Effective field day demonstrations of tillage erosion and soil-landscape restoration

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Tillage Erosion

Tillage erosion greatly reduces productivity of upper slope positions in the Canadian prairies. In 2018, the Manitoba Crop Diagnostic School carried out a demonstration to show the impact of multiple tillage implements on soil movement.

A six inch-deep trench was cut across the length of a gentle slope and filled with grain corn (Figure 1). Three different implements (tandem disc, field cultivator and high-speed shallow disc) were drawn both up and down hill, passing through the trench (Figure 2). The corn kernels acted as an indicator of soil movement – the farther the corn was dragged from the original location of the trench, the more erosive the tillage (Figure 3).

Figure 1: Cutting trench and filling it with grain corn ahead of tillage treatment.

Figure 2: Operating field cultivator up and down slope.

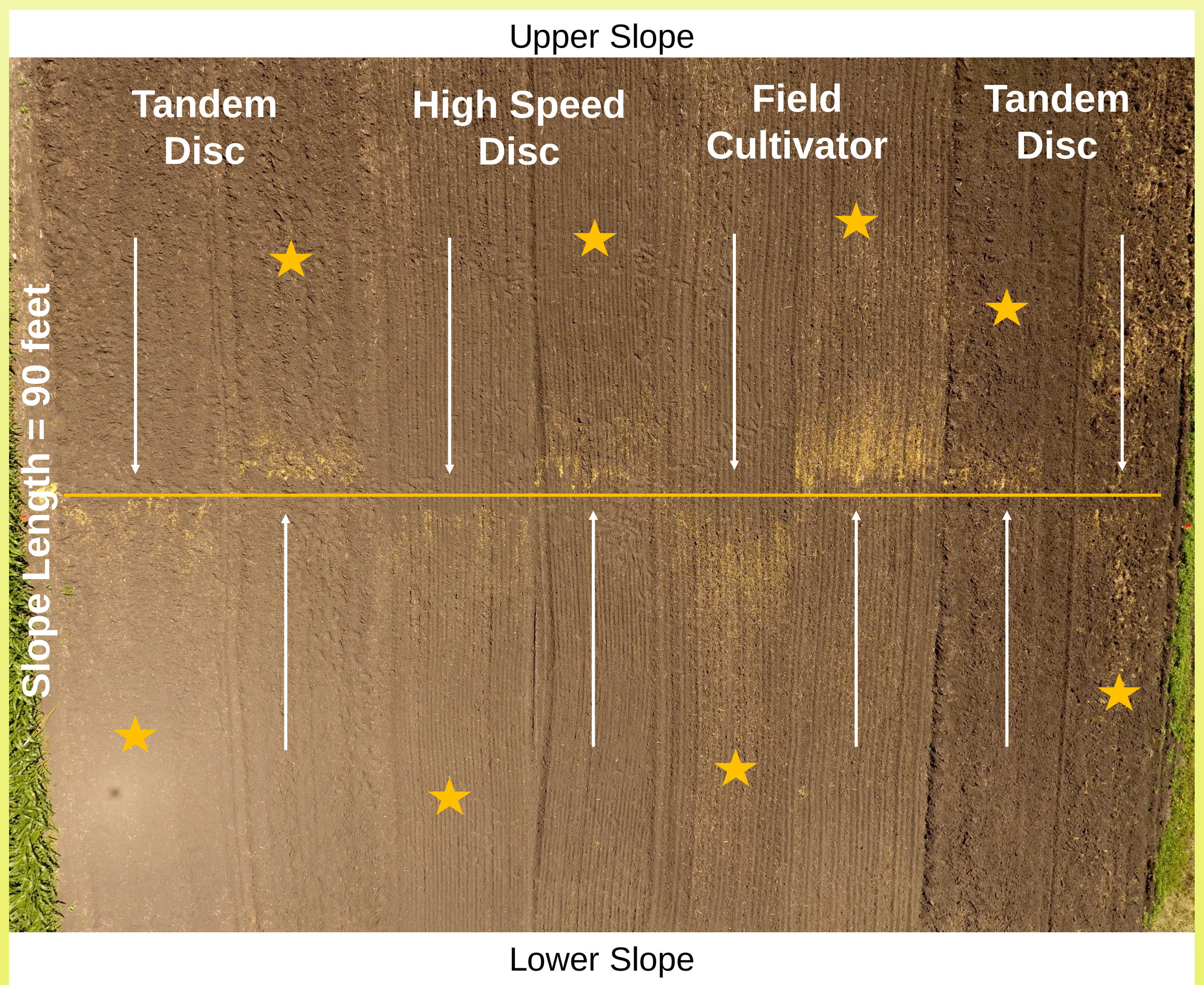

