Soil Erosion: Don't just stop it, fix it!

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Manitoba

Benefits of Tillage

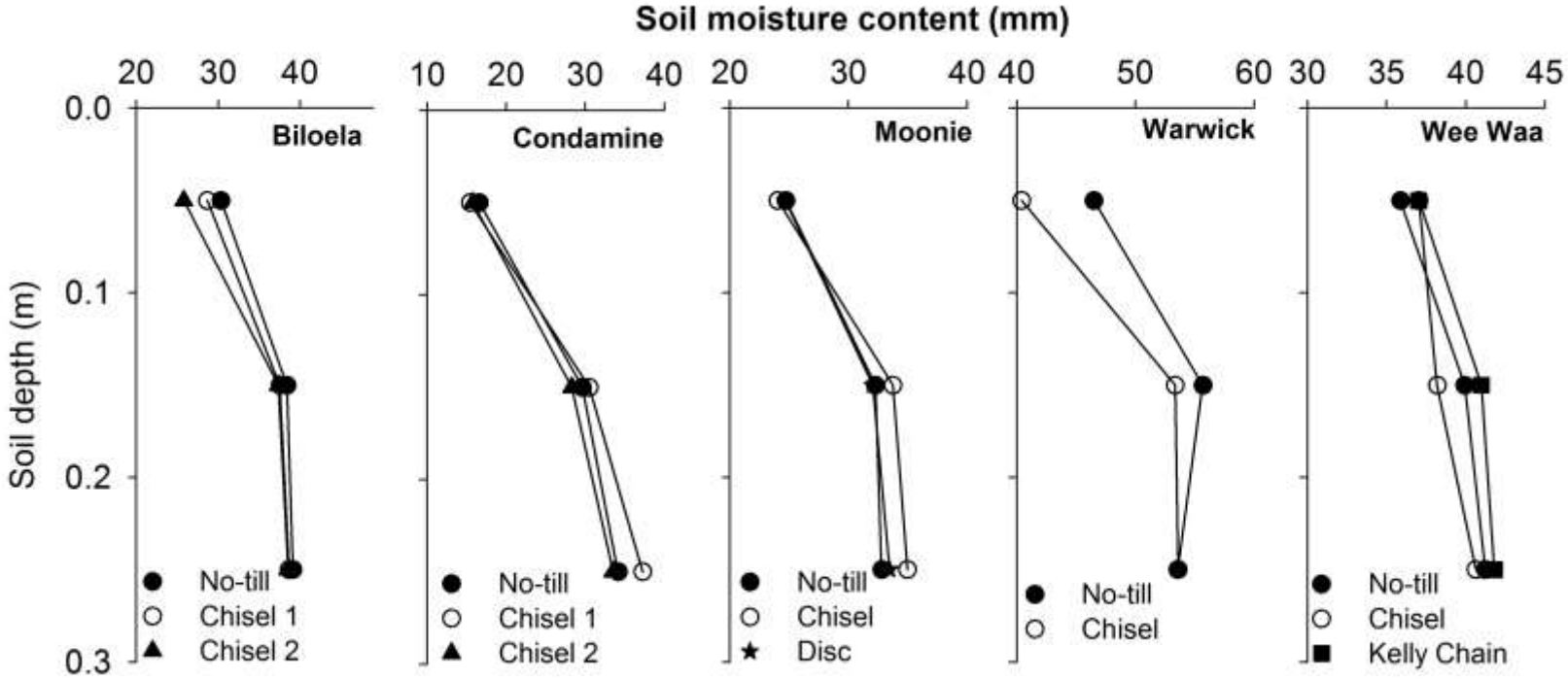
- Prepares the seedbed, improved seed placement and seed-soil contact
- Incorporates nutrients
- Controls weeds
- Required for crop management (i.e. hilling, harvesting of potatoes)

