2.1 Soil Replacement onto Eroded Soils

L.E. Cowell and E. de Jong

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INTRODUCTION

The Floral Basin is in a field north of Floral, Saskatchewan (SW15-36-4), in which water flow and soil movement have been measured in the past. Soil deposited in the grassed runway was moved onto adjacent slopes to study the effect of topsoil addition on eroded agricultural soils. This report presents background information of the site and the first year of yield data.

MATERIALS AND METHODS

The Floral Basin has been described by Martz (1986). A site in the north end of the runway was chosen for this work. The slopes along the runway had about a 7% gradient and included concave and convex faces. On the south slope, which was used for this study, a concave face graded into a convex face within the plot area. Before the soil was moved, soil was sampled and described along four transects across the slope face (Fig. 2.1.1).

In preparation to move soil from the runway to the eroded slope, the grass was sprayed with glyphosate and the disked 2 weeks later. The soil was moved in October of 1989. A large road scraper hauled soil from the runway and placed it on the slope. The soil only covered the apparently eroded portion of the slope and not the crest or toe slope positions. A road grader leveled and packed the soil in the plots.

After the soil was added, soil depths were measure and subsampled. The intended depth of soil added was 0, 5, 10, and 15 cm. The actual soil depths were 0, 6.5±0.9, 11.5±1.2, and 15.6±0.8 cm. The trial was set out in a RCB design with