Figure 3: Aerial photograph of corn kernel distribution after tillage. Orange stars indicate farthest kernel found from the original trench line (orange centre line). White arrows indicate direction of tillage.

Restoring an Eroded Landscape

The practice of moving eroded soil from the base of a slope back to the eroded knoll where it originated is called soil-landscape restoration (Figure 4).

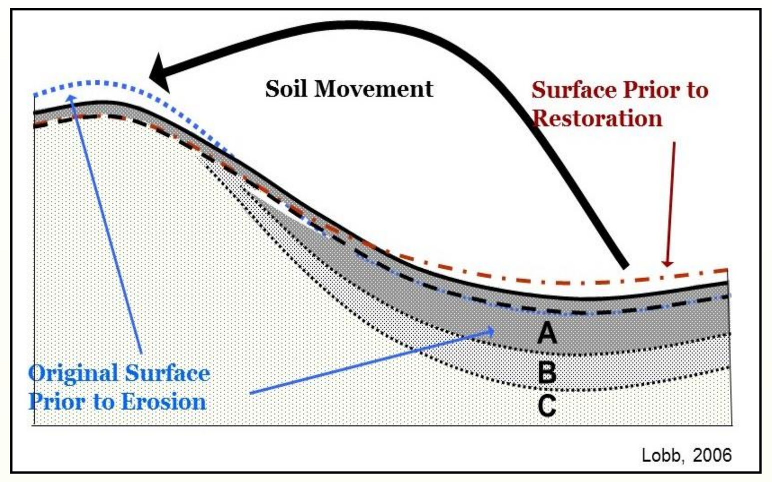

Figure 4: Diagram of soil-landscape restoration.

To demonstrate soil-landscape restoration, four inches of topsoil was removed from the slope bottom and spread on the top. To contrast this, four inches of topsoil was removed from the top slope and deposited at the bottom, to simulate years of tillage erosion. A control plot was left in the centre where no soil movement occurred (Figure 5).

The eroded, control and restoration treatments were seeded to corn on May 16. All rows were fertilized with N, with additional N, P, K, S and Zn fertilizer side-banded to two rows in each plot.

