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EFFECT OF TILLAGE ON SOIL PROPERTIES IN A ROLLING GLACIOLACUSTRINE LANDSCAPE

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INTRODUCTION

Conventional tillage systems (CT), especially tilled summerfallow, have been linked to soil degradation by increasing erosion, reducing soil organic matter, increasing soil compaction and contributing to water pollution. Innovative farming practices, such as zero-till (ZT) are considered to be able to reverse soil degradation. There are concerns, however, about the environmental impact of increased herbicide and fertilizer use. The fate of herbicides and fertilizers may be understood by studying the structural and hydraulic properties of soils. The knowledge of how soil properties are affected by tillage at a landscape scale is essential in comparing ZT to CT systems in a given environment.

Objective: The objective of this study was to compare the effects of CT and ZT systems on soil properties at a landscape scale and their effect on potential runoff.

MATERIALS AND METHODS

Site: Found in a Rolling Glaciolacustrine Landscape known as the **Bear Hills** which are a morainic formation with lacustrine deposits on surface.

Location: **16** kilometers due south of the town of Biggar
NE-7-34-14-W3 & SE-18-34-14-W3
A part of an enclosed watershed

Soils: Entirely Elstow Association with texture ranging from silty loam to silty clay.

Landscape: Elevation difference between lowest and highest point: 27m.
Slope length: broad hills with long slopes (average: 160 m)
Slope gradient: (6 - 30) %

Experimental desian:

- For each study plot:
  - 100 grid points, with a 50 m spacing, were set up
  - 40 sampling points were randomly chosen from 100
  - 40 subdivided into 4 landscape classes:
    - Converging Backslopes (CB)
    - Diverging Backslopes (DB)
    - Footslopes (FS)
    - Shoulders (SH)

    for landscape analysis
  - A topographic survey of the tillage plots was done (Fig. 1)

Measured parameters:

- Organic carbon (combustion method at **840** °C)
- Aggregate stability (wet sieving method)
- Aggregate size distribution (dry sieving)
- Soil strength (cone penetrometer in the field)
- Soil moisture (TDR in the field)
- Infiltration rates (single ring infiltrometer)