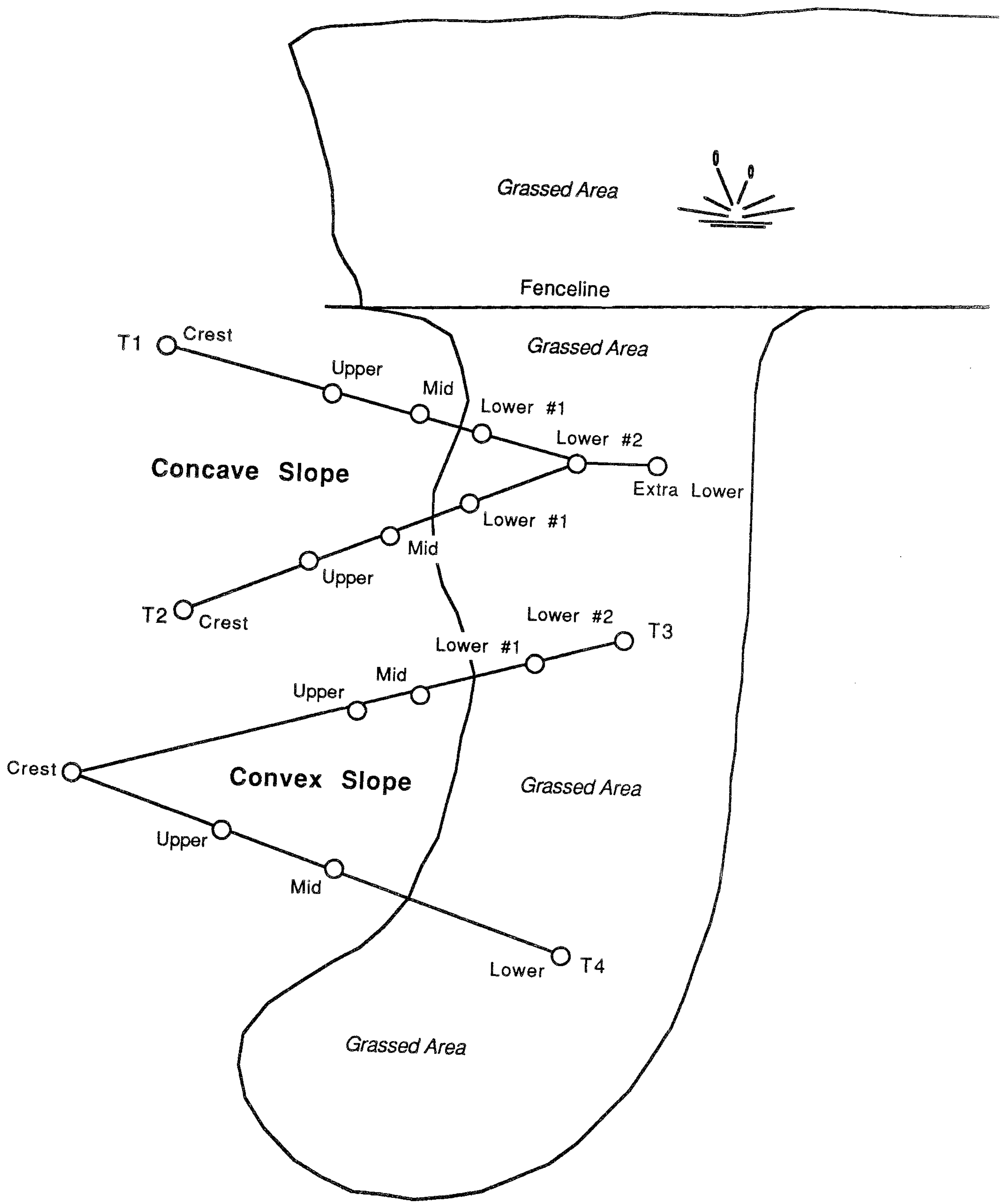

Figure 2.1.1 Study area and transects sampled before soil addition

3 blocks. The plots dimensions were 4 by 25 m. The upper and lower borders of the plots followed the curvature of the slope contours.

Each plot was cultivated in the fall of 1989 to increases water infiltration. In spring the runway was reseeded to grass. Each plot was sampled at the upper, mid, and lower slope positions. The plot was seeded with a double disc drill (22 cm row spacing) to wheat (var. Laura). Each plot was split into two subplots, one fertilized with 80 kg/ha of N as urea (46-0-0) and the other not fertilized. At harvest, 8 m^2 samples were taken from each plot. Yield data were compared in ANOVA tables.

RESULTS AND DISCUSSION

Soil Characteristics

The soil in the area is mapped as an Elstow loam. Soil profiles were described along the four transects before soil addition (Fig. 2.1.1 and Table 2.1.1). Within the plot carbonates were noted to the soil surface on the upper positions and graded to 40 cm depth at the lower positions. The soil was slightly saline near the surface and became moderately saline below 30 cm.

The soil added to the slopes had a fairly high level of nutrients (Table 2.1.2). Also, mineralization of the grass residue added with the soil could have contributed to the available nutrient pool.

In spring, before seeding, the measured soil N and P in the plots were high at all slope positions and in each block (Table 2.1.3). A yield response due to added crop nutrients would not be expected for most sampling positions.

Crop Yield Characteristics

No significant increase of total or grain yield due to soil thickness or N fertilizer was measured (Fig. 2.1.2). This reflects the high level of available nutrients in the soil

Table 2.1.1 Profile description of soils sampled along transects before soil addition

Transect	Slope position	Profile description
T1	Crest	Ap (0-10 cm), B (10-26 cm), Cca Sand lenses in B and C horizons
	Upper	Surface carbonates
	Mid	Ah (0-10 cm), Cca (10-30 cm), Ck Sand lenses at 90 cm
	Lower #1	Ah (0-18 cm), Bk (18-35 cm), Cca (35-60 cm) Salts in Ah and Bk
T1/T2	Lower #2	Ah (0-45 cm), B (45- >90 cm) Salts in B
T1/T2	Lower #3	Ah (0-20 cm), Bk (20-70 cm), Cca
T2	Crest	Ap (0-15 cm), B (15-32 cm), Cca (32-55 cm)
	Upper	Ap (0-10 cm), Cca (15-45 cm), Ck
	Mid	Ap (0-14 cm), Cca (14-40 cm), Ck Salts in Ap
	Lower #1	Ah (0-20 cm), Bk (20-40 cm), Cca (40-65 cm) Salts in Ah and Bk
T3/T4	Crest	Ap (0-12 cm), Cca (12-25 cm), Ck
	Upper	Surface carbonates
	Mid	Ap (0-20 cm), Bk (20-30 cm), Cca (30-50 cm) Salts in Ap
	Lower #1	Ah (0-21 cm), Bk (21-31 cm), Cca (31-46 cm) Salts in Ah and Bk
	Lower #2	Ah (0-45 cm), B (45-75 cm)
T4	Upper	Surface carbonates
	Mid	Surface carbonates
	Lower #1	No profile description
	Lower #2	Ah (0-21 cm), B (21-46 cm), Cca (46-71 cm)

Table 2.1.2 Nutrient characteristics of the soil added to the plots

NO_3-N (ppm)	11
Available P (ppm)	25
Available K (ppm)	323
pH	7.7
Conductivity (ms/cm)	1.1

Table 2.1.3 Available soil N and P measured before seeding on the check plots

Block	Slope position	Available nutrients: NO_3-N (kg/ha) 0-60 cm	Available nutrients: P (kg/ha) 0-15 cm
1	Upper	252	36
	Mid	210	54
	Lower	135	50
2	Upper	330	57
	Mid	87	28
	Lower	196	36
3	Upper	114	62
	Mid	58	32
	Lower	68	24

