

Soil Salinity

Agronomic Receptor Evaluation for Direct Soil Contact

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Phases of Project



Agronomic
Receptor
Evaluation

Greenhouse
Study

Field
Validation

Overview of Presentation

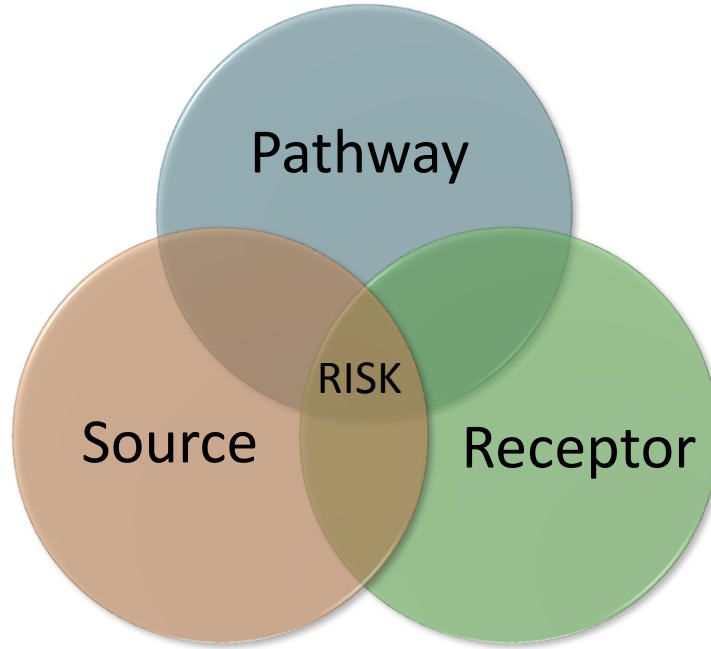
- Introduction and objectives
- Defining the Ecological Direct Soil Contact Pathway with respect to agronomic species
- Identify agronomic species in Alberta
- Assessment of effective rooting depth and salinity sensitivity of agronomic species present in Alberta
- Next steps

Introduction and Objectives

- Applicability of the Ecological Direct Soil Contact pathway as it relates to agronomic receptor species for the White Area of Alberta
- Establish path toward a scientifically defensible depth at which the ecological direct soil contact pathway is applicable



What is Risk?



Ecological Direct Soil Pathway

- Delineation of the biologically active zone at a contaminated site is a prerequisite for quantifying associated risk
- The biologically active zone is the depth at which most of the microbial and invertebrate activity occurs. This zone is often associated with the rhizosphere (a narrow region directly influenced by root secretions)
- Contaminants in soil below the depth of the biologically active zone are not accessible to biota

Ecological Direct Soil Pathway

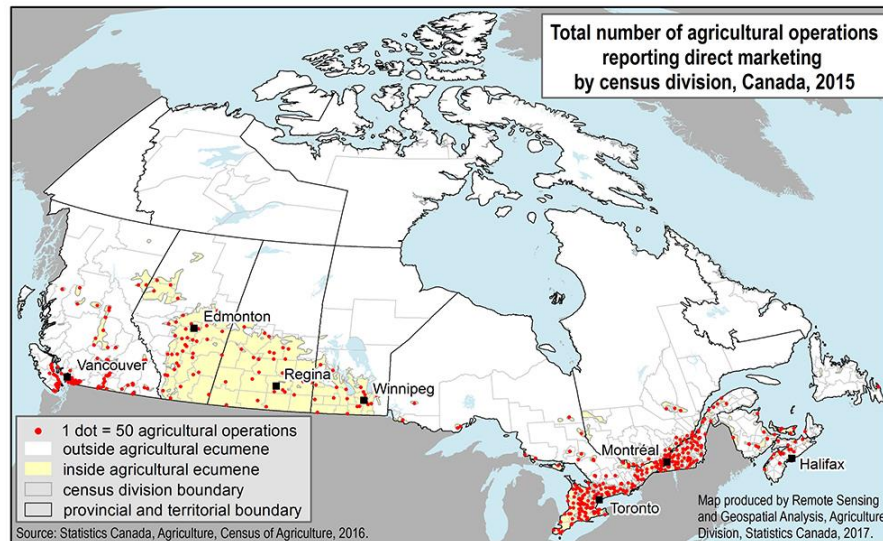
- *Alberta Tier 1 Soil and Groundwater Remediation Guidelines:*
 - Below 1.5 m and above 3.0 m within 5 m of a wellhead the subsoil eco-contact guidelines may be applied (BTEX and PHC F1 to F4)
 - Below 3 m at any site (PHC F1 to F4)
- *Subsoil Petroleum Hydrocarbon Guidelines for Remote Forested Sites in the Green Area:*
 - Below 3 m for coarse-grained soils
 - Below 1.5 m for fine-grained soils