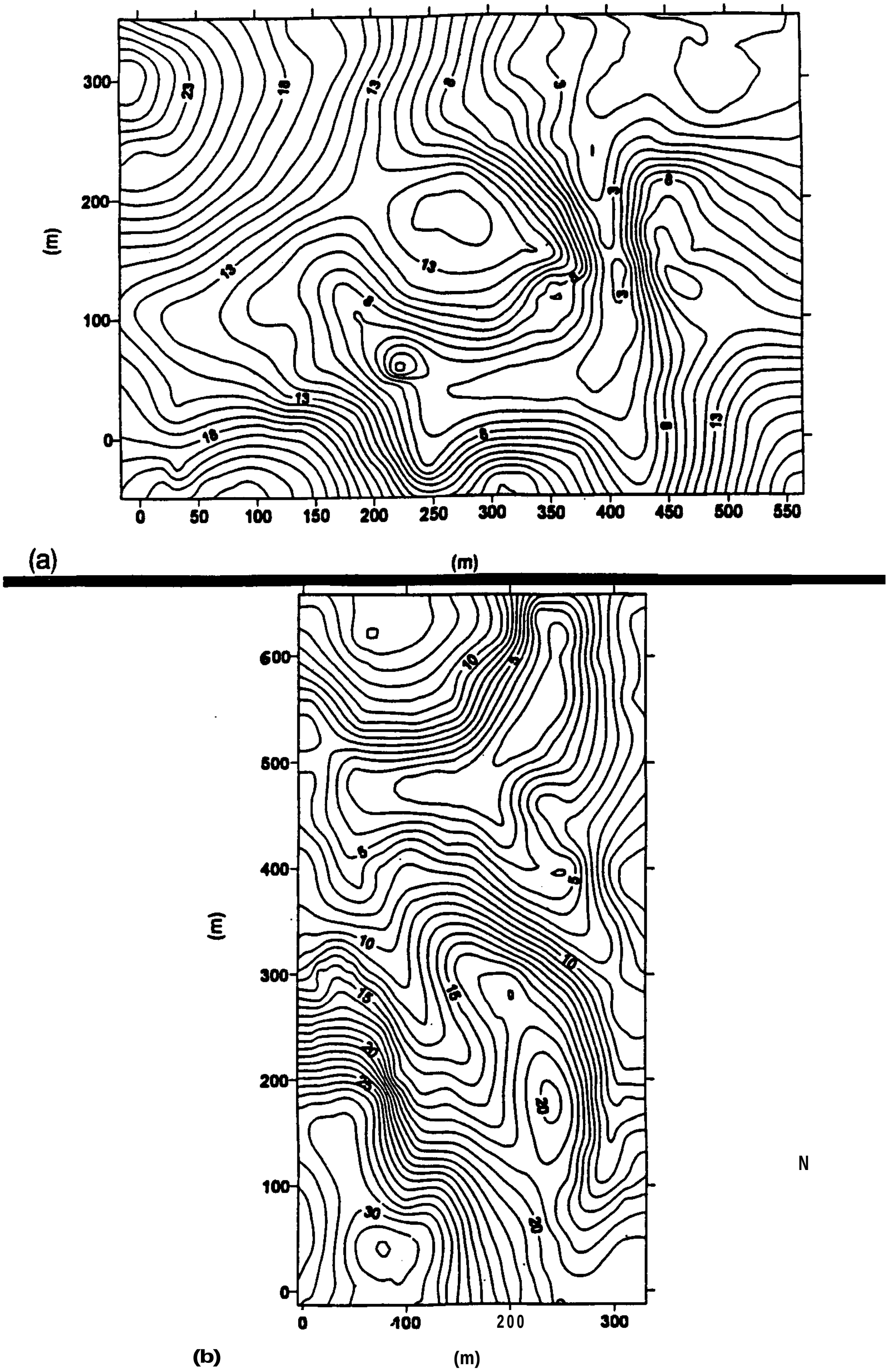

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Figure 1: Contour maps for (a) Zero Tillage and (b) Conventional Tillage study plots

RESULTS

Table 1: The organic carbon, soil structural and hydraulic properties for zero and conventional tillage study plots

	Zero Tillage	Conventional Tillage	Significance
Residue Cover (% area)	93 [10]	10 [7]	**
% Organic Carbon	3.24 [0.6]	2.76 [0.6]	**
Aggregate Stability (%)	61.4 [9]	49.5 [15.41	**
Mean Weight Diameter (mm)	22.0 [5.0]	16.0 [3.8]	**
Strength (50 mm) (N/cm^2)	146 [38]	168 [21]	**
Strength (150 mrn) (N/cm^2)	198 [26]	[No penetration]	**
% Moisture at penetration	25 [3]	28 [3]	**
95-Total Infiltration (mm/hr)	113 [125]	76 [48]	ns
96-Total Infiltration (mm/hr)	83 [38]	69 [45]	ns
95-Final Infiltration (mm/hr)	71 [47]	51 [43]	**
96-Final Infiltration (mm/hr)	76 [44]	52 [43]	**

'* ------> Significantly different ($P \approx 0.05$)
ns -----> Not significantly different
Organic carbon and Aggregate analyses: (soil depth: O-l 00 mm)
Mean [Standard Deviation]