Benefits of Tillage

- Can accelerate the breakdown of excessive crop residue

Benefits of Tillage

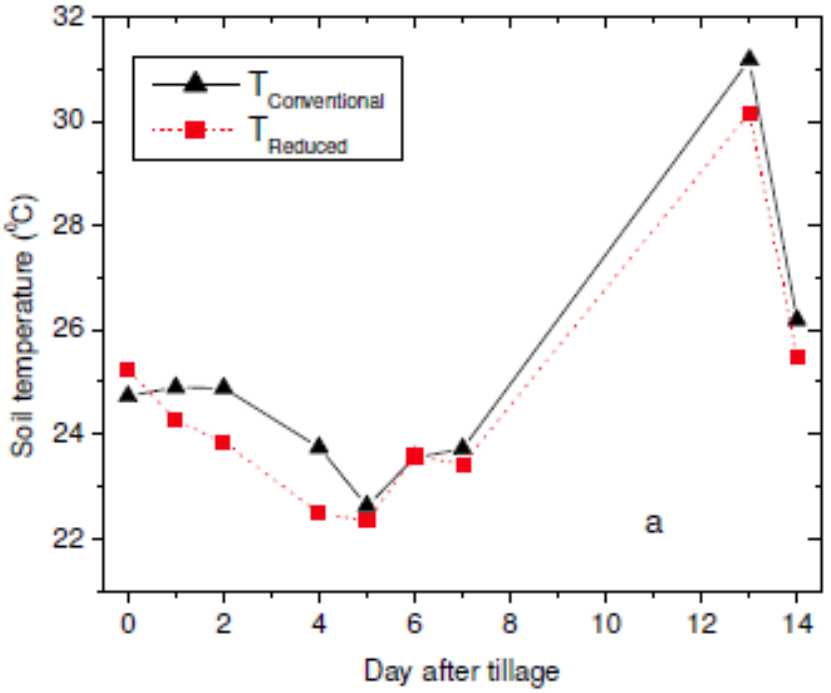
- Accelerates the warming and drying of soil (residue)….maybe

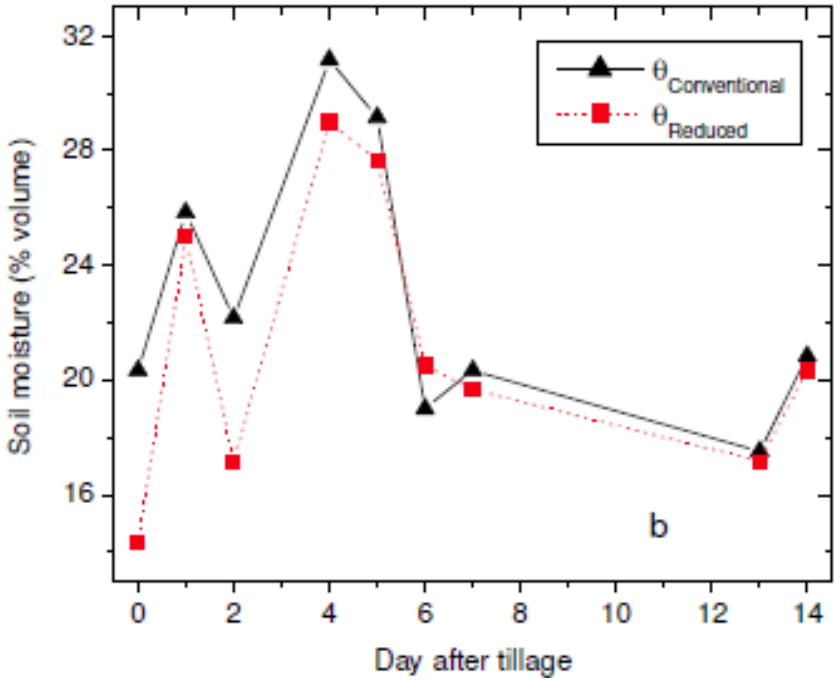


Yang et al. 2013, Australia

Benefits of Tillage

- Accelerates the warming and drying of soil (no residue)….maybe not





Teixeira et al. 2010, Brazil

The Downside of Tillage

- Every tillage pass can cause ¼” of soil moisture to be lost
  - Varies with soil texture, SOM, and residue cover
- Minimizing tillage can conserve valuable moisture
  - Need to weigh this value with weed control, seedbed prep, etc
  - If secondary tillage is needed for seedbed prep, try to time tillage as close to seeding as possible