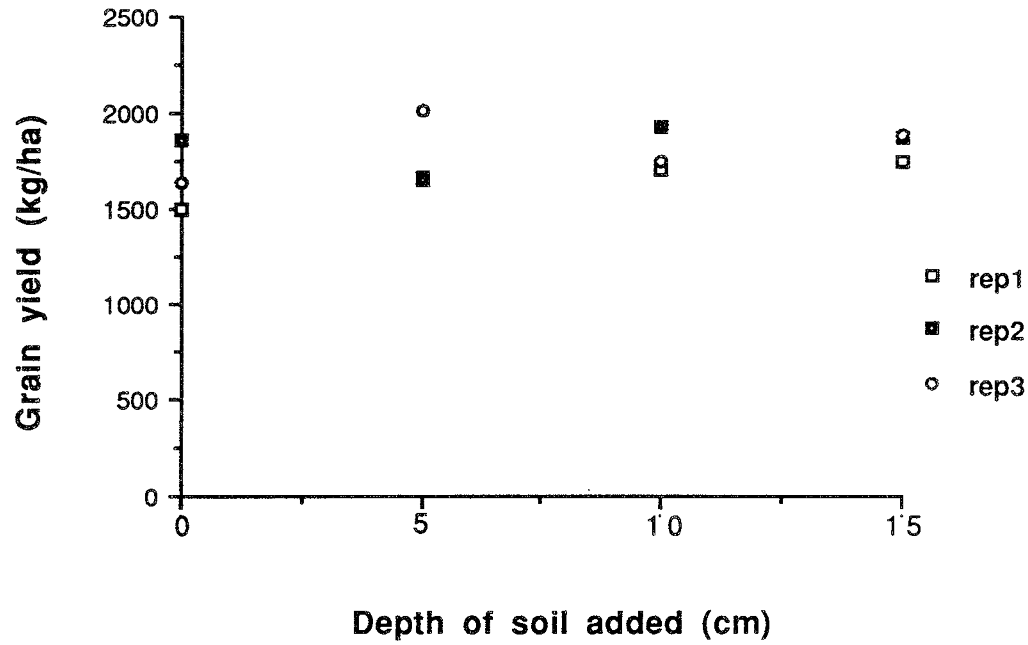

Figure 2.1.2 Average grain yield measured in each replicate for increments of added topsoil

before crop growth. There was apparently no benefit from increased soil thickness due to improved soil structure, water retention, or other properties associated with thick topsoils.

In a very similar study conducted on a Weyburn soil, grain yield was increased by 50% after a 5 cm addition of topsoil (Verity and Anderson, 1990). The authors suggested the yield increase was largely due to a response to available nutrients added with the topsoil. Topsoil thickness and therefore topsoil erosion appears to have affected crop yield primarily through nutrient supply to crops for both soils.

The overall average grain yield for the Floral basin in 1990 was 1782 kg/ha and the average harvest index was 0.38. Water use efficiency from 21.3 cm of precipitation and 6.2 cm of soil water was 65 kg/ha/cm. The low water use efficiency may be a result of the saline subsoil conditions. Salinity may have also been a factor in limiting crop response to additions of topsoil and N fertilizer.

Cost of Topsoil Addition

This goal of this work was to measure the influence of topsoil thickness on crop yield. Some idea of the practicality of topsoil replacement and the present cost of erosion was also gained. The cost of moving and grading the soil was $435; $95 per hour for the scraper over 3 hours and $50 per hour for the grader over 3 hours. The site covered only one-third of an acre. Discounting the cost of the grader, replacement of the soil onto the slope would still cost nearly $1,000 per acre. Soil replacement is an expensive method of land reclamation and erosion is an expensive form of land degradation.

CONCLUSIONS

In the initial year of this study, added topsoil or N fertilizer did not increase total or grain yield. The data from this trial supports the view in previous papers that the primary effect of soil erosion on crop growth is reduced nutrient availability. In this particular case, the high level of available soil nutrients before seeding precluded any crop response to the treatments.

Soil erosion is a costly form of degradation. The loss of crop nutrients with soil loss is the primary cost to agriculture. Replacement of the soil onto eroded areas appears economically unfeasible for the purpose of cereal production in our conditions. Replacement of the nutrients with fertilizer is a more reasonable, though short term, solution. More importantly, prevention of soil loss should be the focus of all farm management.

REFERENCES

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Verity, G. and D.W. Anderson. 1990. Soil erosion effects on soil quality and yield. Can. J. Soil Sci.70:471-484.