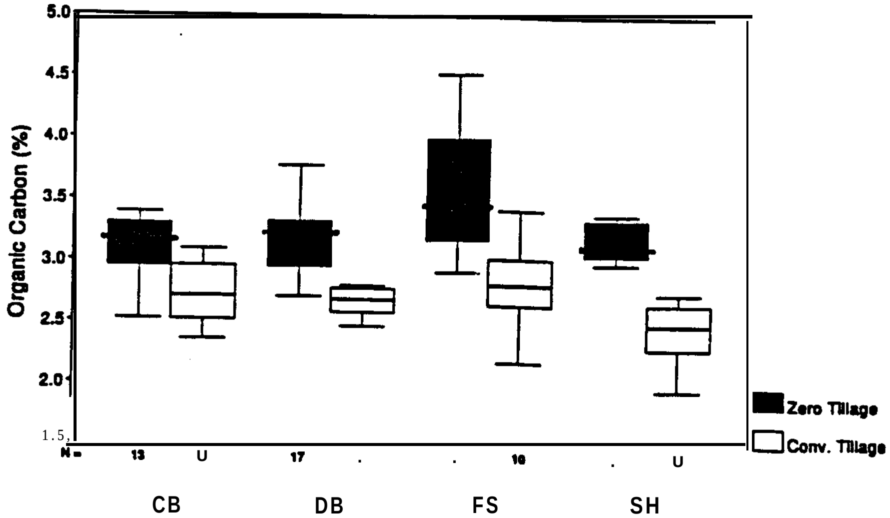

Figure 2: Soil organic carbon content for zero and conventional tillage study plots

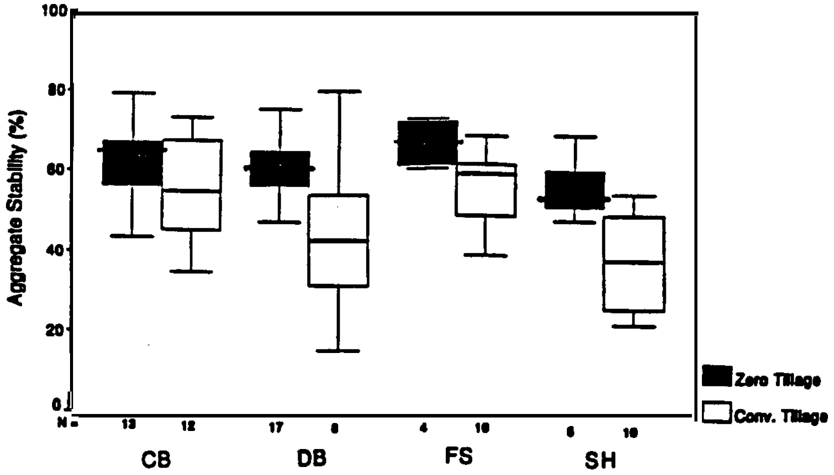

Figure 3: Soil aggregate stability for zero and conventional tillage study plots

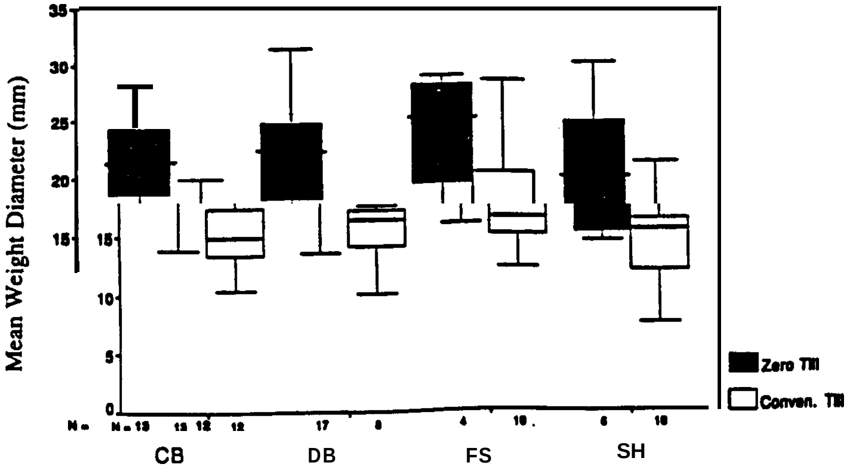

Figure 4: Soil aggregate size, distribution expressed in mean weight diameter for zero and conventional tillage study plots

