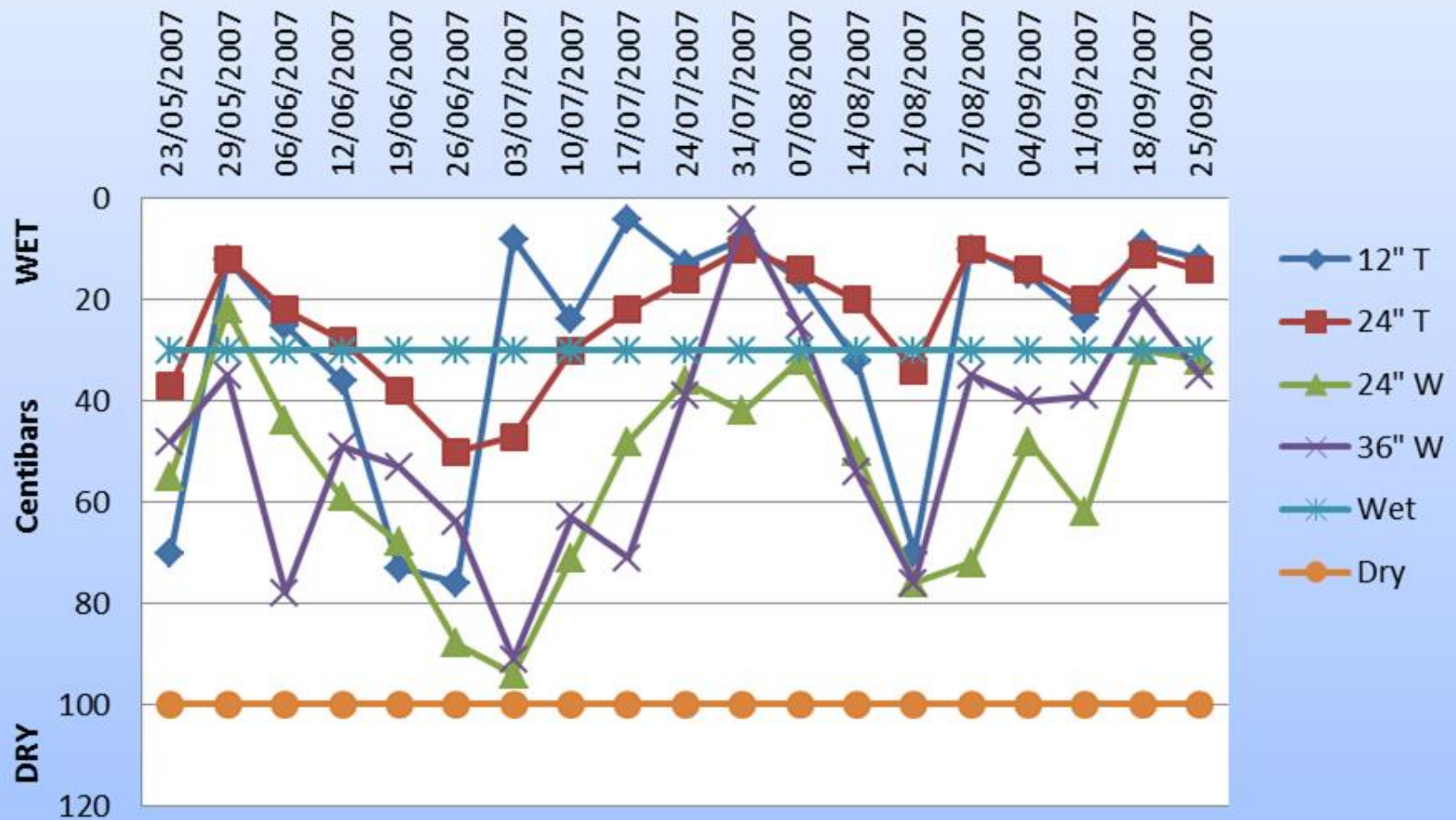


Soil Moisture Study Forage

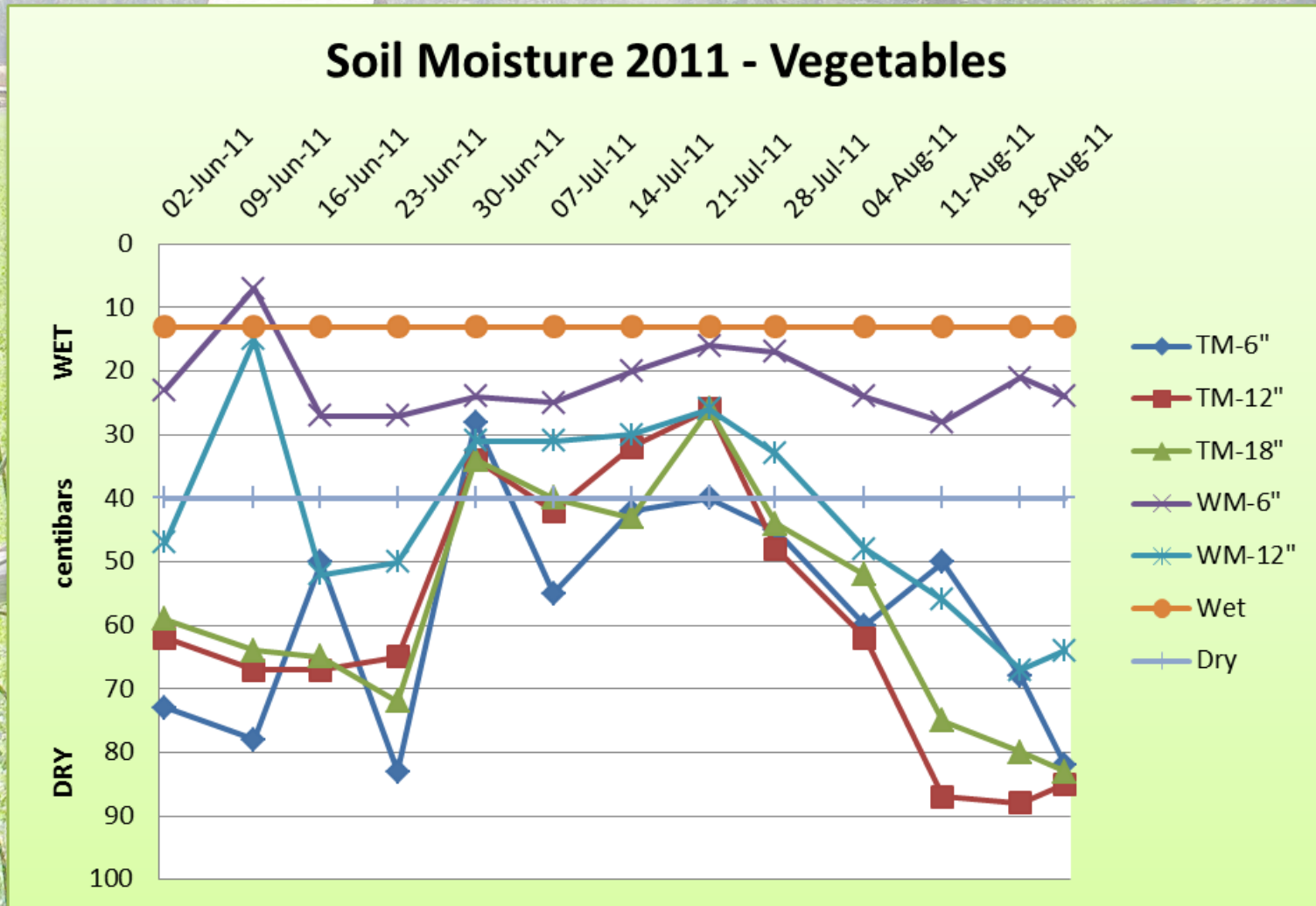


Soil Moisture Study Forage

Soil Moisture 2007

