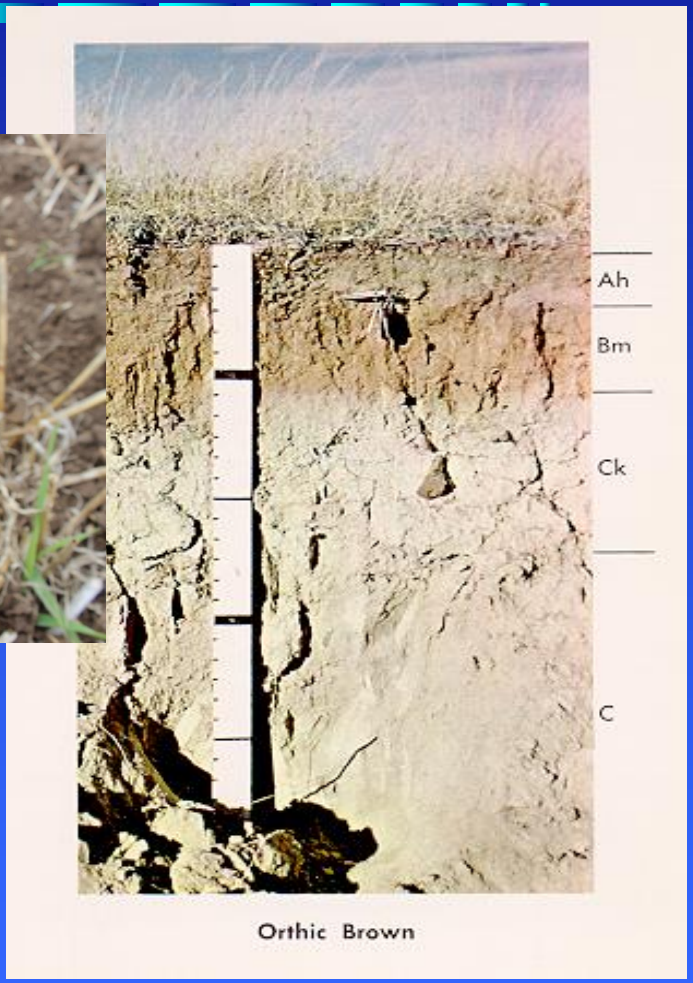
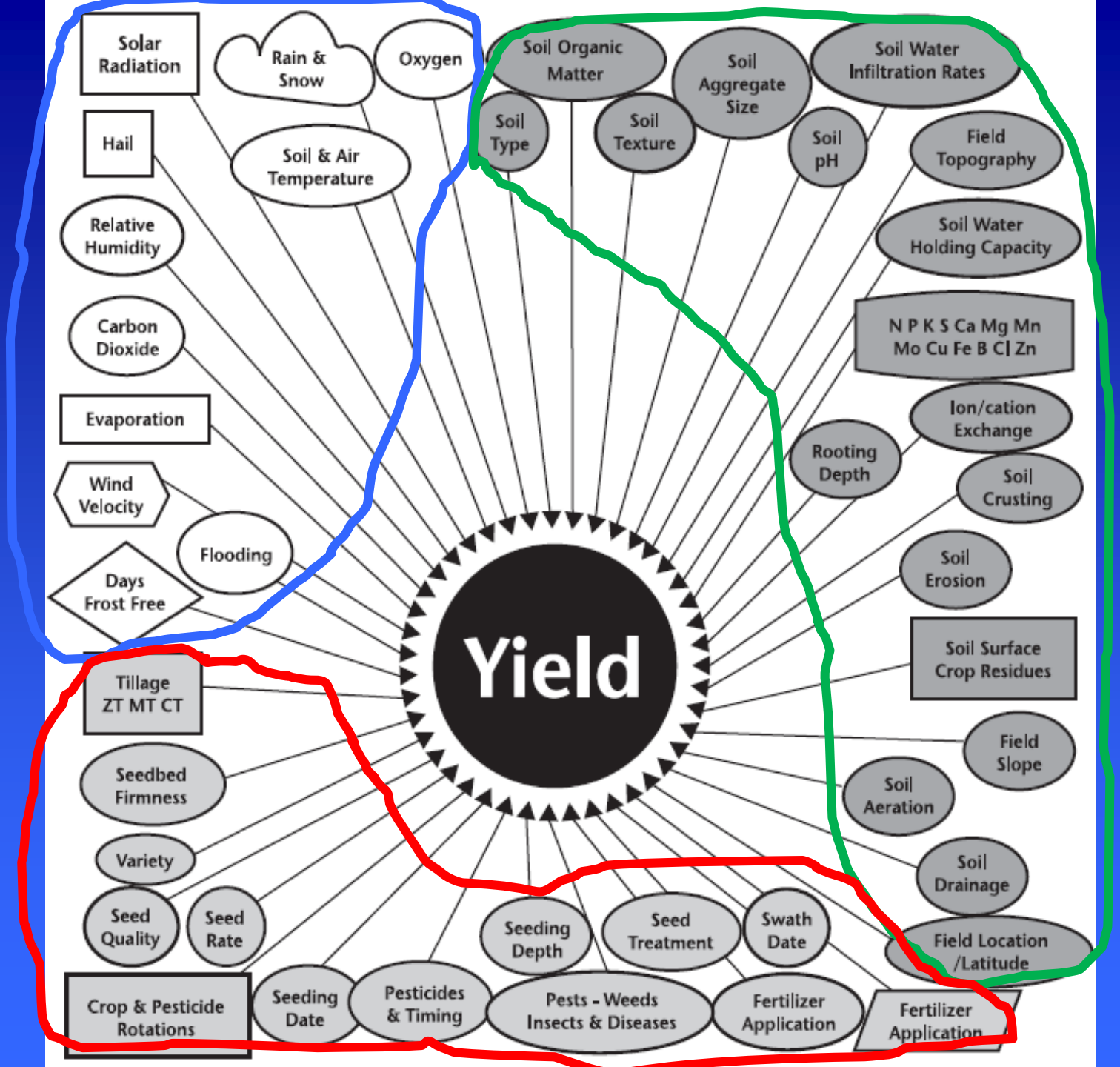
How Well Do You Know Your Soil?

Irrigated Crop Production Update – 2018

Lethbridge, AB

Ross H. McKenzie
Former Agronomy Research Scientist




Yield
Solar Radiation
Rain & Snow
Oxygen
Hail
Soil & Air Temperature
Relative Humidity
Carbon Dioxide
Evaporation
Wind Velocity
Flooding
Days Frost Free
Tillage ZT MT CT
Seedbed Firmness
Variety
Seed Quality
Seed Rate
Crop & Pesticide Rotations
Seeding Date
Pesticides & Timing
Seeding Depth
Pests - Weeds Insects & Diseases
Seed Treatment
Fertilizer Application
Swath Date
Fertilizer Application
Field Location /Latitude
Soil Drainage
Soil Aeration
Field Slope
Soil Surface Crop Residues
Soil Erosion
Soil Crusting
Rooting Depth
Ion/cation Exchange
N P K S Ca Mg Mn Mo Cu Fe B Cl Zn
Soil Water Holding Capacity
Field Topography
Soil pH
Soil Texture
Soil Type
Soil Aggregate Size
Soil Organic Matter
Soil Water Infiltration Rates

Address: 1 ABC Farms Box 123 My Town, AB T0G 0N0	**Grower Name:** Joe Smith 2 **Client's Sample ID:** 1a **Field ID:** Brown Place **Legal Location:** NW 6-39-29-W4	**Tracking Number:** 200610-01999 3 **Date Received:** October 19, 2006 **Report Date:** October 26, 2006 **Disposal Date:** November 30, 2006

Nutrient Analysis (PPM) 4 | **Quality** 7

Depth	N	P	K	SO_4	Cl	Cu	B	Ca	Mg	Fe	Zn	Mn	pH	EC	OM	Texture
0 - 6"	4	11	175	19	12	0.6	0.7	800	300	3	1.5	2.5	6.7	0.4	5.5	Loam
6 - 12"	1			10												
12 - 24"	1			8												
Total																
Range 6	D	D	A	A	M	M	A	A	A	M	A	A	Neutral	Good	Normal	

E: Excess **A:** Adequate **M:** Marginal **D:** Deficient

lb/ac	14	22	350	90									**Cation Exchange** 8			
Available lb/ac	14	22	350	90									**TCEC:** 44 meq/100g			
5													**BS:** 100%			
													Ca	**Mg**	**K**	**Na**
													55%	35%	9%	1%

Recommendations (lb/ac) 9

Crop	Conditions	Yield	N	P_2O_5	K_2O	S	Cl	Cu	B	Ca	Mg	Fe	Zn	Mn
Wheat	Excellent	68	125	30	0	0	0	0	0	0	0	0	0	0
	Average	57	100	25	0	0	0	0	0	0	0	0	0	0

What you know?

- Soil Test – N, P, K, S
- Soil pH
- Soil EC
- Soil OM

- Cation exchange capacity?
- Base saturation?

What should you know?

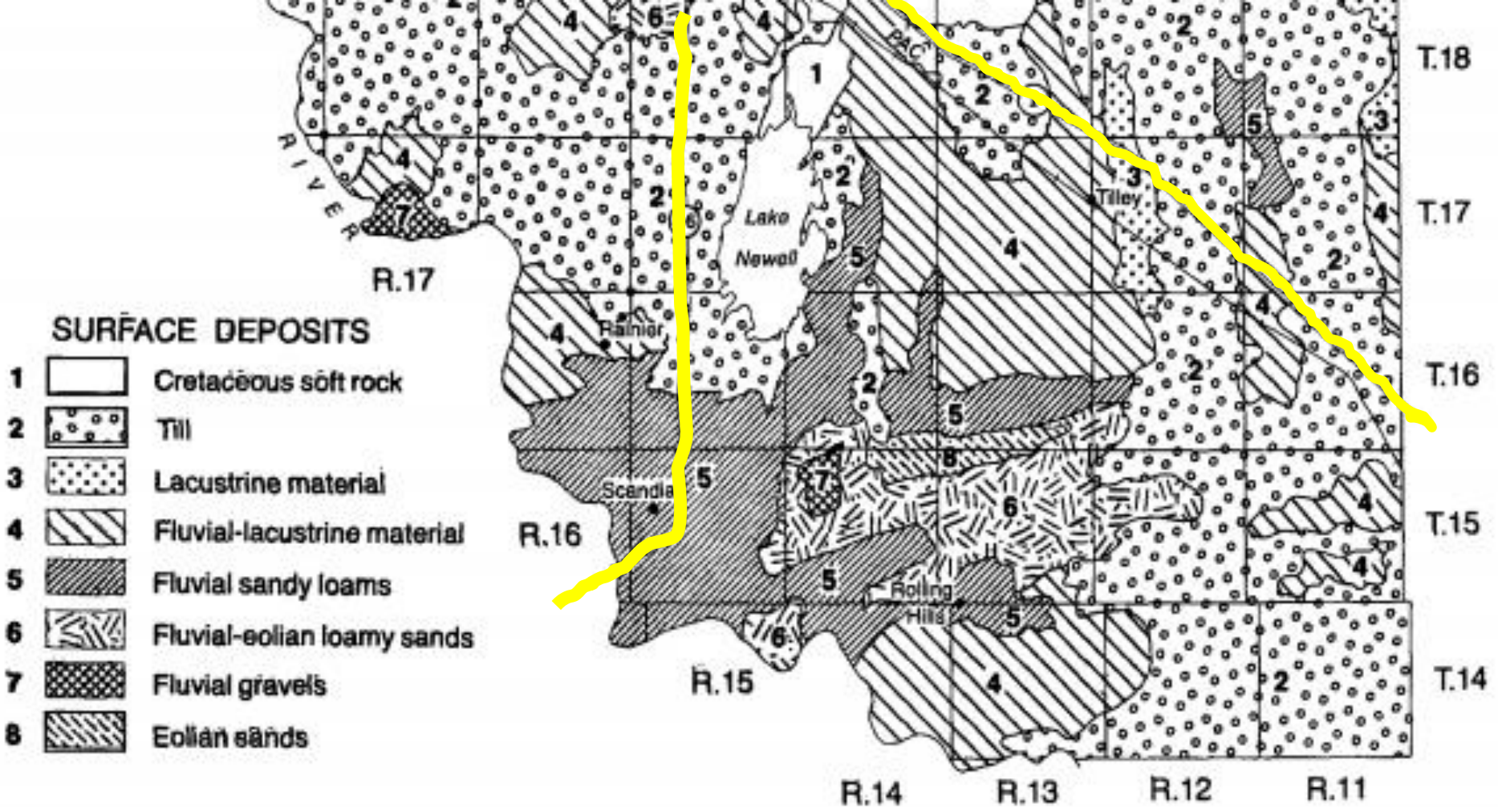
- What is the Parent Material of your soils?
- What are the Soil Series that you farm?
- Physical characteristics
  - Soil texture – how variable
  - Water holding capacity
  - Water infiltration rate
- Chemical characteristics
  - How do these change with depth?