The Downside of Tillage

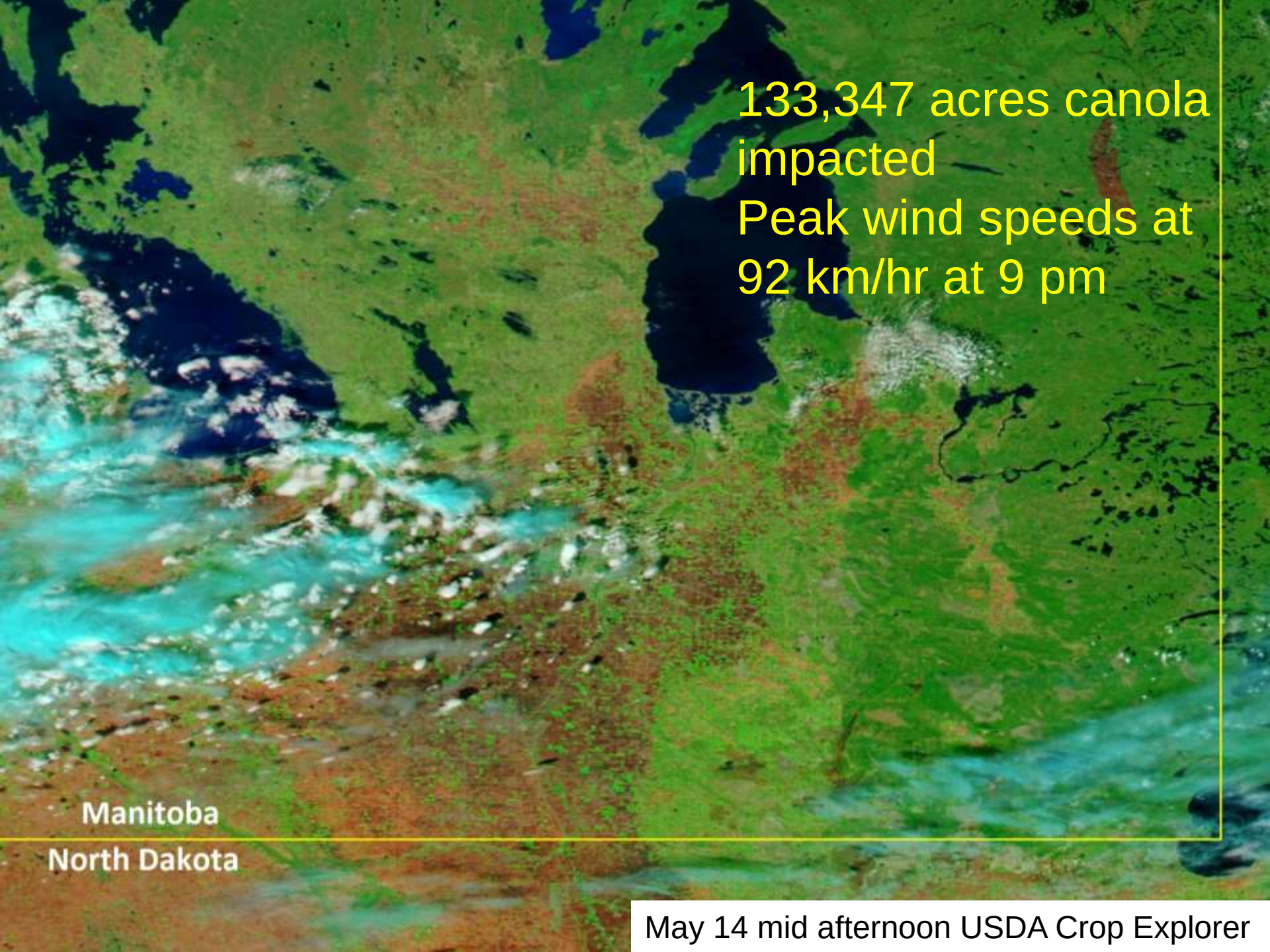
- Accelerated Soil Erosion
- Accelerated Wind and Water Erosion