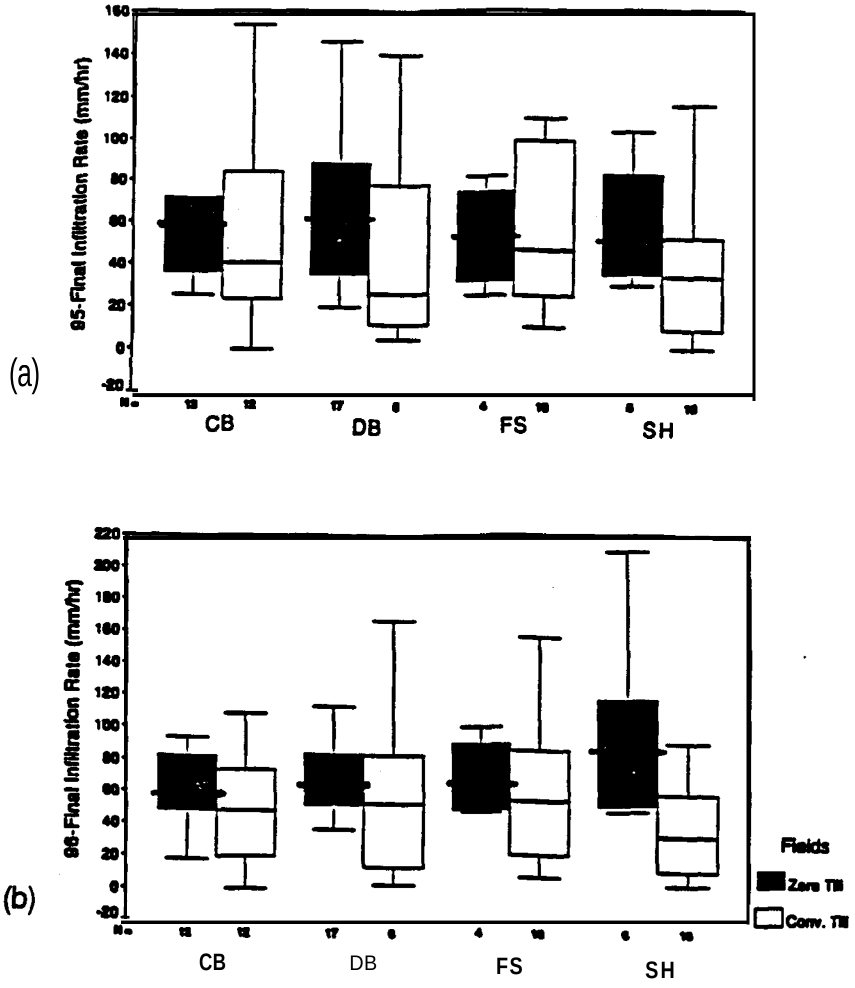

Figure 5: Soil final infiltration for zero and conventional tillage study plots for (a) fall (1995) and (b) spring (1996) seasons.

DISCUSSION

- The lower organic carbon content (Table 1) in the top 100 mm of CT soils could be due to the effects of cultivation. Cultivation (a) dilutes soil organic carbon by mixing it with subsoil, (b) increases organic matter mineralization rate by increasing the aerobicity of top soil, and (c) subjects soil to erosion through which organic carbon is lost from the top soil.

*The higher soil organic carbon could have increased soil aggregate stability and aggregation observed in ZT than CT soils (Table 1). Organic carbon is an aggregate stabilizing and binding agent.

*The higher soil aggregate stability and aggregation and the lower strength at 20 mm and 150 mm depths observed with ZT may have led to higher final infiltration rates (Table 1). The disrupting, exposing and compacting effects of tillage could have contributed to the lower aggregation and stability, as well as higher soil strength on CT than ZT field.

*The shoulders had the lowest aggregate stability and aggregation. They responded to ZT more than the other elements. This could be due to the regosolic nature of the shoulder soils.

CONCLUSIONS

1. The practice of continuous cropping zero tillage (10 years)
    (a) had more soil organic carbon in the top 100 mm of soil surface
    (b) had larger and more stable aggregates
    (c) had higher final infiltration rates
    (d) had lower soil strength
    and
    (e) by inference, decreased potential runoff
    relative to
    the conventional tillage practice (crop-summer-fallow rotation)

2. Soil organic carbon content, structural stability, aggregation, and final infiltration rates were lowest in the more degraded soils of shoulder elements on each tillage field. The differences brought about by ZT (see conclusion # 1) were more pronounced in soils of the shoulder elements.