Point #1

How carefully do you look at your soil?

Soil horizons?

Soil texture changes?



Surficial deposits – County of Newell

Soil Series - Subdivisions of soil families based on soil properties

- Parent material
- Color
- Texture
- Structure
- Thickness and arrangement of horizons
- Abundance and size of stones
- Depth to and concentration of carbonates
- Depth to and concentration of soluble salts
- Soil pH – how does it vary with depth
- Calcareousness
- Soil bulk density – glacial till soils have higher density
- Depth to a bedrock contact, or contrasting material

Examples of Chernozemic Soil Series

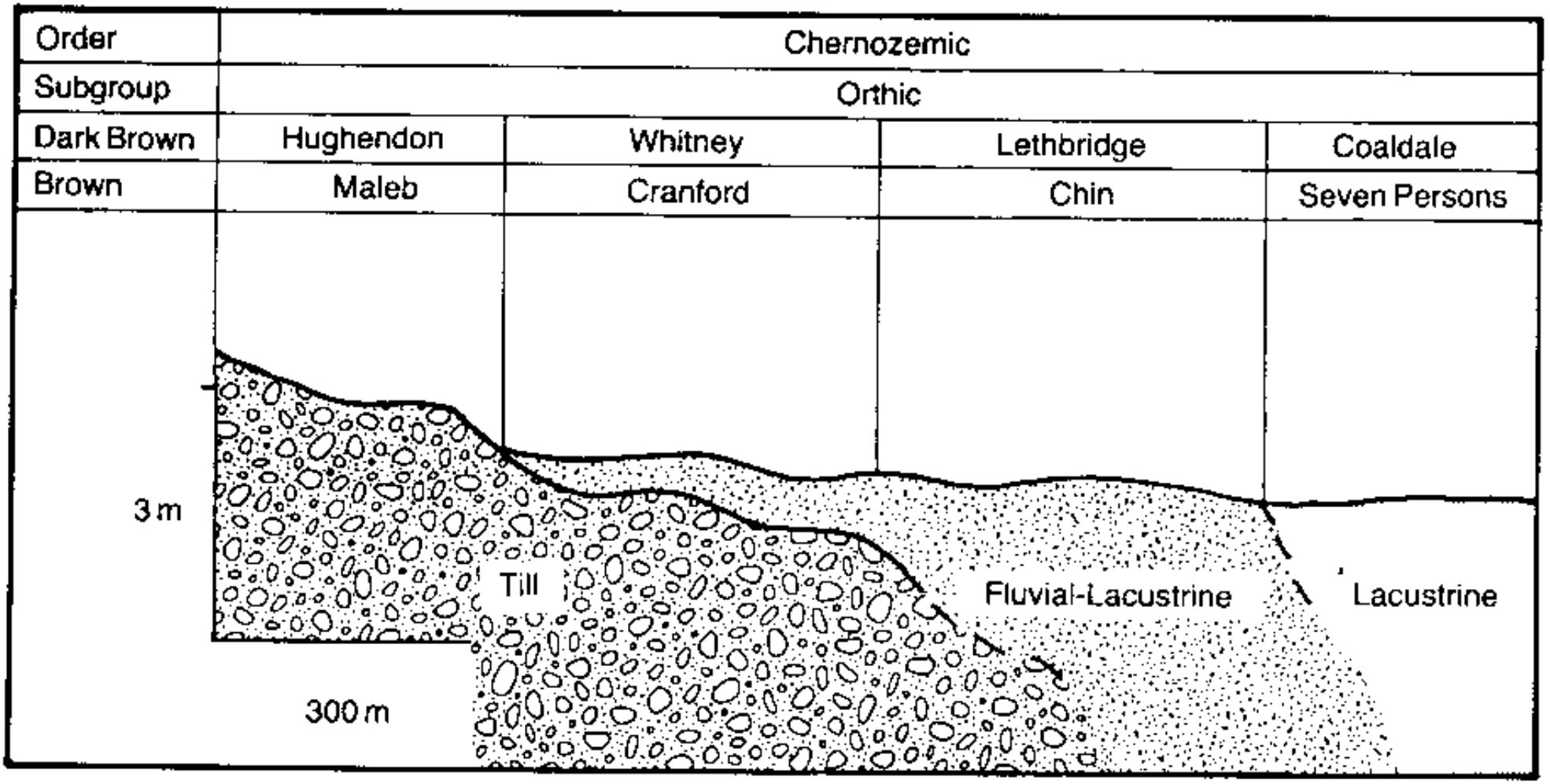
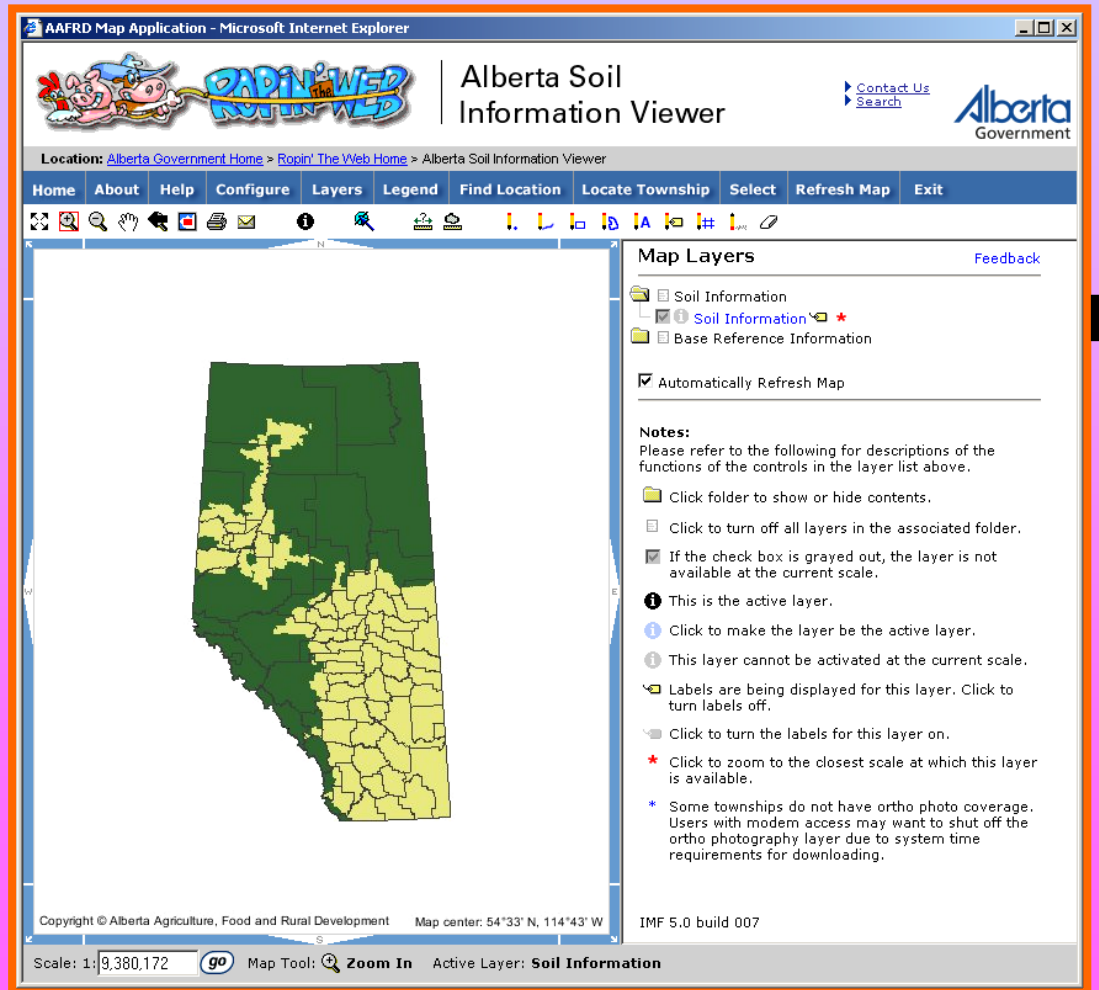


FIG. 15. Schematic cross section of some soils associated with the Chin series

AGRASID

Agricultural Region of Alberta Soil Inventory Database



http://www.agric.gov.ab.ca/asic

Specific Information

Component 1

Component Number	1
Landform Position	M - Mid slope
Extent (%)	50
Slope Gradient (80%)	4
Slope Length (m)	175

Soil

SOIL_CODE	CFD
Soil Series	CRANFORD
Drainage	W - Well
Parent Material Texture (1)	ME - Medium textured: loam, silt loam and very fine sandy loam
Soil Subgroup	O.BC - Orthic Brown Chernozem
Parent Material Code	L3 - Medium textured (VFSL, L, SiCL, CL) over medium or fine textured till