Methodology

1. Describe agricultural land-use in Alberta
2. Establish which crop species are grown
3. Define crops' respective rooting depths
4. Compare and evaluate ecological direct contact depth to 3.0 m
5. Evaluate exclusion depth using salts as a surrogate chemical of concern

Agronomic Species Distribution Database

- Agronomic data from 2001, 2006, 2011 and 2016 was used
- Data from the Alberta Ministry of Agriculture and Forestry
- Supplemental data for 2011 and 2016 were retrieved directly from Statistics Canada



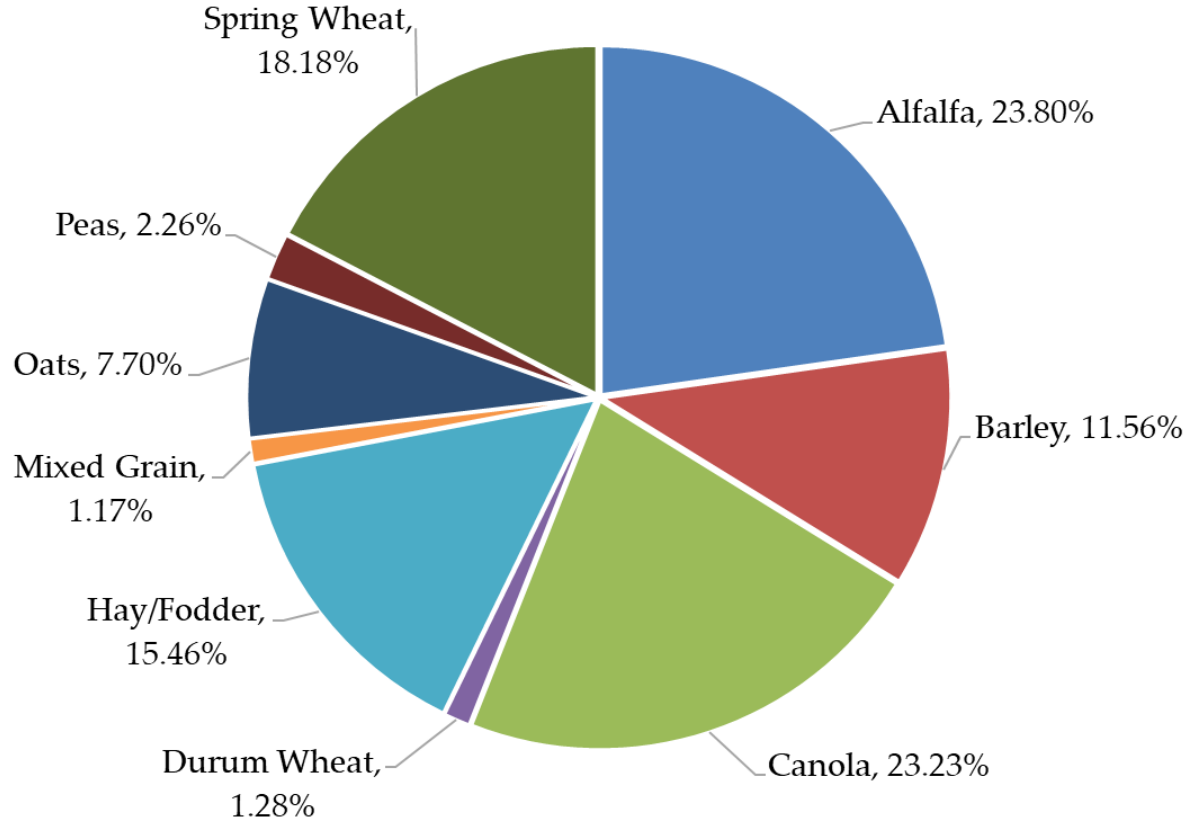
Crop Distribution in Alberta

1. Alfalfa
2. Canola
3. Spring Wheat
4. Barley
5. Hay/Fodder
6. Peas
7. Durum Wheat
8. Mixed Grain
9. Lentils



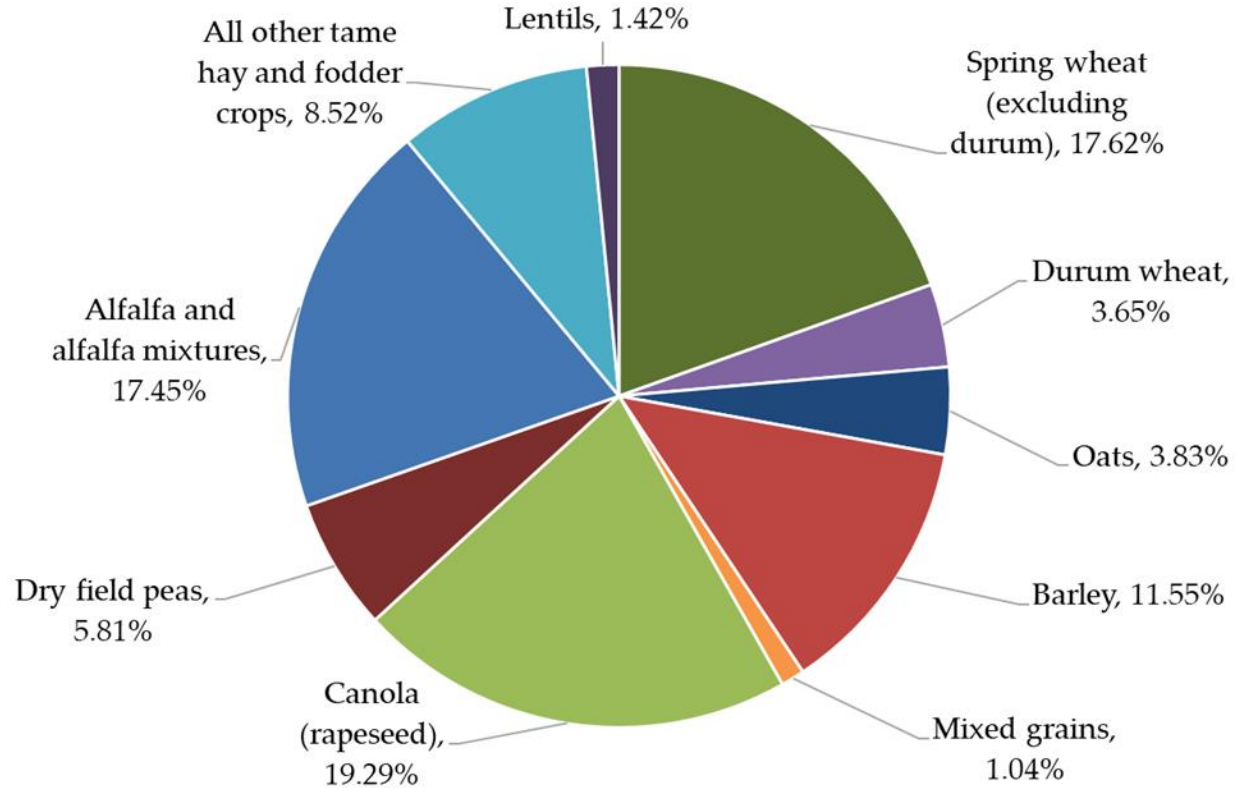
2011 Crop Distribution in Alberta

Percentage of Total Agricultural Land used per Crop Species in Alberta Eco-Regions in 2011 (2011 Census Data)



