# Controlled Traffic Farming: The Effects on Soil Physical and Hydraulic Properties in the Canadian Prairies

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## INTRODUCTION

The use of poor land management systems has lead to the degradation of soil structure. In intensive agricultural systems, excessive tillage and compaction associated with conventional farming or Random Traffic Farming (RTF) have had a profound reduction in soil structure and quality (Strudley et al., 2008). The use of Controlled Traffic Farming (CTF) as a management system can potentially aid in the recovery of soil quality and reduce the harmful effects of soil compaction (McHugh et al., 2008).

**What is controlled traffic farming?**

- Movement of in-field equipment is confined to tramlines.
- Tramlines are permanent tracks inside the field boundary that the equipment utilize for every stage of farming.
- Tramline spacing is based on uniform implement width.
- All implement sizes should be equivalent or multiples of the uniform size.
- Spatial compaction can be reduced from **40%-70%** compared to conventional farming (Tullberg, 2000; Tullberg et al., 2007).

*BENEFITS*

- **R**eduction of cumulative field compaction.
- **I**ncreases in macroporosity and mesoporosity.
- **I**ncrease in infiltration.
- **I**ncrease in soil water use efficiencies.

*OBSTACLES*

- **R**equires matching implement widths.
- **T**ramlines susceptible to rutting.
- **C**ontinual residue management needed.
- **S**oil amelioration takes many years.

## OBJECTIVES

- Determine how soil physical and hydraulic properties change in trafficked and un-trafficked areas.
- Quantify how soil quality changes as a function of CTF implementation.

Figure 1

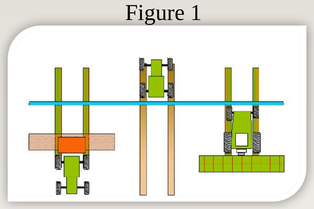


Figure 1. Controlled Traffic Farming Europe. Unilever R&D Colworth Controlled Traffic Farming Project [Online Image]. Retrieved October 28, 2015 from http://www.controlledtrafficfarming.com/Info/CTF-At-Colworth.aspx#2006

## SITE INFORMATION

Figure 2

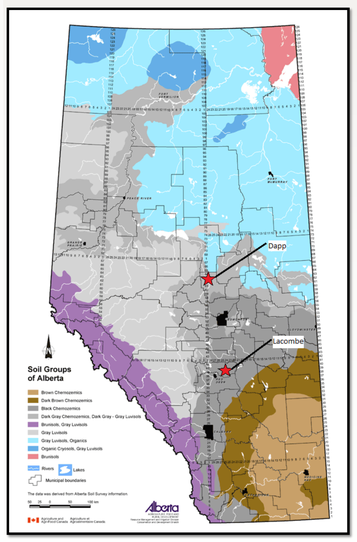



Figure 2. Alberta Agriculture and Forestry. Agricultural Land Resource Atlas of Alberta-Soil Groups of Alberta [Online Image]. Retrieved October 30, 2015 from http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex10307

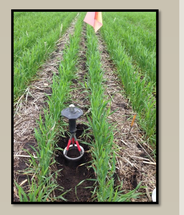
- Soil samples taken from two farm sites at Dapp and Lacombe, Alberta.
- **Dapp**:
  - Dark Grey Luvisol with sandy clay loam texture.
  - Undulating low relief.
  - **CTF** employed for **5** years.
  - 4 **RTF** check strips within site.
  - 48 soil core samples taken at depths of 5-10cm, 15-20cm and 25-30cm.
- **Lacombe**:
  - Black Chernozem with sandy loam texture.
  - Undulating high relief.
  - **CTF** used for **5** years.
  - 4 **RTF** check strips within site.
  - 36 soil core samples taken at depths of 5-10cm and 15-20cm.



## MATERIALS & METHODS

In 2014, soil samples taken randomly within:

- Tracks of **RTF** check strip locations.
- Un-trafficked **CTF** area adjacent to check strip.



Soil physical and hydraulic properties can be accurately measured from undisturbed soil core samples by tensiometers in a UMS HYPROP unit (Peters et al., 2008; Schelle et al., 2013).

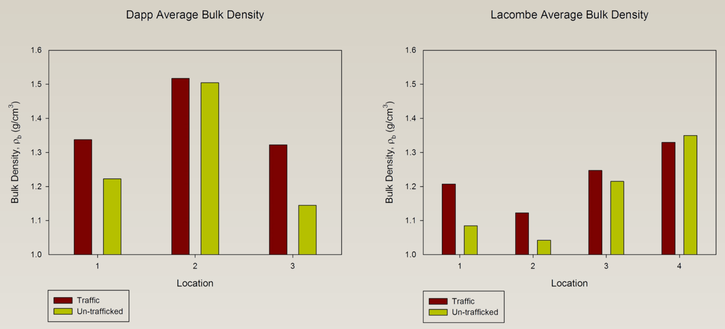
- Uses simple evaporation method.
- Matric potential measured at 1.75 and 3.75 cm heights.
- Measurement range of pF 0.0-3.0 (Schindler et al., 2010a).