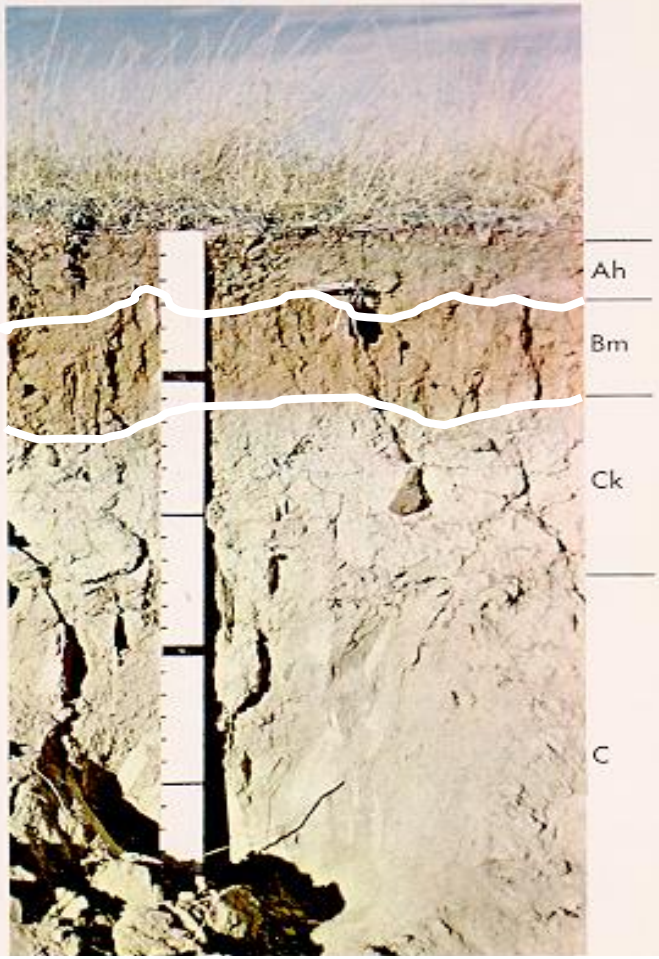
Layer 1

Layer 2

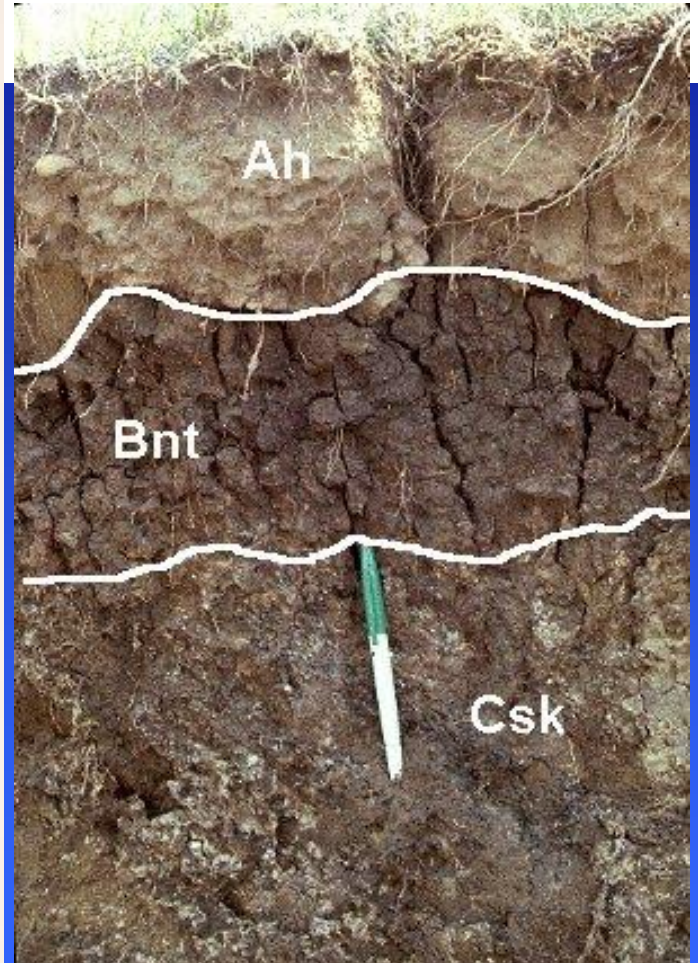

1353
CHN6/U1l
1331
BVL5/U1h
1365
N2/SC1l
1348
CHN1/U1l
1333
BVTA8/U1h
1332
BVTA13/U1hc
1334
CFCH1/U1hc
1356
CHTA4/U1l
Canford
1337
CFCH1/U1lc
1355
CHRI6/U1lc
1352
CHN6/U1l
1330
VL5/U1h
1335
CFCH1/U1hc
1350
CHN13/U1l
1363
1361
AMAst6/U1hc
1345
CFMA1/U1hc
1340
CFD1/U1l
5833
DM6/I1lc
169
ZUN16/I4h
1354
CHRI6/U1lc
1346
CFMA1/U1hc
172
ZWA1/W3
1302
MAB4/I1lc

What are the Soil Series and Horizons in fields on your farm?

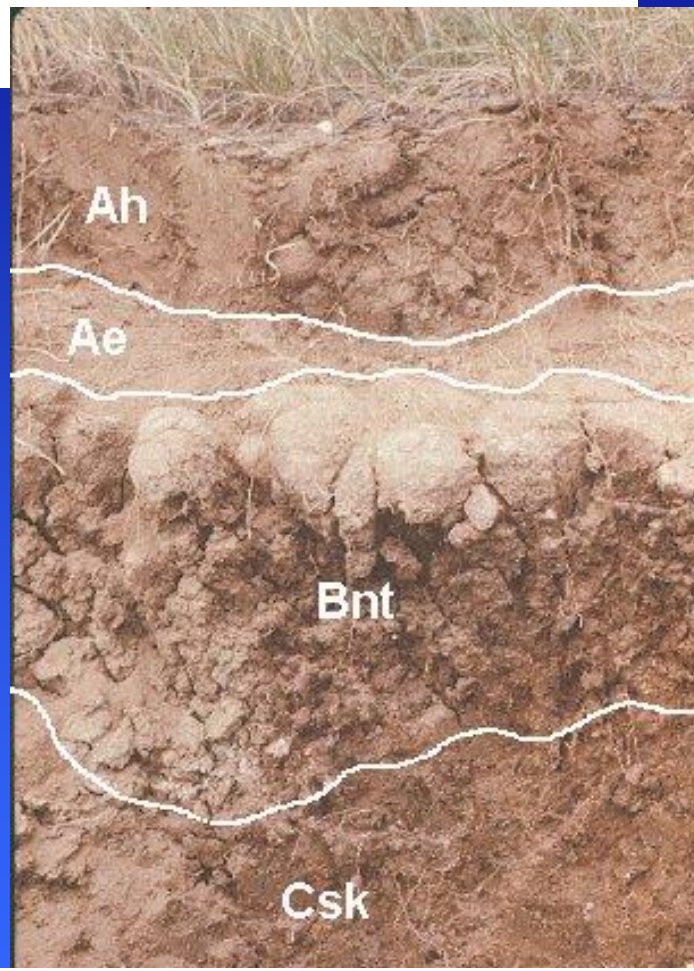
What are the characteristics of each horizon?



Brown Chernozem
Maleb



Brown Solonetz
Bullpound



Brown Solodized Solonetz
Wardlow

Awareness Point #1 – Your Soil

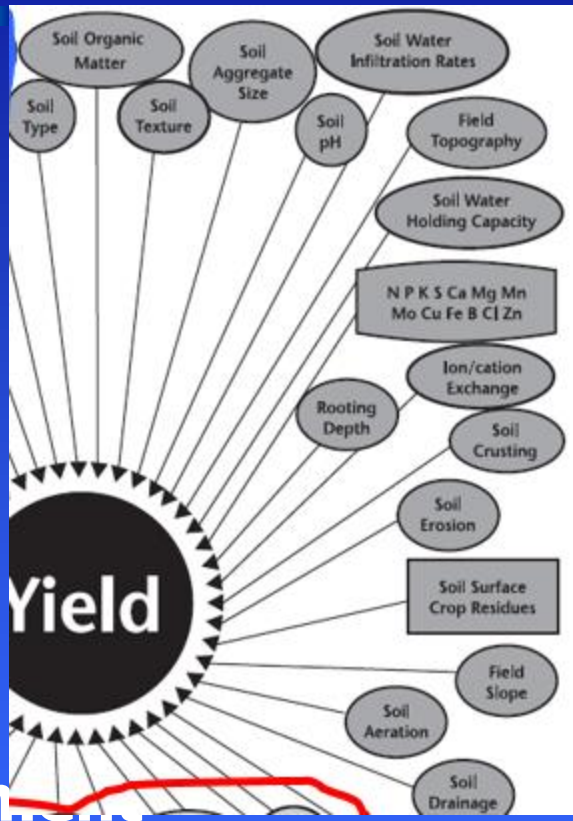
- Learn as much as you can about your soils –
  - What are the Soil Series and Soil Horizons
  - Set Yield Goals based on the Soils you have!

- How variable are your soils?
  - Are you using Variable Rate Technology?

- Have your agronomist show you in the field!!

Soil Issues on Irrigated Land

- Soil Quality – how to improve?
- Soil Fertility - fertilizer management
- Erosion - wind and water
- Manure issues
- High soil pH – Why? How to reduce it?
- Soil salinity
- Sodic & Solonetzic soils
- Soil Compaction
- Water infiltration and runoff – Pivot management
- Soil water holding capacity
  - Irrigation Scheduling



Point #2 - Soil pH

- **Why is soil pH high on irrigated land?**
  - **Most southern Alberta soils developed on parent material with high calcium**
  - **Irrigation water originates from the Rocky Mountains, which are mainly limestone**

- **pH of irrigation water is typically between 8.5 and 9**

Awareness Point #2 – Soil pH

- Most irrigated top soil in Alberta have a pH between 7.0 and 8.2 - this is normal
- Some nutrients are slightly less available but
  - it is not a concern
- How much elemental sulphur (S°) to reduce soil pH from 8.0 to 7.0:
  - about 10,000 lb/ac

Point #3 - Salt Affected Soils

There are different types of salt-affected soils:

- **Saline soils** – have a high enough soluble salts in soil to impair crop growth
  - Soil colour – white salts

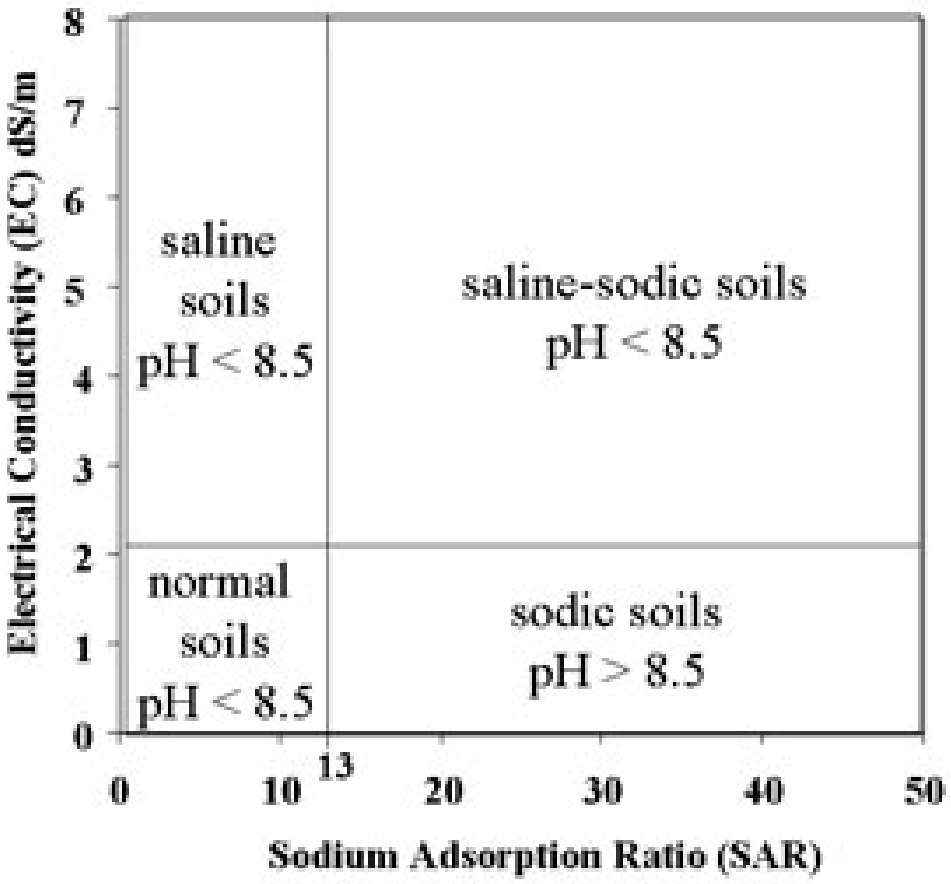
- **Sodic soils (Solonetzic)** – have a high level of exchangeable sodium (Na^+), which affects soil structure & affects on crop growth and yield
  - Soil colour – dark or black sheen