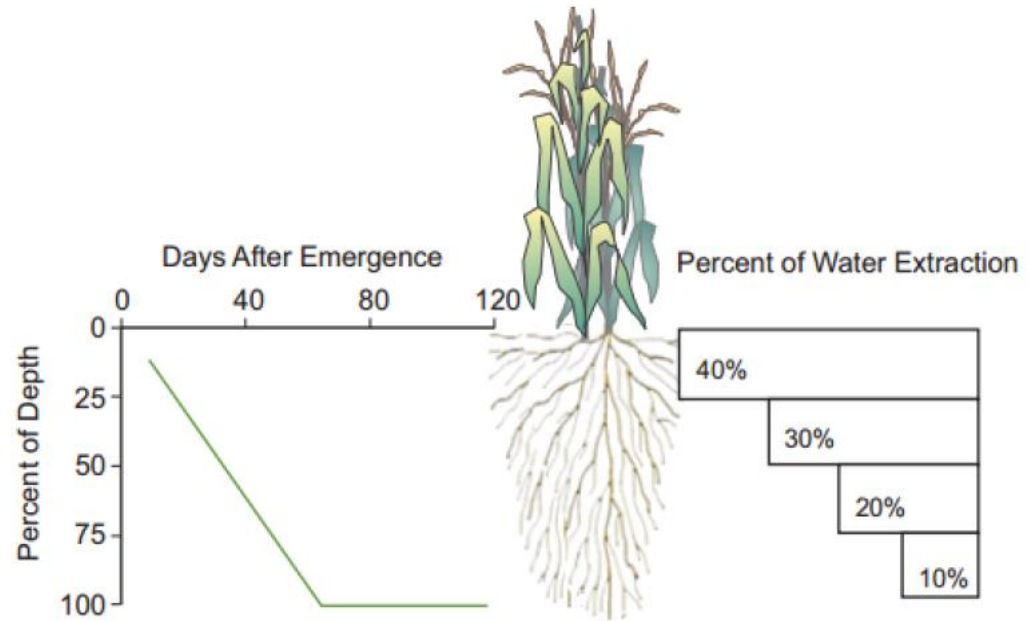
2016 Crop Distribution in Alberta

Percentage of Total Agricultural Land used per Crop Species in Alberta Census Divisions in 2016 (2016 Statistics Canada Agriculture Census)



Eco-Contact and Effective Rooting Depth

- Effective rooting depth is the zone, or depth, by which most of the plant available water is obtained.



From: Kranz *et al.* (2008)