- Van Genuchten model fitted water retention curve (van Genuchten, 1980).
- S-Index used to observe change in soil quality (Dexter, 2003).

$$\theta = \theta_r + \frac{(\theta_s - \theta_r)}{(1 + (\alpha h)^n)^m}$$

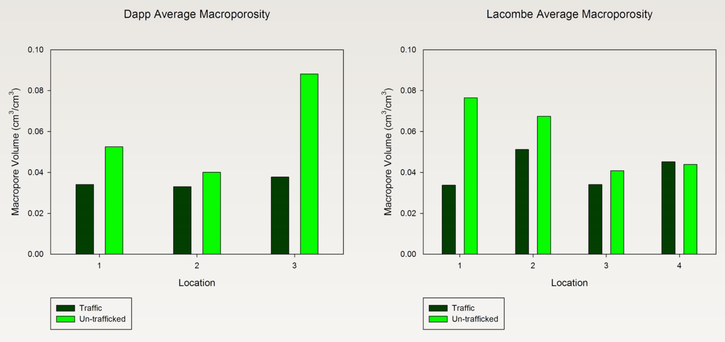
$$S = -n(\theta_s - \theta_r)\left(\frac{2n-1}{n-1}\right)^{(1/n-2)}$$

## PRELIMINARY RESULTS



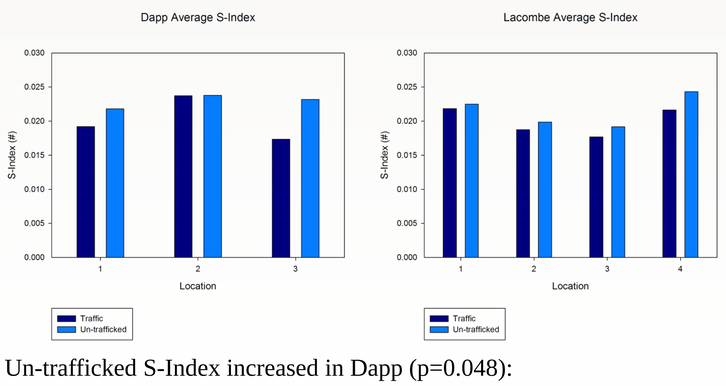

Un-trafficked density decreased in Dapp (p=0.004) and Lacombe (p=0.024):

- Dapp average $\Delta\rho_b$ = 0.115 g/cm$^3$.
- Lacombe locations 1 & 2 average $\Delta\rho_b$ = 0.101 g/cm$^3$.




Un-trafficked macroporosity (> 30 µm) increased in Dapp (p=0.003) and Lacombe (p=0.017):

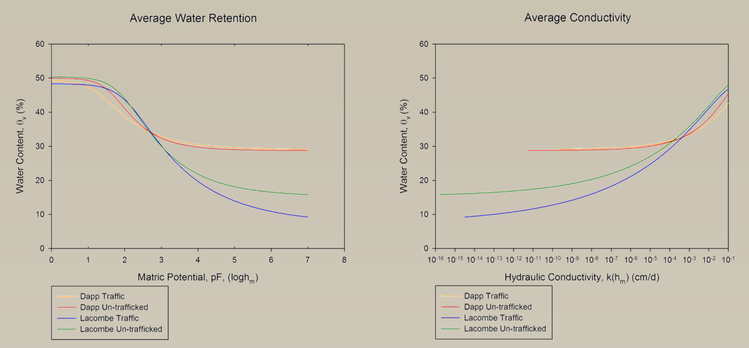
- Dapp average $\Delta\Phi$= 0.025 cm$^3$/cm$^3$.
- Lacombe locations 1 & 2 average $\Delta\Phi$= 0.030 cm$^3$/cm$^3$.




Un-trafficked S-Index increased in Dapp (p=0.048):

- Dapp average $\Delta$S = 0.003.
- Lacombe average $\Delta$S = 0.001.

## PRELIMINARY RESULTS *(continued)*




Un-trafficked areas increased in van Genuchten modelled saturated water content ($\theta_s$) and residual water content ($\theta_r$):

- Dapp $\Delta\theta_s$ = 0.6 % and $\Delta\theta_r$ = 0.2 %.
- Lacombe $\Delta\theta_s$ = 2.1% and $\Delta\theta_r$ = 8.0%.

## SUMMARY

The confinement of traffic to tramlines has had a positive impact on soil properties within the un-trafficked areas, which is in agreement with McHugh et al. (2008).

- Un-trafficked soil quality improvements:
  - Verification of two independent indicators: correlations between the decreases in bulk density and increases in macroporosity in both Dapp ($\rho$ = -0.624***) and Lacombe ($\rho$ = -0.623***).
  - Correlations between the increases of both S Index and mesoporosity (30 µm to 4.5 µm) in both Dapp ($\rho$ = 0.781***) and Lacombe ($\rho$ = 0.827***).
- Soil changes are a function of landscape:
  - Amelioration occurred in all locations at Dapp.
  - Significant improvements found in locations 1 & 2 but not at locations 3 & 4 in Lacombe.
  - Significant changes in Lacombe based on soil sub-groups:
    - 1 & 2 = Eluviated Black Chernozem.
    - 3 & 4 = Orthic Black Chernozen.
  - Soil quality improvement more noticeable in uniform (flat) landscapes.

*ONGOING RESEARCH*

- Modelling study on spatial heterogeneity of soil properties:
  - **C**yclic gridded sampling of plots.
  - **G**eostatistical analysis on physical, hydraulic and fertility properties.
  - **U**se of HYPROP and WP4 coupled with laboratory extractions.
  - **I**ncorporation of LiDAR elevation analysis.
  - **A**id in delineation of management zones.
- Soil pot study on alterations in density and moisture content:
  - **C**rop response analysis on faba beans *(Vicia faba)*.
  - **U**se of randomized complete block design with replicates.
  - **G**reen house experiment with field simulated conditions.
  - **A**id in determination to seed or not seed tramlines.

## ACKNOWLEGMENTS

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