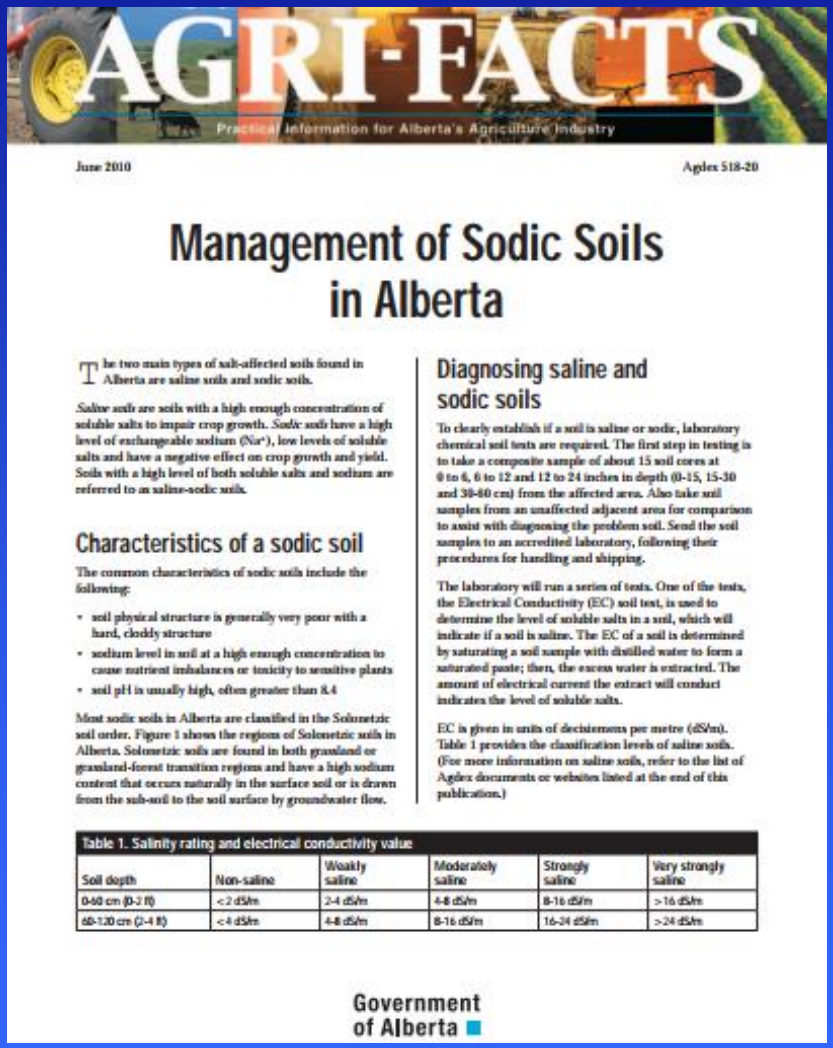
Lab Methods for Diagnosis:

- **Saline soil -** Electrical Conductivity (EC)

- **Sodic soil -** Sodium Adsorption Ratio (SAR)
  or Exchangeable Sodium Percentage (ESP)

Classes of Salt Affected Soils





AGRI-FACTS

Practical information for Alberta's Agriculture Industry

June 2010 Agdex 518-20

Management of Sodic Soils in Alberta

The two main types of salt-affected soils found in Alberta are saline soils and sodic soils.

Saline soils are soils with a high enough concentration of soluble salts to impair crop growth. *Sodic soils* have a high level of exchangeable sodium (Na^+), low levels of soluble salts and have a negative effect on crop growth and yield. Soils with a high level of both soluble salts and sodium are referred to as saline-sodic soils.

Characteristics of a sodic soil

The common characteristics of sodic soils include the following:

- soil physical structure is generally very poor with a hard, cloddy structure
- sodium level in soil at a high enough concentration to cause nutrient imbalances or toxicity to sensitive plants
- soil pH is usually high, often greater than 8.4

Most sodic soils in Alberta are classified in the Solonetzic soil order. Figure 1 shows the regions of Solonetzic soils in Alberta. Solonetzic soils are found in both grassland or grassland-forest transition regions and have a high sodium content that occurs naturally in the surface soil or is drawn from the sub-soil to the soil surface by groundwater flow.

Diagnosing saline and sodic soils

To clearly establish if a soil is saline or sodic, laboratory chemical soil tests are required. The first step in testing is to take a composite sample of about 15 soil cores at 0 to 6, 6 to 12 and 12 to 24 inches in depth (0-15, 15-30 and 30-60 cm) from the affected area. Also take soil samples from an unaffected adjacent area for comparison to assist with diagnosing the problem soil. Send the soil samples to an accredited laboratory, following their procedures for handling and shipping.

The laboratory will run a series of tests. One of the tests, the Electrical Conductivity (EC) soil test, is used to determine the level of soluble salts in a soil, which will indicate if a soil is saline. The EC of a soil is determined by saturating a soil sample with distilled water to form a saturated paste; then, the excess water is extracted. The amount of electrical current the extract will conduct indicates the level of soluble salts.

EC is given in units of decisiemens per metre (dS/m). Table 1 provides the classification levels of saline soils. (For more information on saline soils, refer to the list of Agdex documents or websites listed at the end of this publication.)

Table 1. Salinity rating and electrical conductivity value

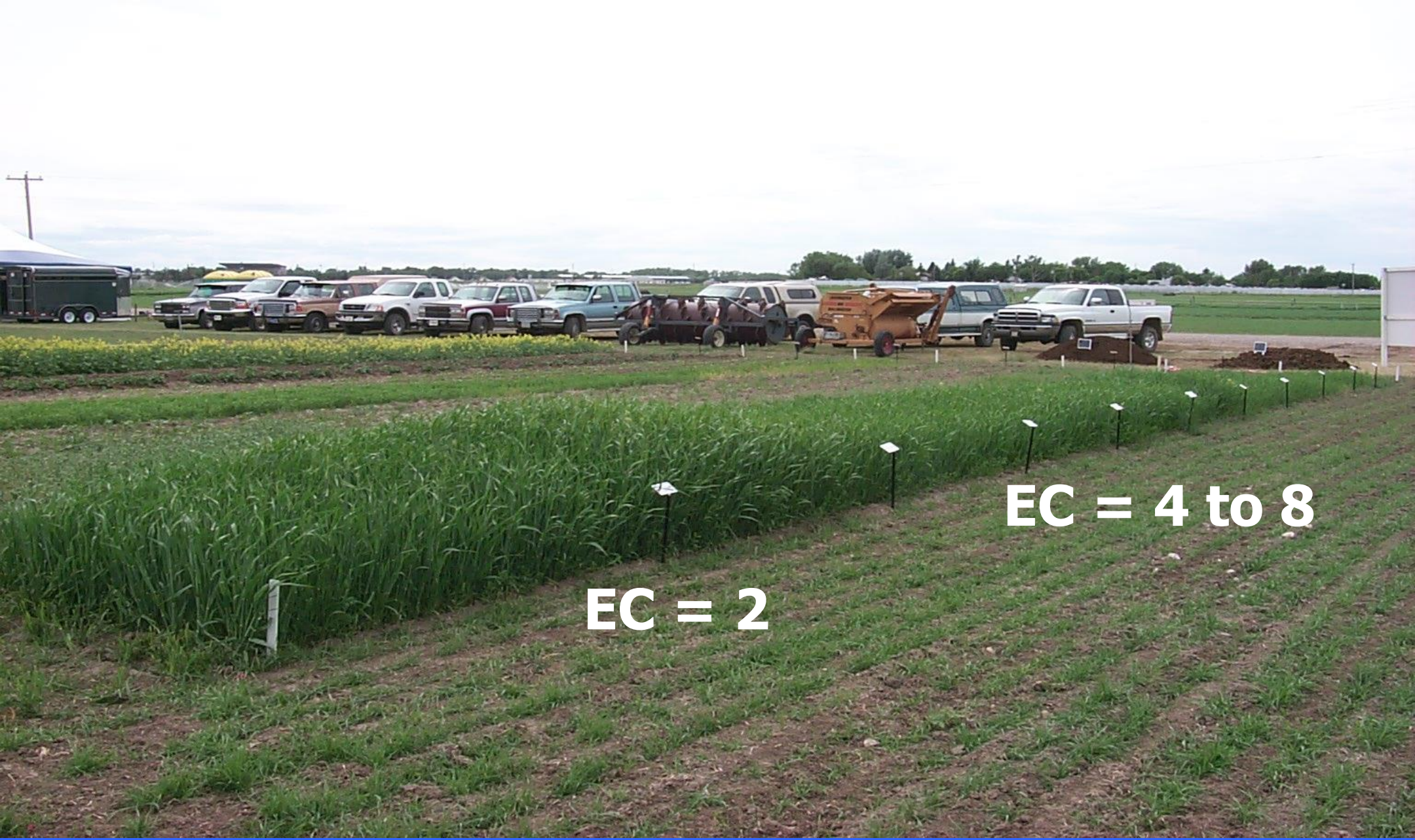
Soil depth	Non-saline	Weakly saline	Moderately saline	Strongly saline	Very strongly saline
0-60 cm (0-2 ft)	<2 dS/m	2-4 dS/m	4-8 dS/m	8-16 dS/m	>16 dS/m
60-120 cm (2-4 ft)	<4 dS/m	4-8 dS/m	8-16 dS/m	16-24 dS/m	>24 dS/m

Government of Alberta

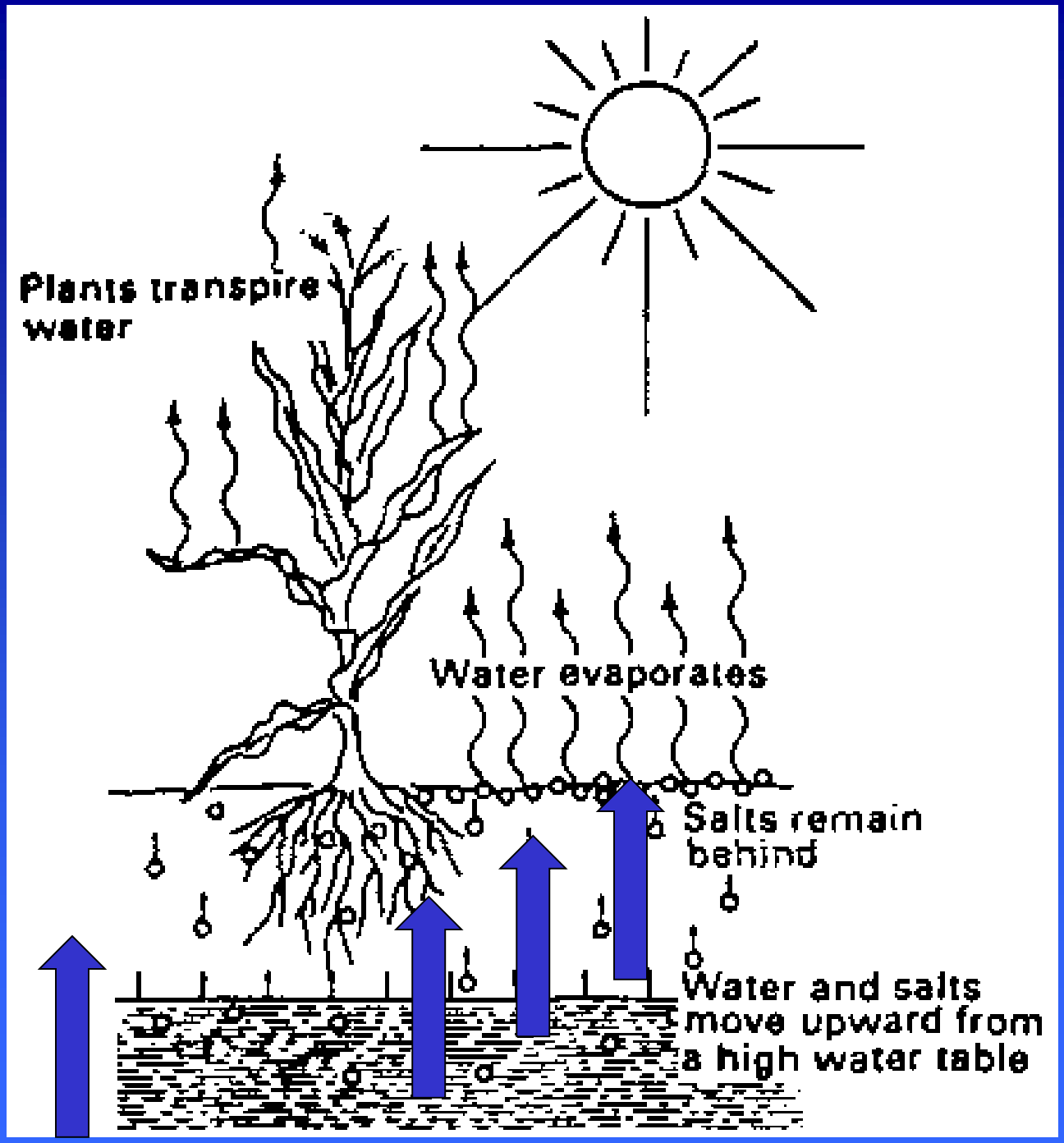
Source: McKenzie & Woods 2010, Alberta Agriculture Adgex 518-20

Salinity Rating and E.C. values

Soil Depth (cm)	Non Saline	Weakly Saline	Moderate Saline	Strongly Saline	Very Strongly Saline
	(dS/m)				
0-60 cm	<2	2-4	4-8	8-16	>16



EC – Affect of increasing salinity on barley growth



Development

- Water table rises within ~1 to 1.5 m of soil surface
- Water and salts move up by capillary action into the root zone

How Best to Identify Salinity?