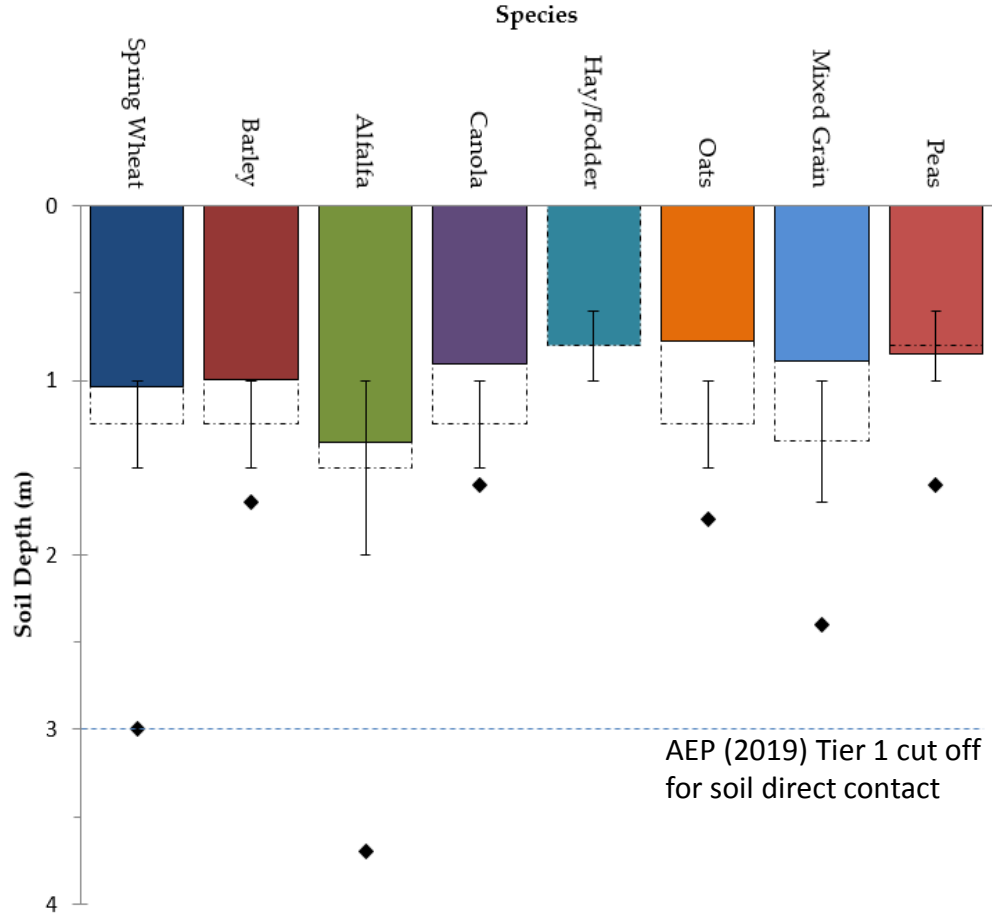
Legend:



Cumulative root distribution which 95% of plant root occurs

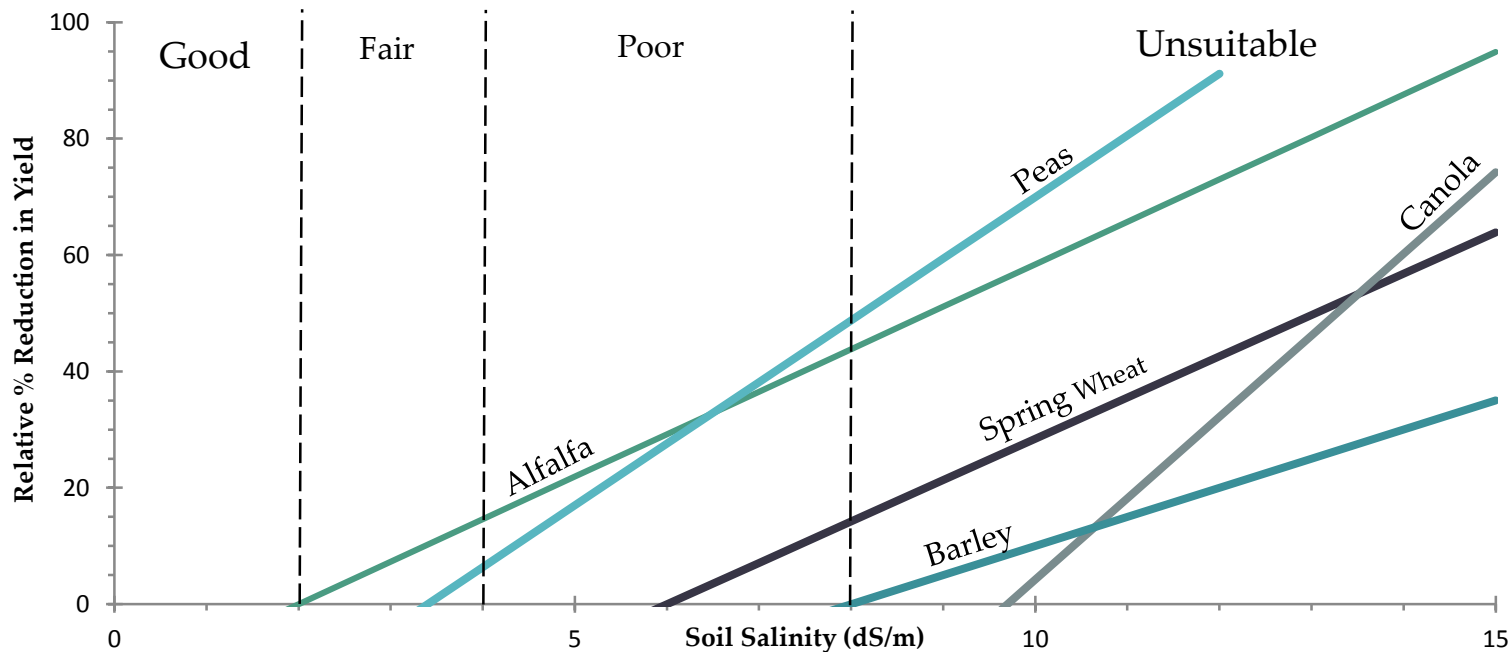
Effective root zone depth at which mature crops will deplete available water supplies

