Using Landscape Restoration to Increase Crop Yield on Severely Eroded Hilltops in Southwestern Manitoba

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A Growing Concern

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 (Figure 2a). 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).

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

An Alternative Practice

Landscape restoration is an alternative practice to restore eroded hilltops by moving the accumulated topsoil and replacing it on the eroded hill tops where it originated (Figure 2b).

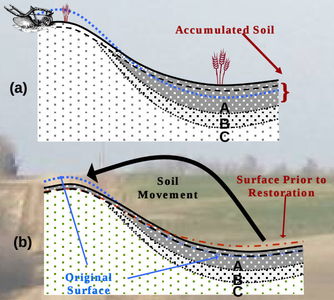

Figure 2. The soil redistribution process. **(a)** Topsoil is lost from convex upper slope positions and accumulates in concave lower slope positions and depressions. **(b)** Landscape restoration: replacing accumulated topsoil on eroded hilltops to restore crop productivity.

A large field scale study was conducted in south western Manitoba to examine the impact of landscape restoration on grain yields. Four study sites were selected to compare yield differences on severely eroded hilltops and hilltops which had been restored with 10 cm (4 in) of added topsoil.

Materials and Methods

- Topsoil was removed from depressions using front-end loaders and hydraulic landscapers and applied at a depth of 10 cm (4in).
- A paired comparison design was used comprising a treatment plot 10cm (4in) added topsoil and a control plot (no added topsoil).
- Yield was randomly sampled from each plot four times .

Study Sites

Site	Location	Crop Type	Soil Group
MZTRA 1	Brookdale, Manitoba	Flax	Black Chernozem
MZTRA 2	Brookdale, Manitoba	Flax	Black Chernozem
MZTRA 3	Brookdale, Manitoba	Peas	Black Chernozem
BRX	Bruxelles, Manitoba	Wheat	Dark Gray Chernozem
SWL	Swan Lake, Manitoba	Flax	Dark Gray Chernozem
TRE	Treherne, Manitoba	Peas	Dark Gray Chernozem

Results

Table 1. Average grain yield (kg ha^{-1}), yield increase (%), and significance (p>0.05) of control (no added topsoil) and addition treatment (10 cm added topsoil) from Brookdale (MZTRA), Bruxelles (BRX), Swan Lake (SWL), and Treherne (TRE), Manitoba.

Site	Crop	Treatment Pairs	Control Yield (kg ha^{-1})	Addition Yield (kg ha^{-1})	Yield Difference (kg ha^{-1})	Yield Difference (%)	Prob >t
MZTRA 1	Flax	9	1907	2679	772	40	0.006
MZTRA 2	Flax	6	1731	2402	672	39	0.040
MZTRA 3	Peas	6	2499	3111	612	24	0.036
BRX	Wheat	5	840	1917	1077	128	0.011
SWL	Flax	3	404	784	380	94	0.011
TRE	Peas	4	1249	2049	800	64	0.001

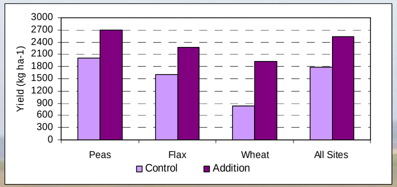

Figure 3. The effect of 10 cm (4in) added topsoil to eroded hilltops on crop yield.

Table 2. Average grain yield (kg ha^{-1}), yield increase (%), and significance (p>0.05) of depressions and removal plots from Bruxelles (BRX), Swan Lake (SWL), and Treherne (TRE), Manitoba.

Site	Crop	Treatment Pairs	Depression Yield (kg ha^{-1})	Removal Yield (kg ha^{-1})	Yield Difference (kg ha^{-1})	Yield Difference (%)	Prob >t
BRX	Wheat	3	2609	2654	-45	-2	0.39
SWL	Flax	3	1767	1407	360	20	0.07
TRE	Peas	3	3330	2740	590	18	0.31
All Sites	All Crops	9	2568	2267	301	12	0.18

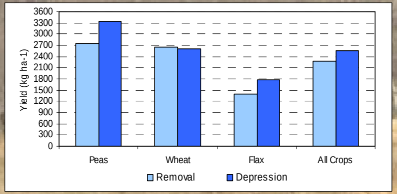

Figure 4. The effect of removing topsoil from areas of accumulation within a landscape on grain yield.

Discussion

Significantly higher grain yields were observed in addition plots (10 cm added topsoil) at all four sites (MZTRA, BRX, SWL, TRE). As well, average yield differences and percent yield increase were also found to be higher in addition plots than those of control plots (Table 1).

When data was pooled based on crop type, significantly larger grain yields in the addition plots were still evident (Figure 3).

There were no significant differences found when the depressions and removal areas were compared despite the wheat crop having greater yields in the removal area than the depression (BRX) (Table 2 and Figure 4).

Conclusion

The consistent yield increases observed on the restored hilltops and the lack of a yield decrease in the removal areas indicate that replacing 10 cm (4in) of topsoil to severely eroded hilltops can increase grain yield by as much as 128% and restore crop productivity in eroded landscapes

Generally, crops are stressed on eroded hilltops because these areas have reduced levels of organic matter and subsequently less available water and poor nutrient availability. However, replacing organic-rich topsoil on eroded hilltops may improve these soil properties and as a result directly contribute to increased grain yield.

Therefore, as an alternative management strategy, landscape restoration provides producers with a logical, practical, and effective way to restore crop productivity on eroded hilltops without compromising yield in areas where topsoil is removed.

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