- **Initially - Can use soil sampling and EC analysis**

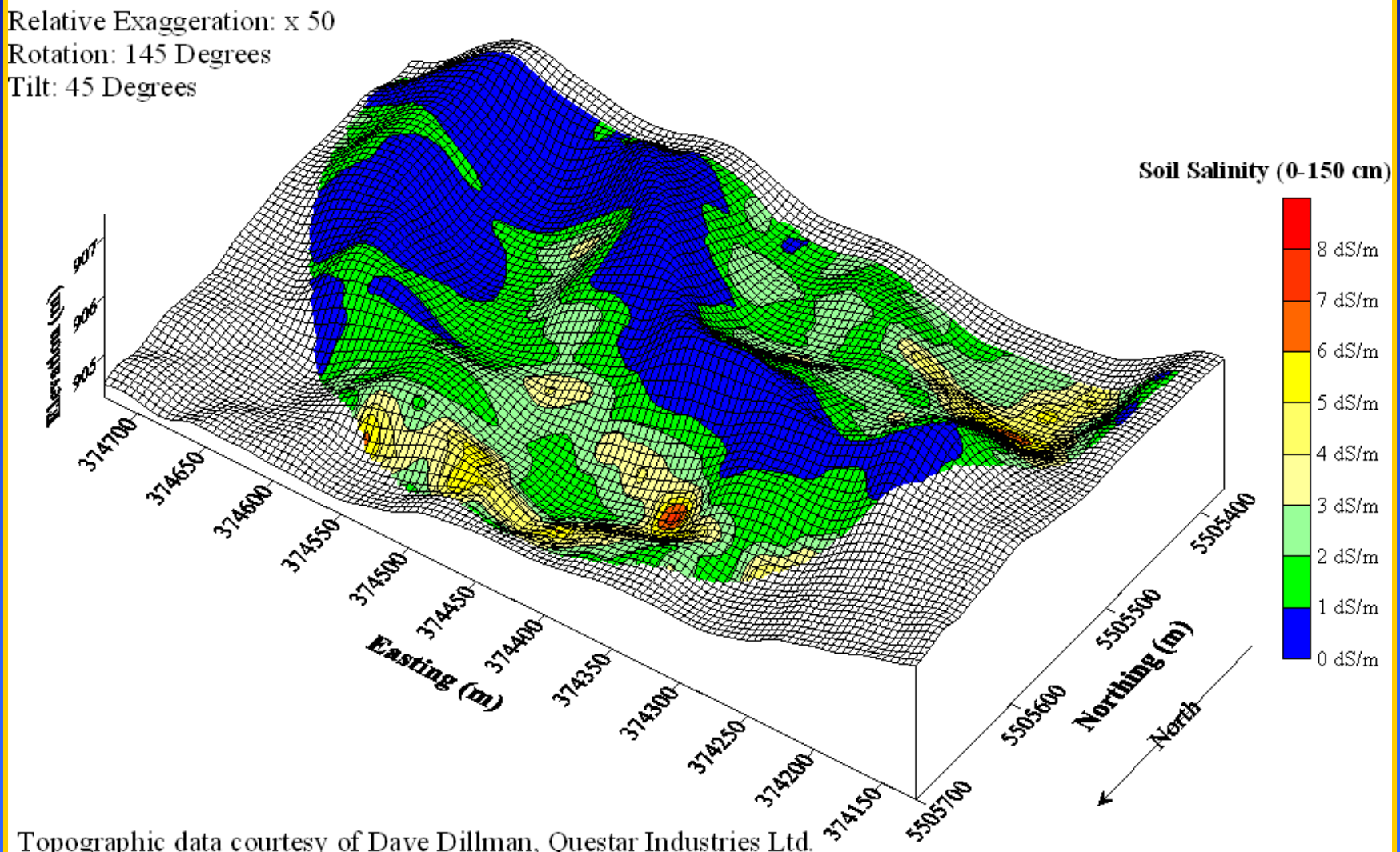
How to Map Soil Salinity on your farm:

- **EM38 or Veris can be used to identify saline soil areas on a field scale.**
- **HOW – hire an experienced agronomist to use an EM 38 to map Soil EC and Topography and develop composite maps.**
- **Both must be very carefully calibrated to the site before the mapping process!**

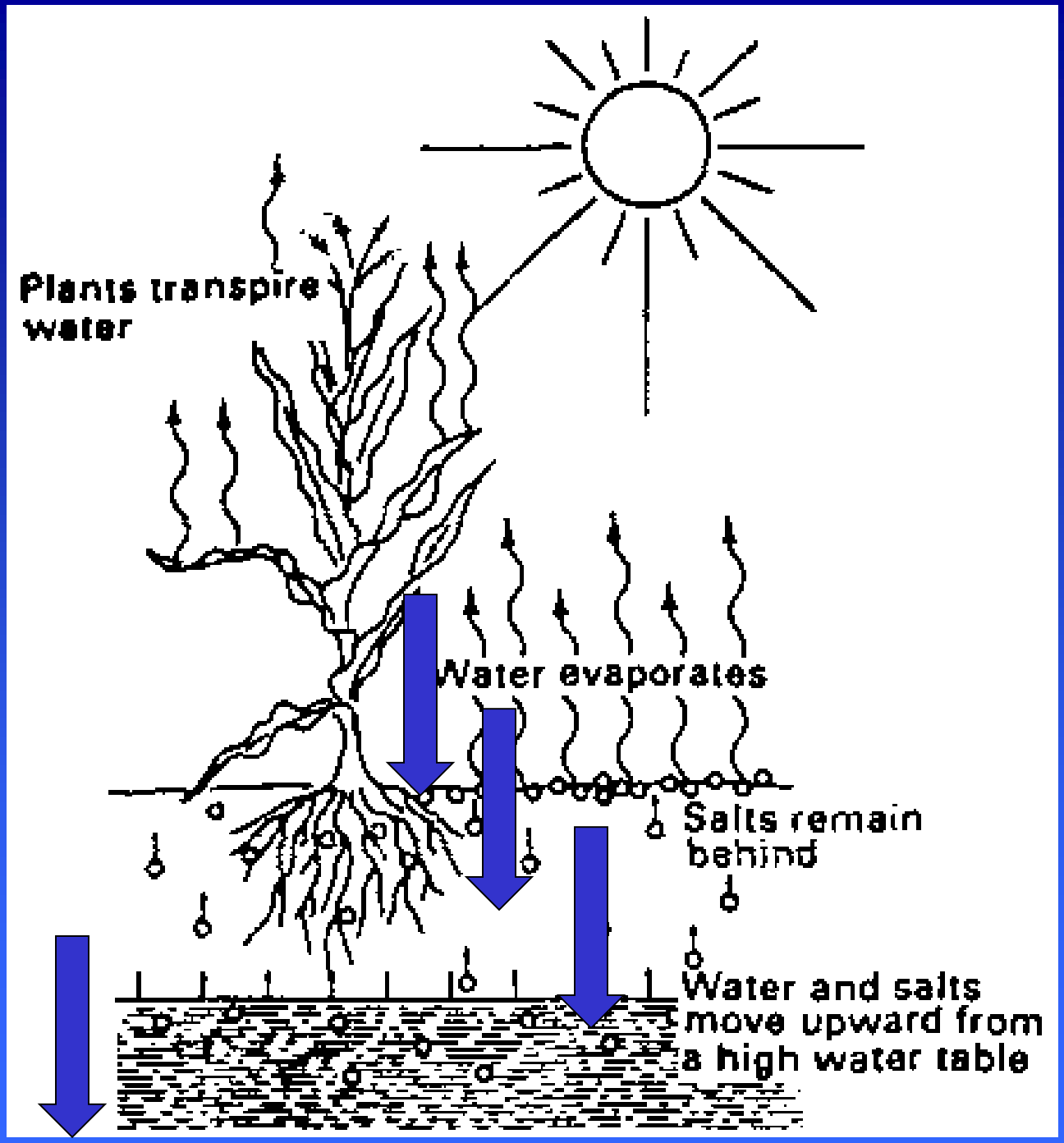
Veris 3100

Geonics EM38

Composite Map of EC and Topography



Topographic data courtesy of Dave Dillman, Questar Industries Ltd.
Salinity data collected by the Soil and Water Agronomy Program, CDC South, AAFRD



Reclamation:

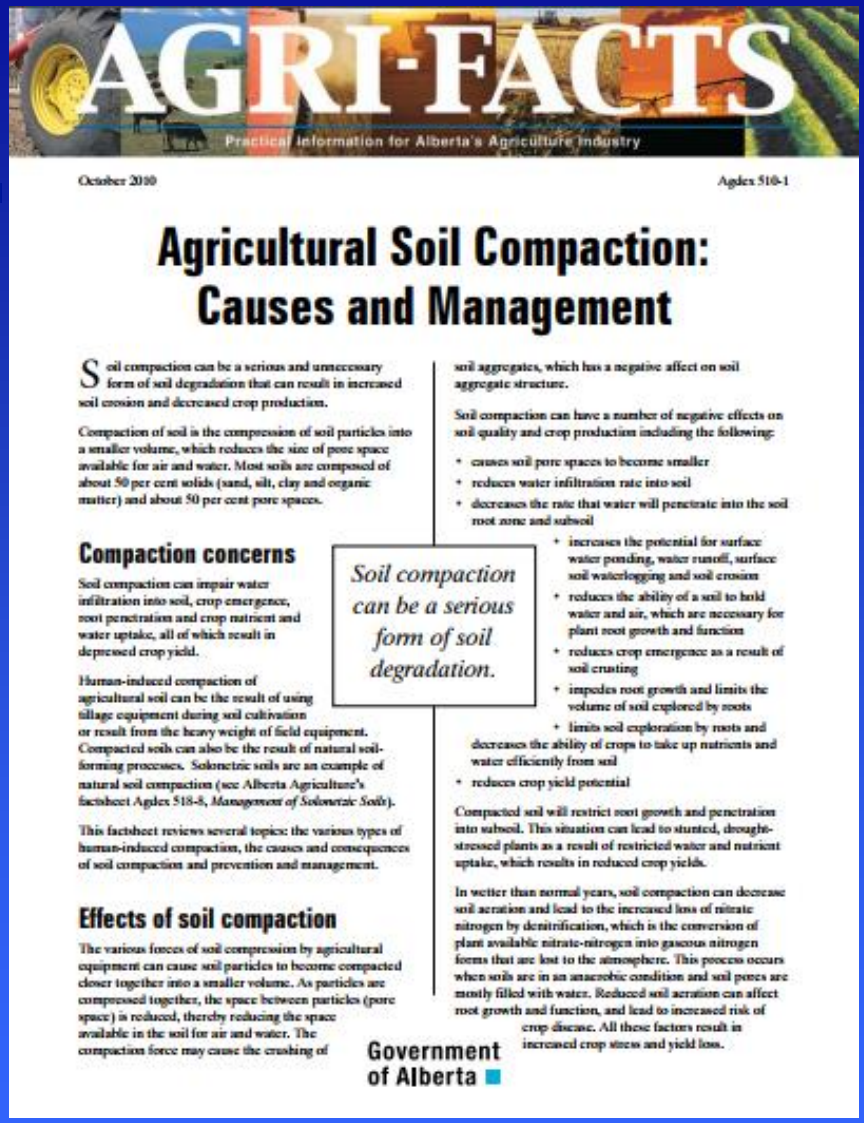
- Lower water table
  - Source of excess water?
  - Cultural controls
  - Subsurface drainage
- Leach salts from root zone

Awareness Point #3 – Salt Affected Soils

- Use soil analysis and interpretation to identify saline or sodic soils
- Investigate the extent of the problem
- Investigate the possible ways to economically and sustainably improve or correct the problem?