◆ Maximum reported rooting depths



Data adapted from: Jianling *et al.* 2016 and USDA 2016

Eco-Contact and Crop Sensitivity



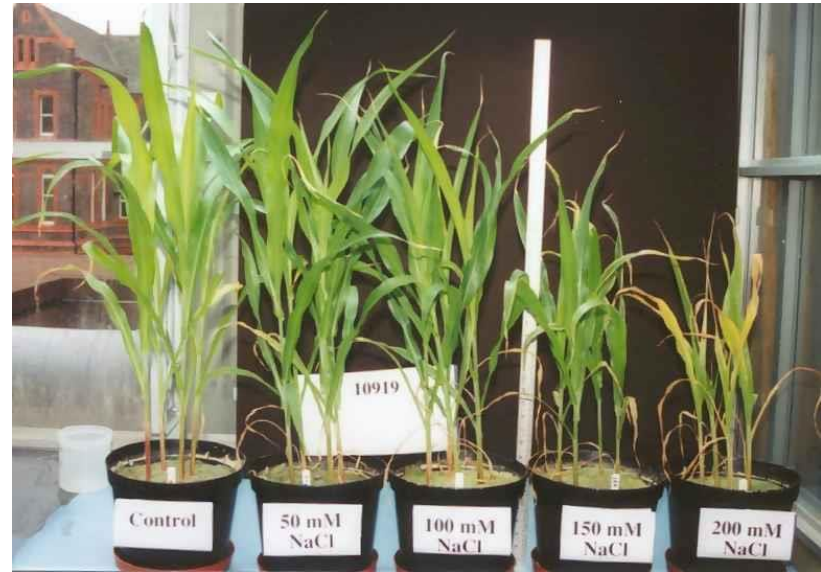
Crop sensitivity analysis for a select number of prevalent crop species in Alberta (AENV 2001).

Eco-Contact and Effective Rooting Depth

- Alfalfa chosen as surrogate species in Alberta:
 - identified as the deepest rooting species currently, and projected to be (next 10 to 20 years), commercially grown in Alberta
 - considered sensitive to salinity
 - ubiquitous across all ecoregions
 - conservative surrogate
 - need to validate effective and maximum rooting depth for alfalfa grown under Alberta soil and climatic conditions

Validation of Eco-Contact Methodology

- Indicators of Salt Stress
 - Affect photosynthesis, protein synthesis and lipid metabolism
 - Reduce plants ability to take up water
 - Reduction of leaf surface growth
 - Reduction in crop yield



<https://www.liverpool.ac.uk/~sd21/stress/salt.htm>

Data Gaps

Knowledge Gaps	Further Work
Evidence from Alberta that microbial and invertebrate activity, exist within the rhizosphere to the depth dictated by plant rooting	Field study to define the biologically active zone
Validation of rooting depths for alfalfa in Alberta	Field study to acquire observational evidence
Effect salinity has on root structure and distribution for alfalfa	Lab/greenhouse study to the effect NaCl has on plant health (both above and below ground)