Photo:
Nicole Clouson


May 24, 2017
Photo: Rejean Picard

May 14, 2012

Photos: John Heard



May 14 mid afternoon USDA Crop Explorer

Ditch deposition

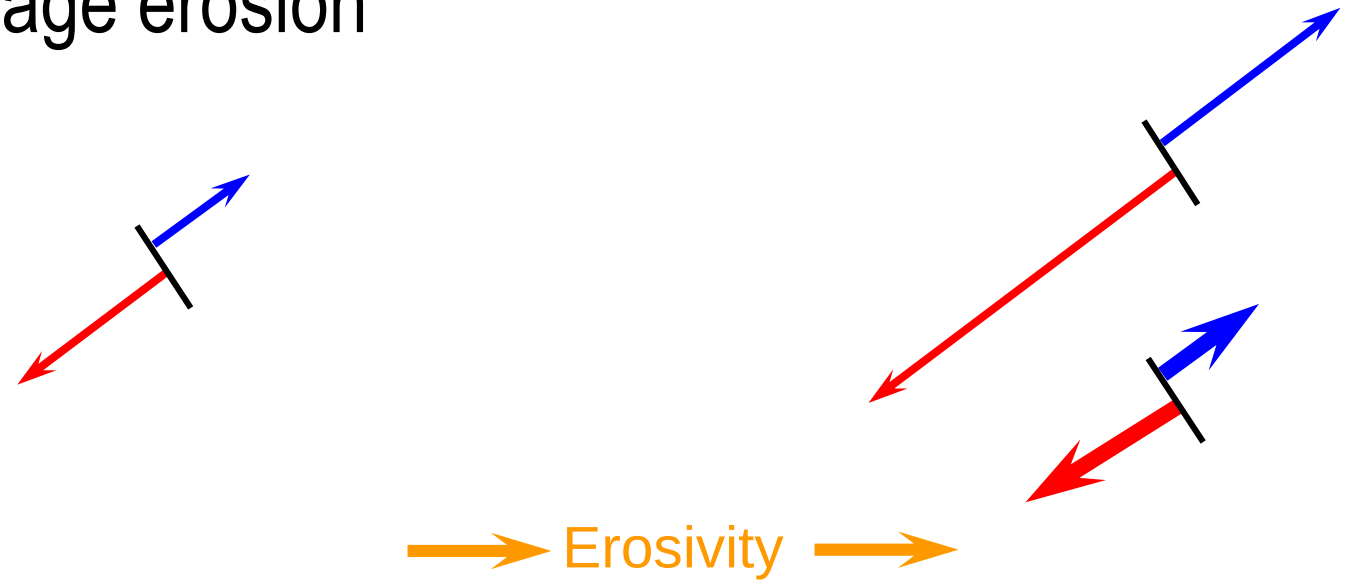
Soil test Nitrate-N

Lb/ac in 0-6”

- *Field = 122 /b N/ac*
- *Ditch soil = 1325 lb N/ac*

Tillage Erosion

- Cropping and tillage systems that employ intensive tillage (frequent, deep, fast) can cause severe tillage erosion



Tillage translocation and tillage erosivity of seeding operations

Seeding Tool	Tillage System	Tillage Translocation: Soil movement on level land			Tillage Erosivity: Tillage translocation variability on sloping land
		T_L (m) [a]	λ_{90} (m) [a]	T_M (kg m^{-1}) [a]	β (kg m^{-1} $\%^{-1}$) [a]
Air-seeder with Knives [b]	Conventional Tillage	0.10	0.69	4.4	0.1
		0.41	1.05	35	1.0
Cultivator plus Air-seeder with Knives [b]	"				
Air-seeder with Knives [c]	Zero-Till	0.16	0.88	8.2	0.1
Air-seeder with Sweeps [c]	"	0.51	1.33	30	1.0

[a] T_L = average distance of soil movement in till-layer; λ_{90} = distance to which 90% of translocated soil is moved; T_M = mass of soil moved per m width of tillage; β = mass of soil moved per m width of tillage per % of slope grade (+ve downslope).