Point #4
Soil Compaction

- Soil compaction can affect water infiltration and land productivity
- Various types of tillage can cause soil compaction and equipment weight can also be a problem.
- Compaction is more severe when:
  - Soils are wetter and have a higher clay or silt content



AGRI-FACTS

Practical information for Alberta's Agriculture Industry

October 2010 Agdex 518-1

Agricultural Soil Compaction: Causes and Management

Soil compaction can be a serious and unnecessary form of soil degradation that can result in increased soil erosion and decreased crop production.

Compaction of soil is the compression of soil particles into a smaller volume, which reduces the size of pore space available for air and water. Most soils are composed of about 50 per cent solids (sand, silt, clay and organic matter) and about 50 per cent pore spaces.

Compaction concerns

Soil compaction can impair water infiltration into soil, crop emergence, root penetration and crop nutrient and water uptake, all of which result in depressed crop yield.

Human-induced compaction of agricultural soil can be the result of using tillage equipment during soil cultivation or result from the heavy weight of field equipment. Compacted soils can also be the result of natural soil-forming processes. Solonetzic soils are an example of natural soil compaction (see Alberta Agriculture's factsheet Agdex 518-8, *Management of Solonetzic Soils*).

This factsheet reviews several topics: the various types of human-induced compaction, the causes and consequences of soil compaction and prevention and management.

Soil compaction can be a serious form of soil degradation.

Effects of soil compaction

The various forces of soil compression by agricultural equipment can cause soil particles to become compacted closer together into a smaller volume. As particles are compressed together, the space between particles (pore space) is reduced, thereby reducing the space available in the soil for air and water. The compaction force may cause the crushing of soil aggregates, which has a negative affect on soil aggregate structure.

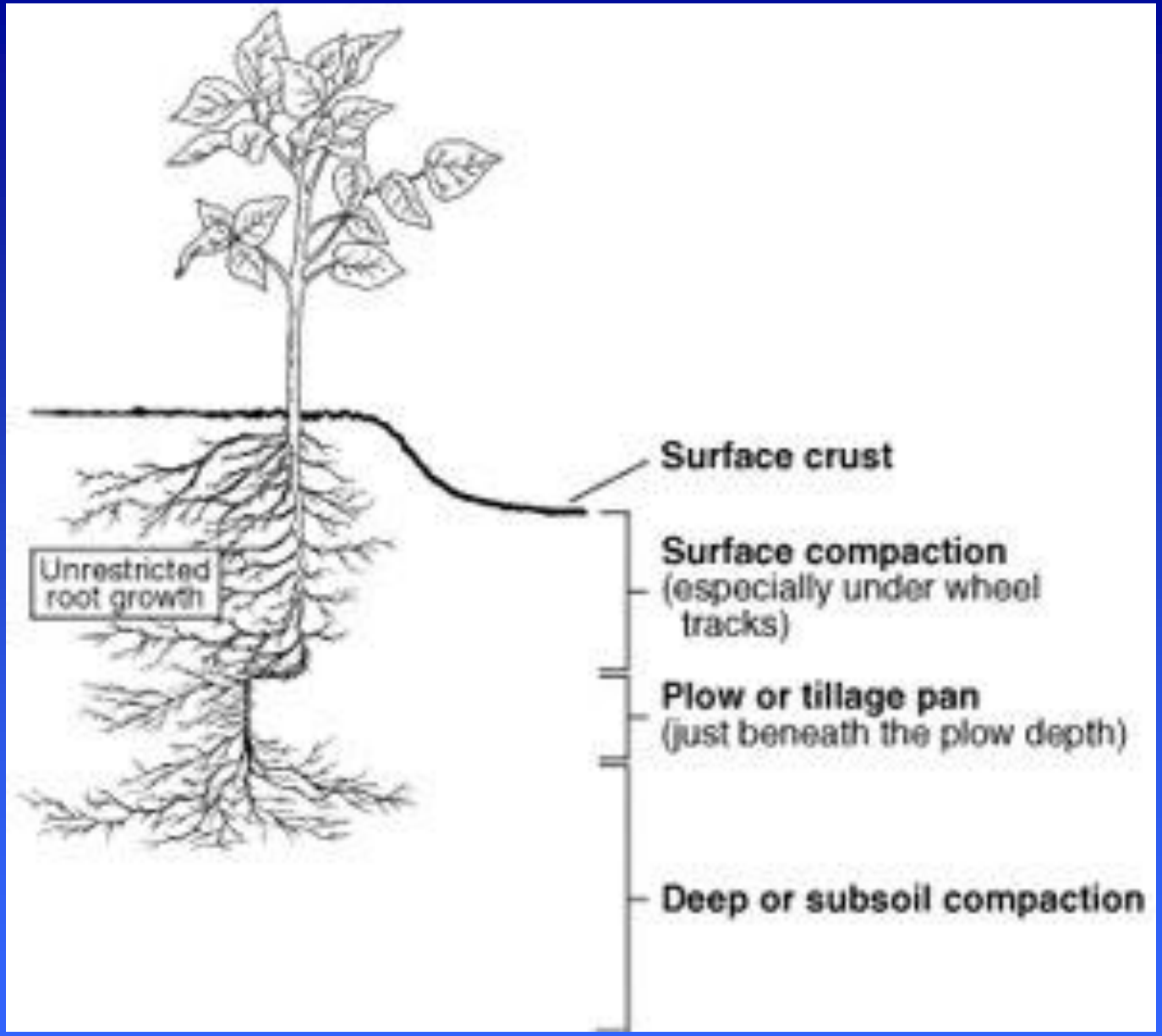
Soil compaction can have a number of negative effects on soil quality and crop production including the following:

- causes soil pore spaces to become smaller
- reduces water infiltration rate into soil
- decreases the rate that water will penetrate into the soil root zone and subsoil
- increases the potential for surface water ponding, water runoff, surface soil waterlogging and soil erosion
- reduces the ability of a soil to hold water and air, which are necessary for plant root growth and function
- reduces crop emergence as a result of soil crusting
- impedes root growth and limits the volume of soil explored by roots
- limits soil exploration by roots and decreases the ability of crops to take up nutrients and water efficiently from soil
- reduces crop yield potential

Compacted soil will restrict root growth and penetration into subsoil. This situation can lead to stunted, drought-stressed plants as a result of restricted water and nutrient uptake, which results in reduced crop yields.

In wetter than normal years, soil compaction can decrease soil aeration and lead to the increased loss of nitrate nitrogen by denitrification, which is the conversion of plant available nitrate-nitrogen into gaseous nitrogen forms that are lost to the atmosphere. This process occurs when soils are in an anaerobic condition and soil pores are mostly filled with water. Reduced soil aeration can affect root growth and function, and lead to increased risk of crop disease. All these factors result in increased crop stress and yield loss.

Government of Alberta


Surface crust
Surface compaction
(especially under wheel tracks)
Plow or tillage pan
(just beneath the plow depth)
Deep or subsoil compaction
Unrestricted root growth

Awareness Point #4
Soil Compaction

1. Keep Tillage to a Minimum & Vary Annual Tillage Depth and Direction:

Decrease tillage depth in wet soils and can increases depth in drier soils in fall to shatter the compacted soil layer.

2. Crop Rotations:

In the long term – use crop rotations to improve soil organic matter and improved soil structure – this will reduce soil crusting and compaction!

3. Equipment Weight:

Try to reduce weight of equipment to minimize deeper compaction

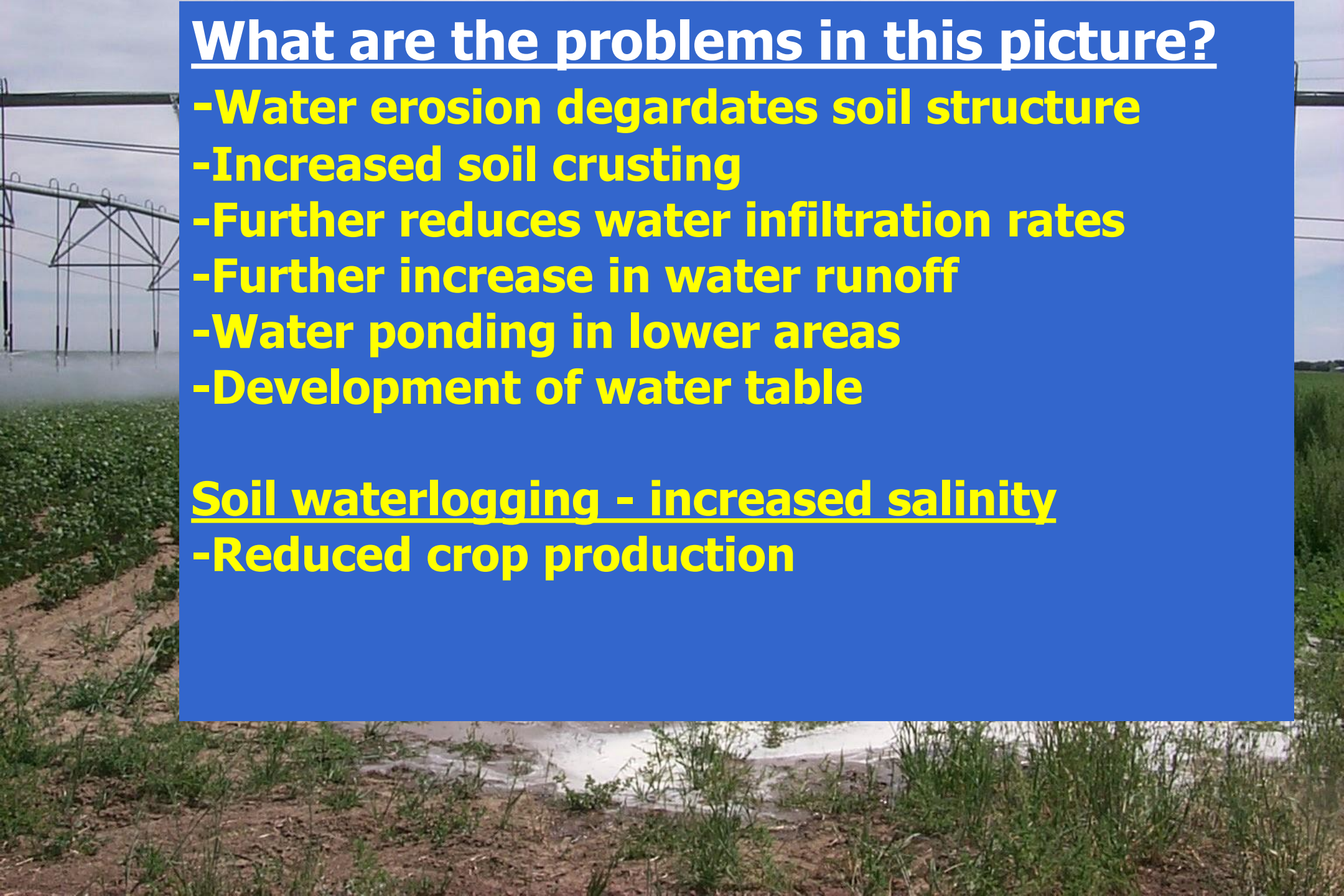
3. Sub-soiling & Deep ripping:

ONLY use when soil is dry - to shatter compacted soil at the depth you are tilling.

Point #5 - Water Infiltration/Runoff:

- Water infiltration is affected by:
  - Soil water content
  - Soil texture
  - Soil structure
  - Soil organic matter
  - Surface soil cover


What are the problems in this picture?
What are the solutions?