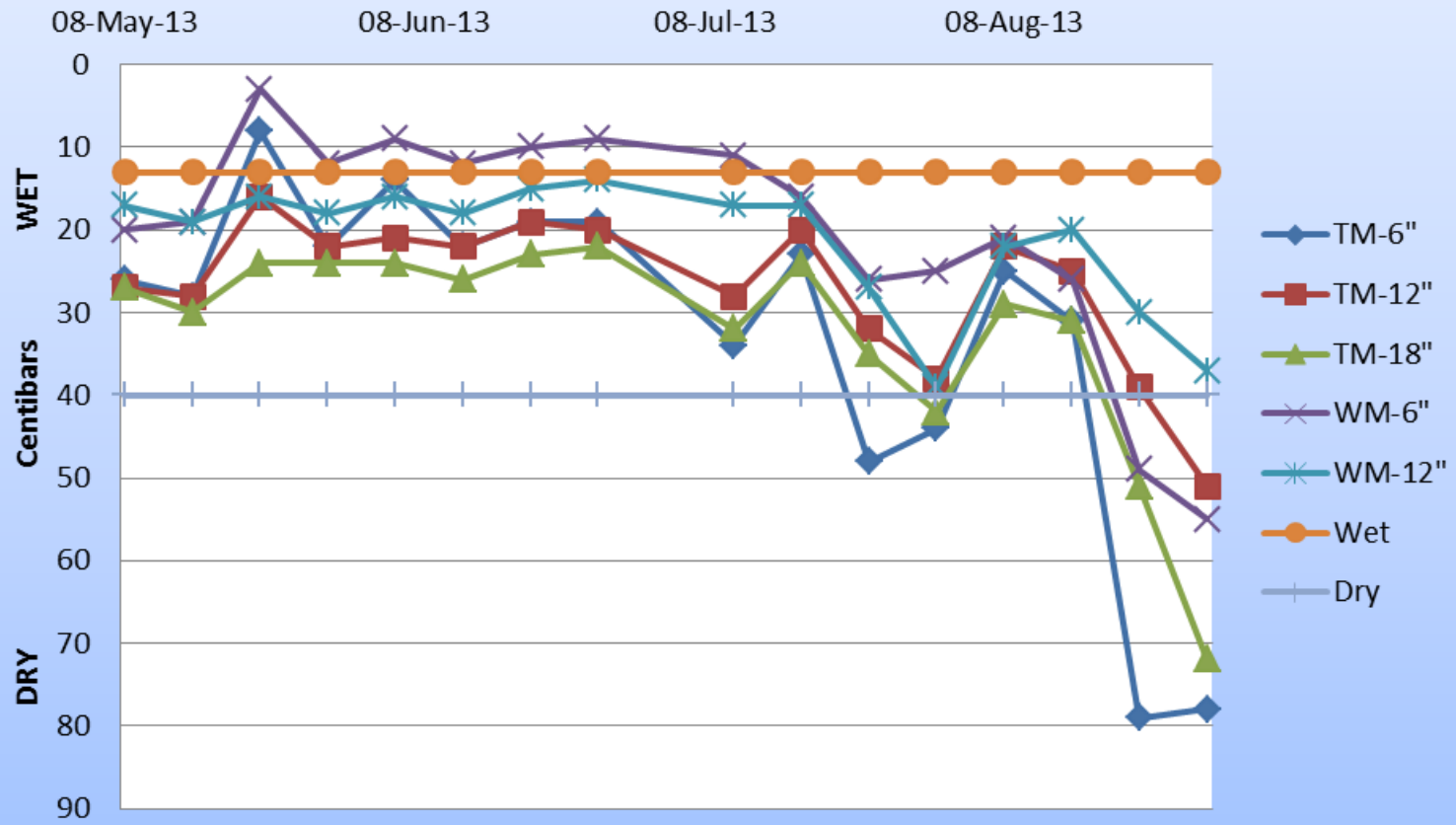


Soil Moisture Study Vegetables



Soil Moisture Study

Soil Moisture 2013 - Vegetables



Climatic Irrigation Scheduling

- Using weather station data to track Actual ET.
- Remember that irrigation systems are designed using Peak ET.
- When Actual ET consumes all of the water stored in the soil it is time to irrigate.