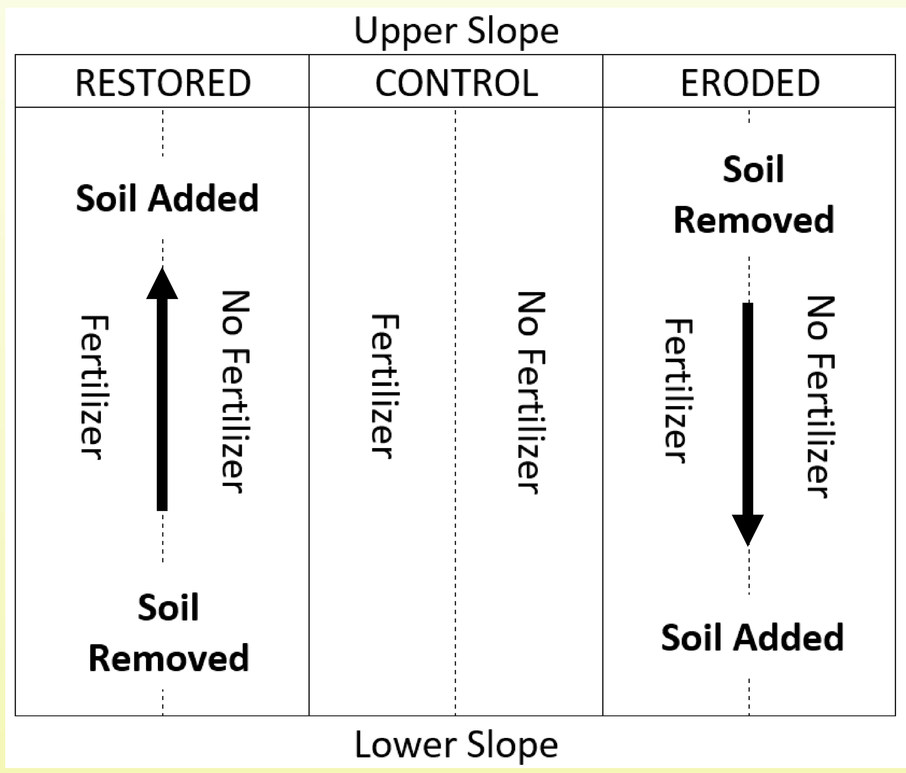

Figure 5: Layout of simulated erosion and restoration. For the "eroded" plot soil was removed from the upper slope and deposited at lower to simulate years of tillage erosion. For the "restored" plot, soil was removed from the lower slope and placed on the upper slope to simulate soil-landscape restoration.

Corn growth was depressed in the unfertilized rows of the upper slope (Figure 6), but much less difference was observed at the lower slope position (Figures 7). The use of fertilizer improved growth, most strikingly in the eroded plot, and was less apparent in the restored plot.

Figure 6: Upper slope position: eroded (i.e. soil removed), control, and restored (i.e. soil added) from left to right. Two unfertilized rows on left of each plot.

Figure 7: Lower slope position: eroded (i.e. soil gained from top slope), control, and restored (i.e. soil removed to add to top slope) from left to right. Two unfertilized rows on right of each plot.

Participants Findings

Participants were generally shocked at how far corn moved with each tillage implement.

- Average movement was 13-16 feet from the original trench, following two passes.
- After the corn emerged, some was found growing up to 40 feet from the trench in almost every treatment.
- There was only a slight difference in movement between uphill and downhill tillage direction – this was attributed to the tractor being well-powered for all implements.
- There was also little difference between tillage implements, probably due to operating speed. The high speed disc was only operating at 7mph due to the short slope length, less than the 10-12mph normal field operating speed.

Figure 8: A group observing corn distribution, noting the furthest movement of corn kernels/plants from the original trench along slope centre. Note: the soil-landscape restoration demonstration can be seen in the background.

There was much discussion about the practical aspects of the soil-landscape restoration practice.

- Erosion of the soil reduced %OM, P, K, Zn and increased pH in the soil test (data not shown). Restoring the soil improved these measures.
- Soil-landscape restoration of the upper slope improved corn growth more than the fertilizer alone, and did not appear to penalize lower slope areas where the soil was removed.

Additionally, research has shown:

- Applying fertilizer improves crop growth on eroded soils, producing near non-eroded yields on finer textured soils with good water holding capacity (i.e. clay loams) but does not provide full recovery on coarser textured soils.[1]
- With soil-landscape restoration, yields on eroded soils can be increased immediately.[2]
- The economic payback occurs within 3-4 years, faster yet if the farmer uses his or her own scraping equipment.
- Yields at the bottom of the slope are unaffected as long as no more than eight inches of soil is removed.

This demonstration has since been repeated at two other field days in Western Canada.

References:

[1]Kapoor and Shaykewich. 1990. Simulated soil erosion and crop productivity. In Proc. Manitoba Society of Soil Science. Pp.125-130.
[2]Li, Lobb and Tiessen. 2006. Soil erosion and conservation. Encyclopedia of Environmetrics