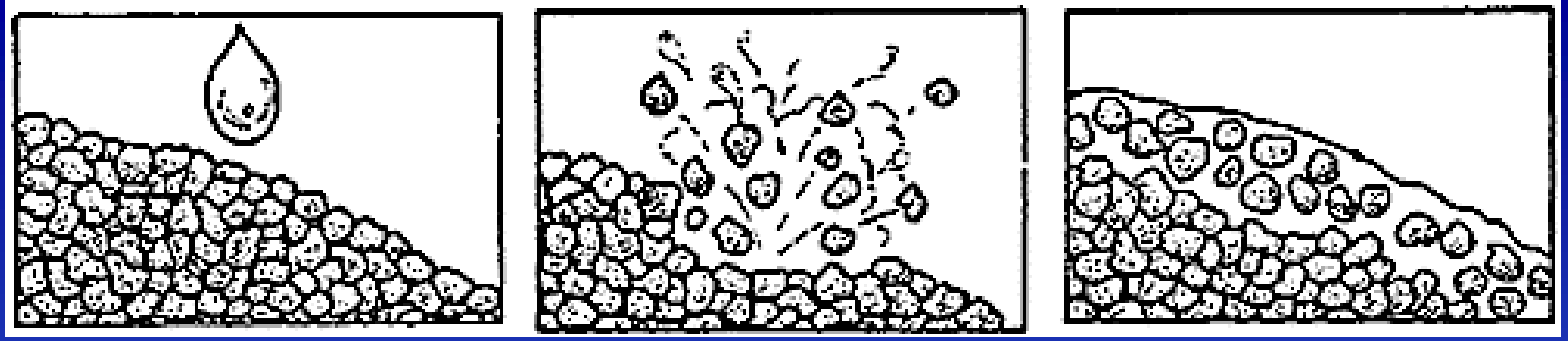


What are the problems in this picture?

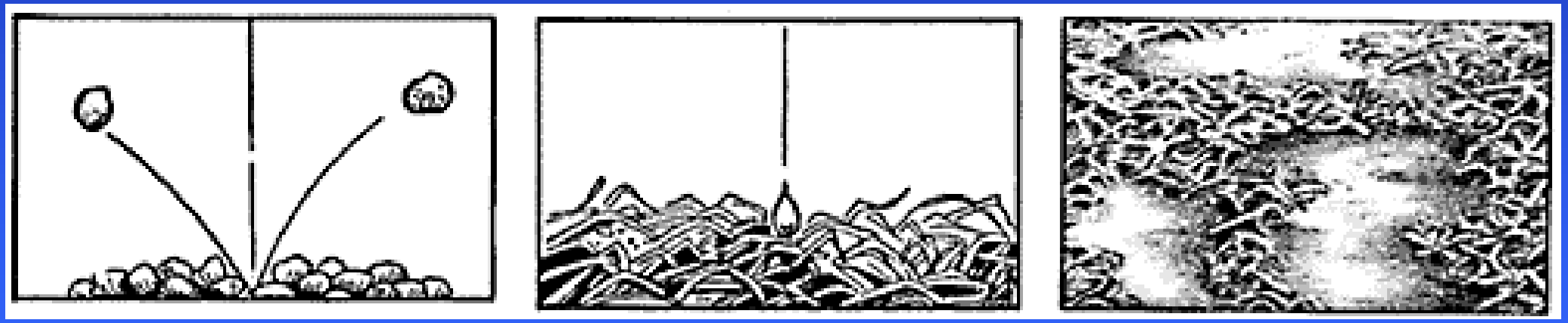
-Water erosion degardates soil structure
-Increased soil crusting
-Further reduces water infiltration rates
-Further increase in water runoff
-Water ponding in lower areas
-Development of water table

Soil waterlogging - increased salinity

-Reduced crop production



Splash erosion and breakdown of soil aggregates



Benefit of protective residue cover

Awareness Point #5 – Water Infiltration:

- Try to match irrigation water application rates with soil intake rates
- As much as possible leave residue on soil surface to protect soil structure and reduce runoff
- Consider using variable rate irrigation in fields more prone to increased water runoff and ponding

Point #6 - Soil Water Holding Capacity

- Need to know your soil texture
  - Estimate water holding capacity of your soil

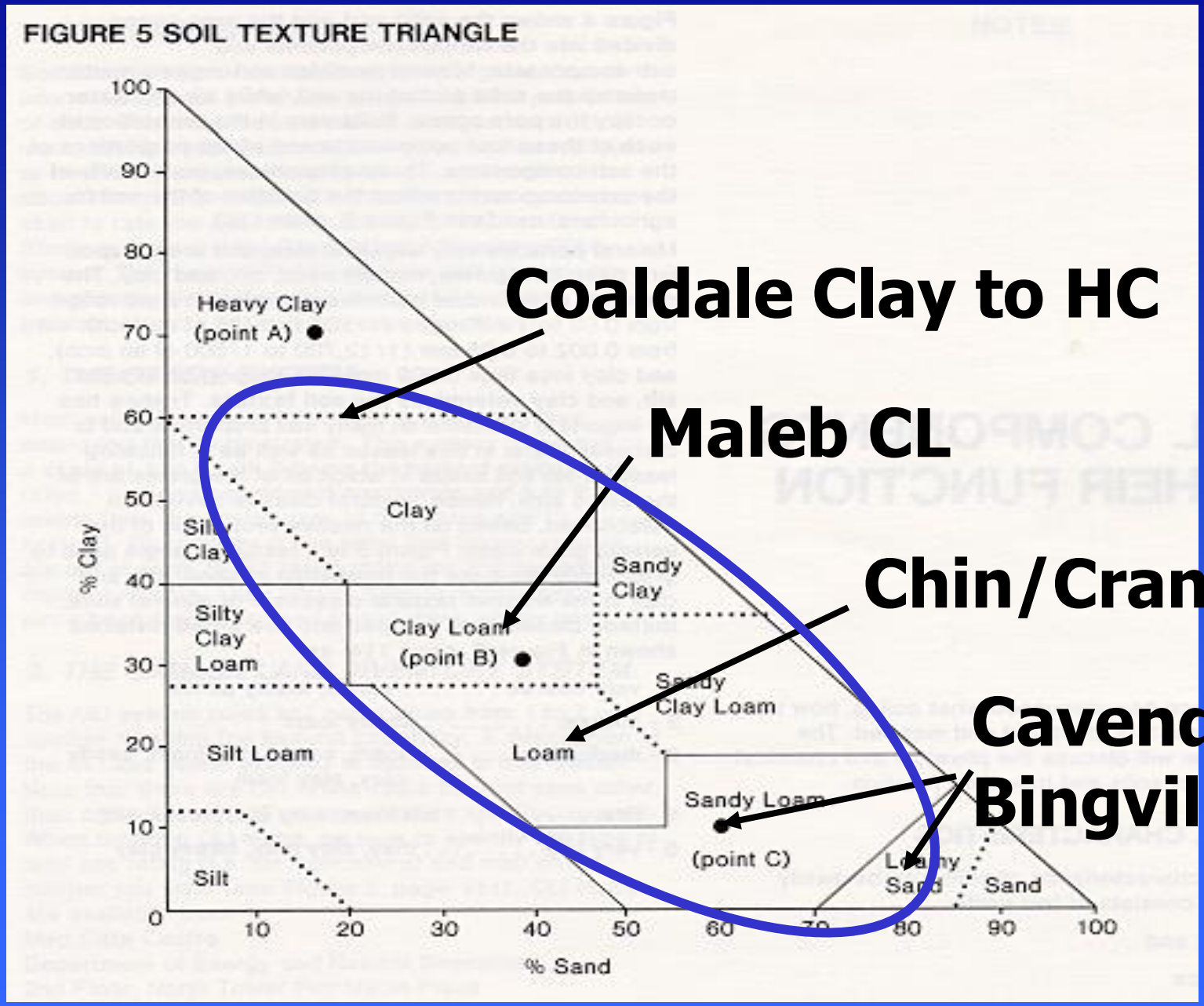
- If your pivot applies and the crop takes up 12” of water from soil over a growing season – how many lb of water/acre??
- >2,700,000 lb of water/acre
- 1350 tons of water/acre
  - We don’t appreciate the amount of water crops use!!

Soil Texture & Water Holding Capacity

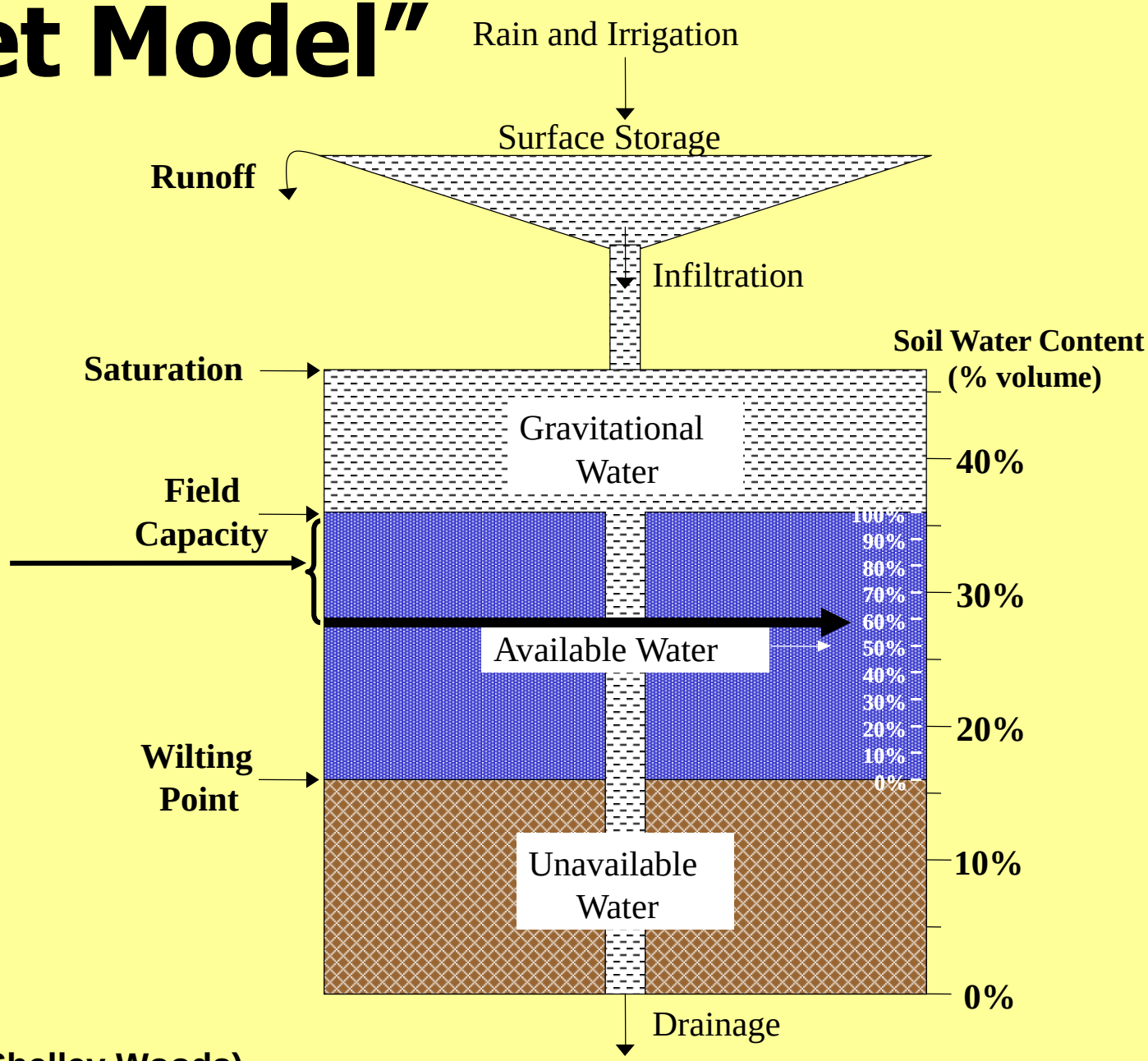
- How much water will your soils hold??