Online Tools

- <http://ag-calc.irrigationbc.com/>



The image shows the web interface for the Agricultural Irrigation Scheduling Calculator. The background is a photograph of a large center pivot irrigation system in a green field with mountains in the distance. The title 'Agricultural Irrigation SCHEDULING CALCULATOR' is centered in a serif font, with 'SCHEDULING CALCULATOR' in orange. Below the title, there are three main sections: a login area for returning users, a 'First visit' section with explanatory text, and a sidebar for additional tools. At the bottom, there is a funding statement and logos for Growing Forward 2, British Columbia, and Canada.

Agricultural Irrigation SCHEDULING CALCULATOR

Returning Users

Username

Password

Login

[Forgotten Username/Password](#) [Help](#)

Is this your first visit to the calculator?

This Irrigation Scheduling Calculator uses real-time daily Evapotranspiration (ET) rates determined from climate stations that are linked to www.Farmwest.com.

However, climate stations in the Province of Quebec are provided by MDDEP (Environnement Quebec) and Environment and Climate Change Canada through AgWeather Quebec.

For cases where climate stations are not available, the Calculator allows users to input local ET data that reflects the climate conditions at their specific location.

[Register New Account](#)

Also Available:

Landscape Irrigation Scheduling Calculator



Click to Switch!



This tool is funded in part through *Growing Forward 2*, a federal-provincial-territorial initiative.

Growing Forward 2   **BRITISH COLUMBIA** **Canada** 

Online Tools

- <http://www.bcagriculturewatercalculator.ca/>

The screenshot displays the BC Agriculture Water Calculator web application. The interface includes a top navigation bar with the BC Agriculture Water Calculator logo and a search bar. A central map of British Columbia shows the province's outline and major water bodies. The map is interactive, with zoom controls on the left and a north arrow at the bottom right. A sidebar on the right contains a 'Welcome' message, a 'Help' link, and a 'Make a Diagram' button. Below these, there are links for 'Irrigation', 'Livestock', and 'Save Report'. The 'About this Application' section explains that the tool helps agriculture water users estimate annual irrigation or livestock water demand based on geographic location, soil type, crop type, and irrigation type. A 'Get started with irrigation water demand' section provides a two-step guide: 1. Find your property by searching for an address (above) OR zooming in on the map. 2. Click your property on the map to select it. The bottom of the page features logos for the Okanagan Basin Water Board, Investment Agriculture Foundation of British Columbia, Growing Forward 2, the partnership for water sustainability in BC, and the British Columbia and Canada governments.

BC Agriculture Water Calculator

Place, address or 9-digit PID Search

Welcome Help Make a Diagram

Irrigation Livestock Save Report

About this Application v1.3.0

The BC Agriculture Water Calculator helps agriculture water users in British Columbia estimate the annual irrigation or livestock water demand for a farm. Irrigation water demand estimates are made based on the geographic location of the farm, as well as its soil type, crop type and type of irrigation. Livestock water demand estimates are made for a given number and type of animals.

Get started with irrigation water demand

1. Find your property by
searching for an address (above)
OR
zooming in on the map.
2. Click your property on the map to select it.

200 km
100 mi

Leaflet | © Government of British Columbia, DataBC, GeoBC, data.gov.bc.ca

Okanagan Basin Water Board

Investment Agriculture Foundation of British Columbia

Growing Forward 2

the partnership for water sustainability in bc

BRITISH COLUMBIA

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Questions



Luree Bl

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