

The Effect of Landscape Restoration on Soil Properties Influencing Crop Productivity

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An Alternative Practice

In cultivated hilly landscapes, tillage erosion is the dominant soil erosion process and is responsible for local soil displacement and redistribution within the landscape. Organic-rich topsoil is lost from upper slope positions and accumulates in lower slope positions and depressions. Over time the hilltops become severely eroded resulting in a reduction of soil organic matter, shallow soil profiles, poor water holding capacity and nutrient availability, increased stoniness and carbonates at the soil surface, and ultimately poor crop growth (Figure 1).

Landscape restoration is an alternative land-management practice that has shown to significantly increase crop yields on severely eroded hilltops by at least 24% without comprising yield in areas where soil is removed. This practice involves restoring eroded hilltops by removing topsoil from areas of accumulation and replacing it on eroded hilltops where it originated.



Figure 1. Localized areas of reduced crop productivity in a cultivated hilly landscape in southwestern Manitoba as a result of tillage erosion. (PFRA photo)

Objective

The purpose of this study is to determine the soil physical and chemical properties that are improved by landscape restoration and contribute to increased crop yields on restored hilltops.

A large field-scale study was established in southwestern Manitoba to monitor soil fertility, soil organic matter, and soil moisture.



Materials and Methods

- Topsoil was removed from cropland depressions using a hydraulic landscaper and applied on eroded hilltops at a depth of 10 cm (4 in).
- A paired comparison design was used comprising a treatment plot, 10cm (4 in) added topsoil, and a control plot, no added topsoil.
- Soil samples were taken at a depth of 0 to 15 cm (0 to 6 in) from each plot and analyzed for soil fertility and organic matter.
- Volumetric moisture content at the soil surface was measured using a Hydra Probe capacitance probe.

Results

Table 1. Nitrate (NO³-N), phosphorus (Olsen-P), potassium (K), and sulphur (S) analysis at 0 to 15 cm (0 to 6 in) on control and addition plots.

Treatment	NO ³ -N lb ac ⁻¹	Olsen-P ppm	K ppm	S lb ac ⁻¹
Control	19.75	17.25	136.00	15.00
Addition	40.50	32.00	214.75	23.00
P>t	0.002	0.049	0.147	0.017

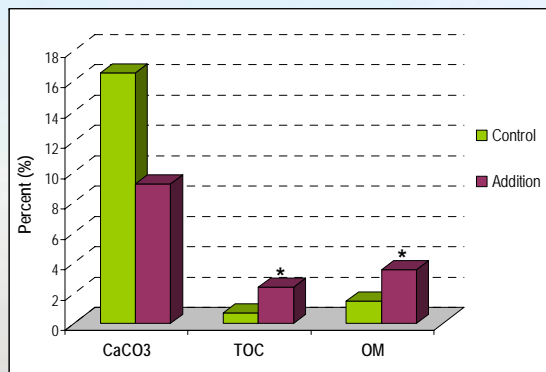


Figure 1. Comparison of calcium carbonate (CaCO₃), total carbon (TC), and organic matter (OM) on control and addition plots. * indicates significance at alpha level 0.05.

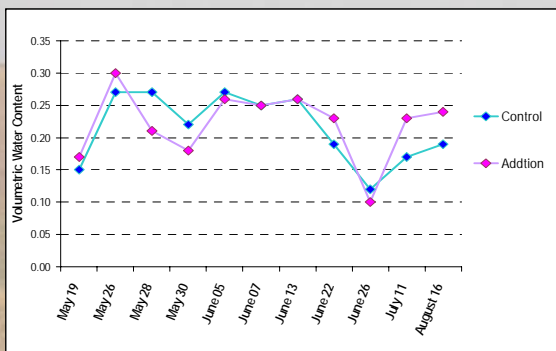


Figure 2. Surface volumetric moisture content in control and addition plots using a capacitance probe.



Discussion

- Nitrate, phosphorus, and sulphur, 40.5 lb ac⁻¹, 32 ppm, 23 lb ac⁻¹, respectively, were all significantly higher in plots where 10 cm (4 in) of topsoil was added compared to control plots (Table 1).
- Although there was no significant difference in calcium carbonate content between treatments, organic matter and total organic carbon were significantly higher in the addition plots (Figure 1).
- Although it is well known that a decrease in soil moisture is a direct cause of reduced crop growth, the volumetric water content at the soil surface did not show any consistent trends or significance between control and addition plots (Figure 2).



Conclusion

Crop productivity on eroded hilltops is reduced because these areas have low levels of organic matter, decreased levels of soil moisture, and poor nutrient availability. However, landscape restoration has shown to significantly increase crop productivity by replacing organic-rich topsoil on eroded hilltops.

This study examined how landscape restoration improves the chemical and physical environment essential for increased crop productivity and found that by adding 10 cm (4 in) of topsoil on eroded hilltops, the nutrient status of the soil and organic matter levels are significantly increased contributing to increased crop productivity.

Therefore, as an alternative land-management practice, landscape restoration provides producers with a logical, practical, and effective way to improve soil properties responsible for restoring crop productivity on eroded hilltops.



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