Soil Texture	Approximate Available Water-Holding Capacity
	(mm water/ 100 cm of soil)
Loamy sand	100
Sandy loam	140
Loam	180
Sandy clay loam	160
Silt loam	200
Clay loam	200
Silty clay loam	220
Sandy clay	170
Silty clay	210
Clay	190

Soil Texture Triangle – Soil Series & Textures

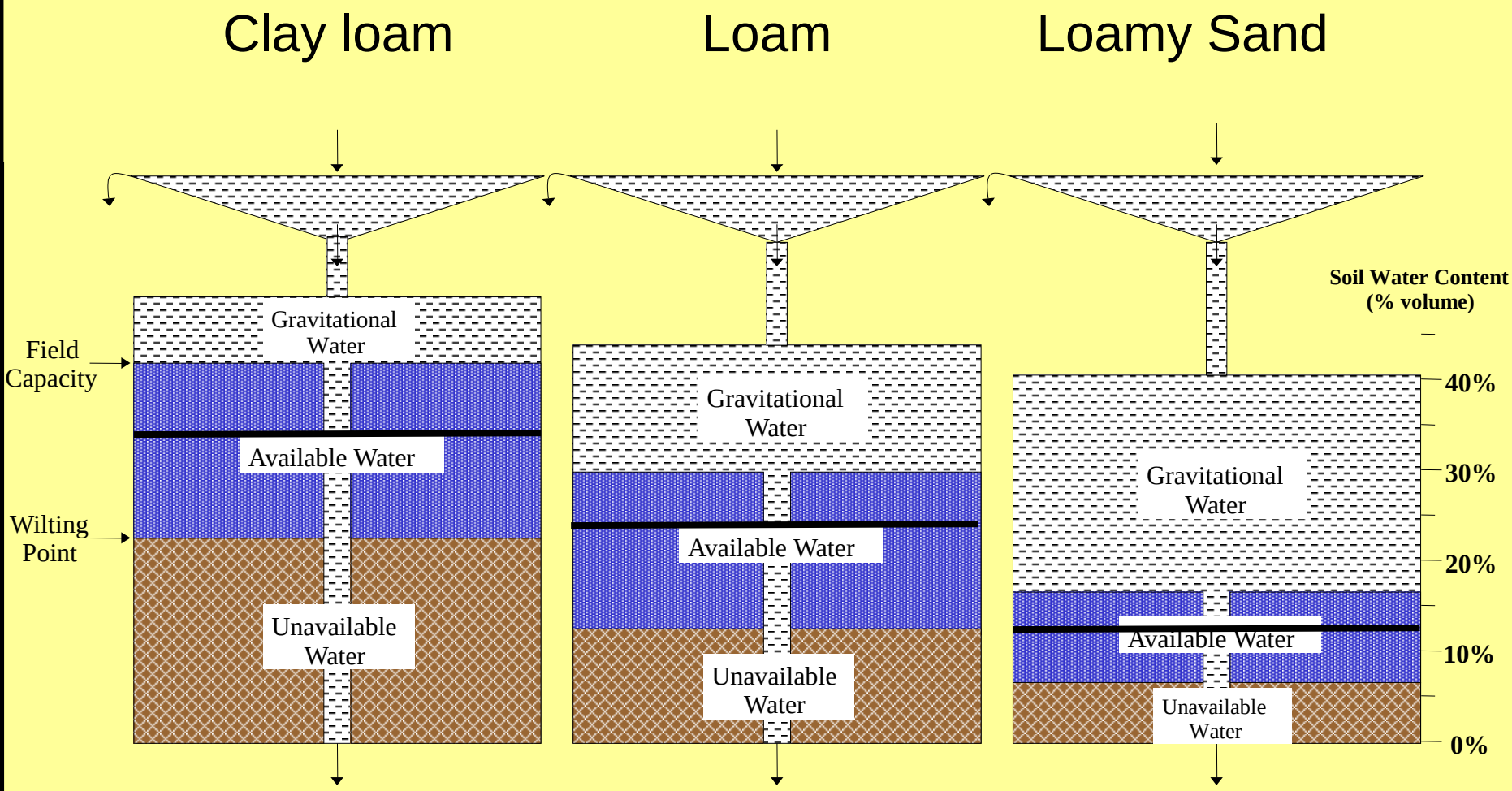


"Bucket Model"



(Figure credit: Dr. Shelley Woods)

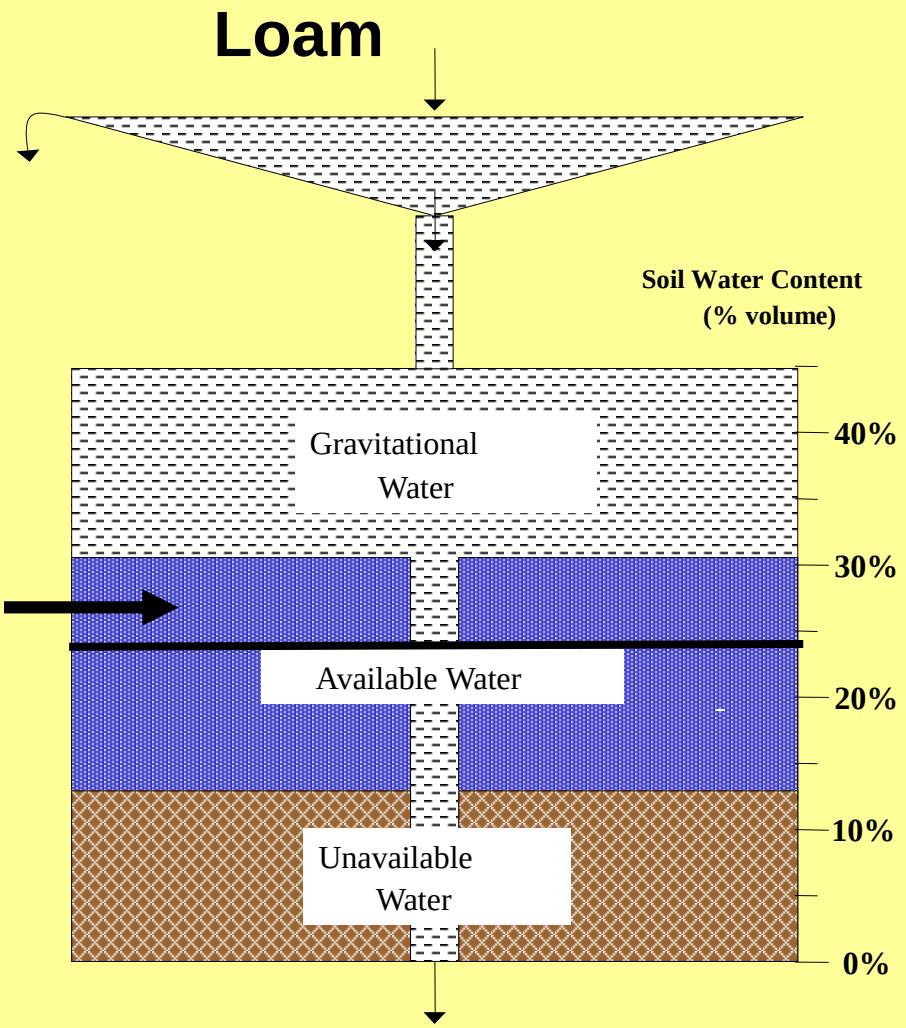
FC and WP *vs* Soil Texture



(Figure credit: Dr. Shelley Woods)

Soil Texture	Approximate Available Water-holding Capacity		Allowable Depletion 40% (mm water/ 50 cm of soil)
	(mm water/ 100 cm of soil)	(mm water/ 50 cm of soil)	
Loamy sand	100	50	20
Sandy loam	140	70	28
Loam	180	90	36
Sandy clay loam	160	80	32
Silt loam	200	100	40
Clay loam	200	100	40
Silty clay loam	220	110	44
Sandy clay	170	85	34
Silty clay	210	105	42
Clay	190	95	38

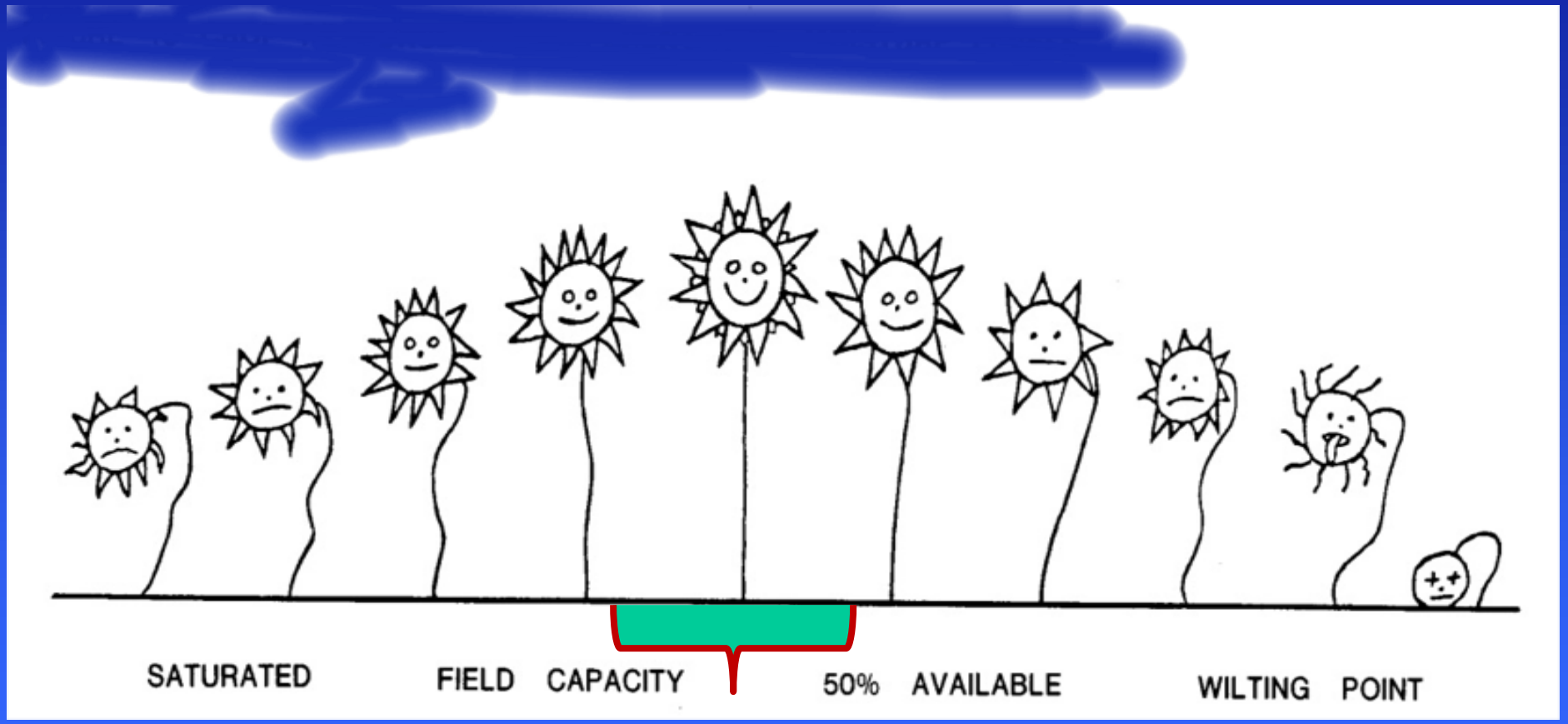
Loam Textured Soil



36 mm RAW
In 50 cm
Root Zone

(Figure credit: Dr. Shelley Woods)

Crop behavior when soil moisture is above Field Capacity (wet) and close to Wilting point (dry)



Awareness Point #6
Soil Water Holding Capacity

- Know your soil textures & water holding capacities
- Knowing your soil water is critical to determining when to irrigate!

Summary:

- Get to know your soils and all their characteristics!
- Learn to diagnose soil problems!
- Know the water holding capacities of your soils!

- Great soil management:
  - Will improve soil quality over time!
  - Will achieve optimum crop yields!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Questions ?