Phase 2 – Greenhouse Study

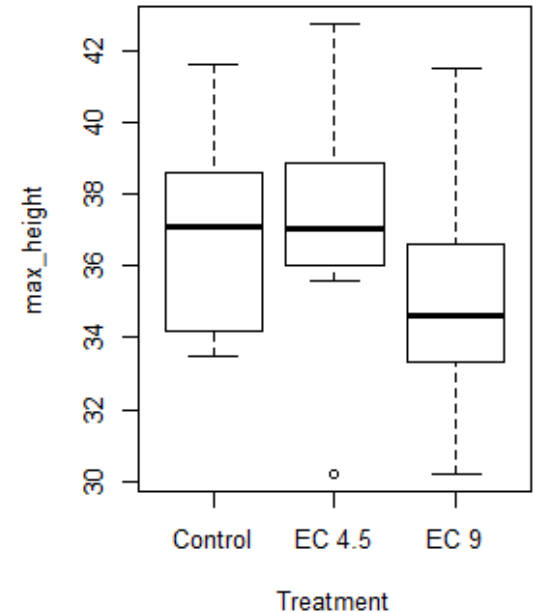
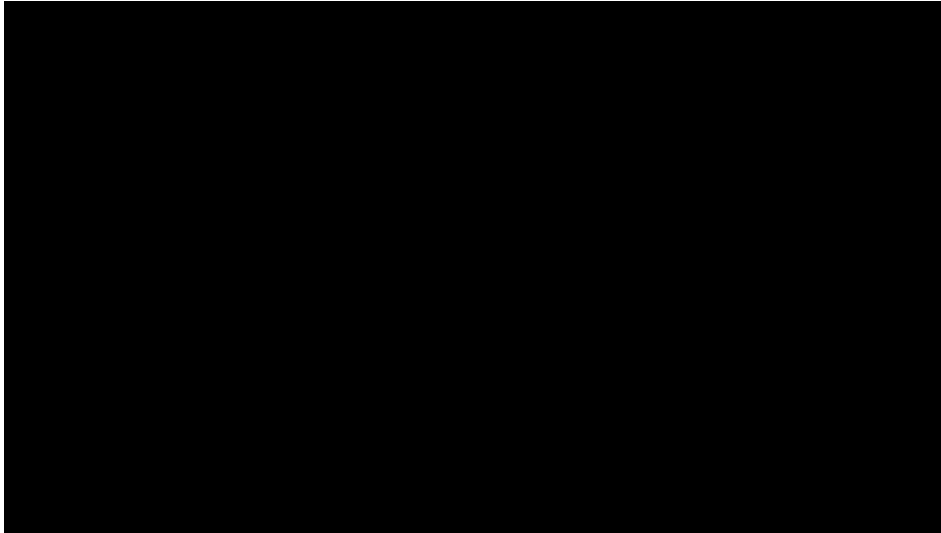
Objective: Evaluate the effects of salinity (NaCl) on plant health (both above and below ground) when found at various depths within the soil profile and specific to those depths within and below the ERZ.



Treatments/ Parameters	Number	Description
Soil	1	sandy loam
Plant Species	1	Medicago sativa (alfalfa)
Soil Electrical Conductivity	3	Control (0 dS/m) 8 dS/m 16 dS/m
Soil Depth	4	50, 100, 150, 175 cm bgs
Replicates	8	PVC columns (200 cm tall by 30 cm wide)
Total # Columns = 72		

Phase 2 – Bonus “Proof of Concept Study”

Objective: assess the feasibility of utilizing an industrial X-Ray CT Scanner to assess the biological impacts on alfalfa roots grown in salinity impacted soil



Phase 3 – Field Validation

- Validate effective and maximum rooting depth for alfalfa grown under Alberta conditions
- Assess the correlation between abundance and vertical distribution of soil invertebrates to validate the depth of the biologically active zone



Thank you

Questions?