[b] Experiments carried out in Manitoba, Canada, 2004.

[c] Experiments carried out in Saskatchewan, Canada, 2006.

Tillage Erosion

A horizon eroding from hilltop

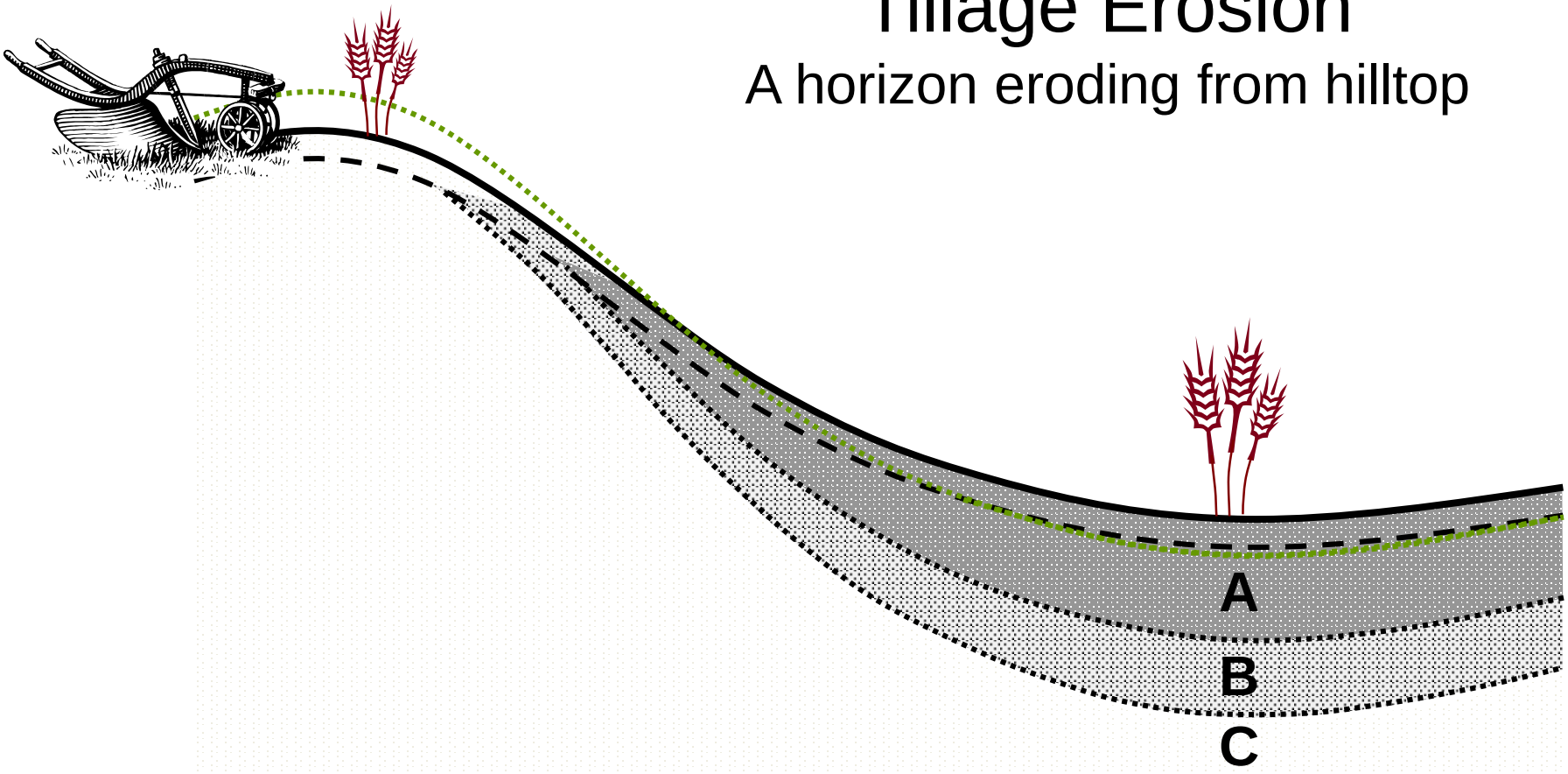
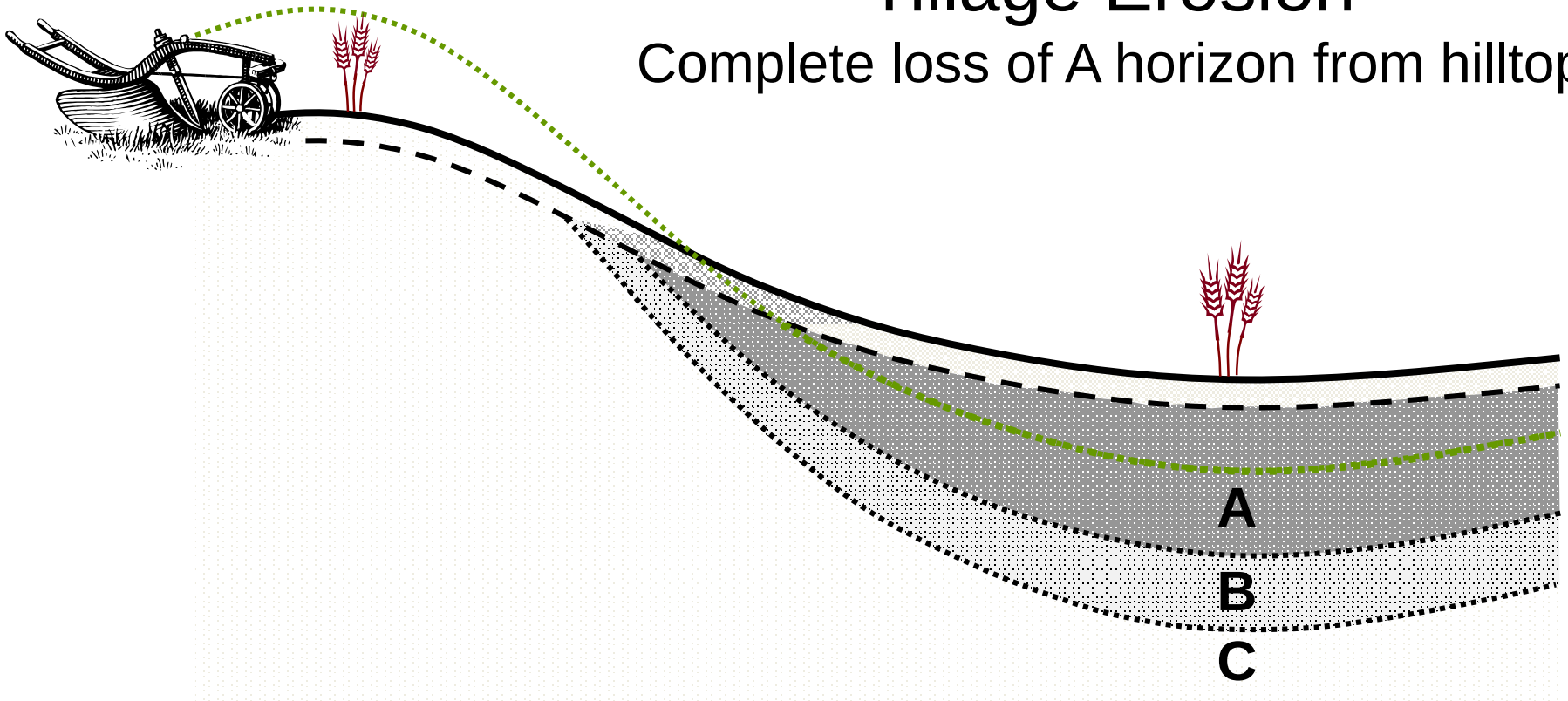


Image: David Lobb, University of Manitoba

Tillage Erosion

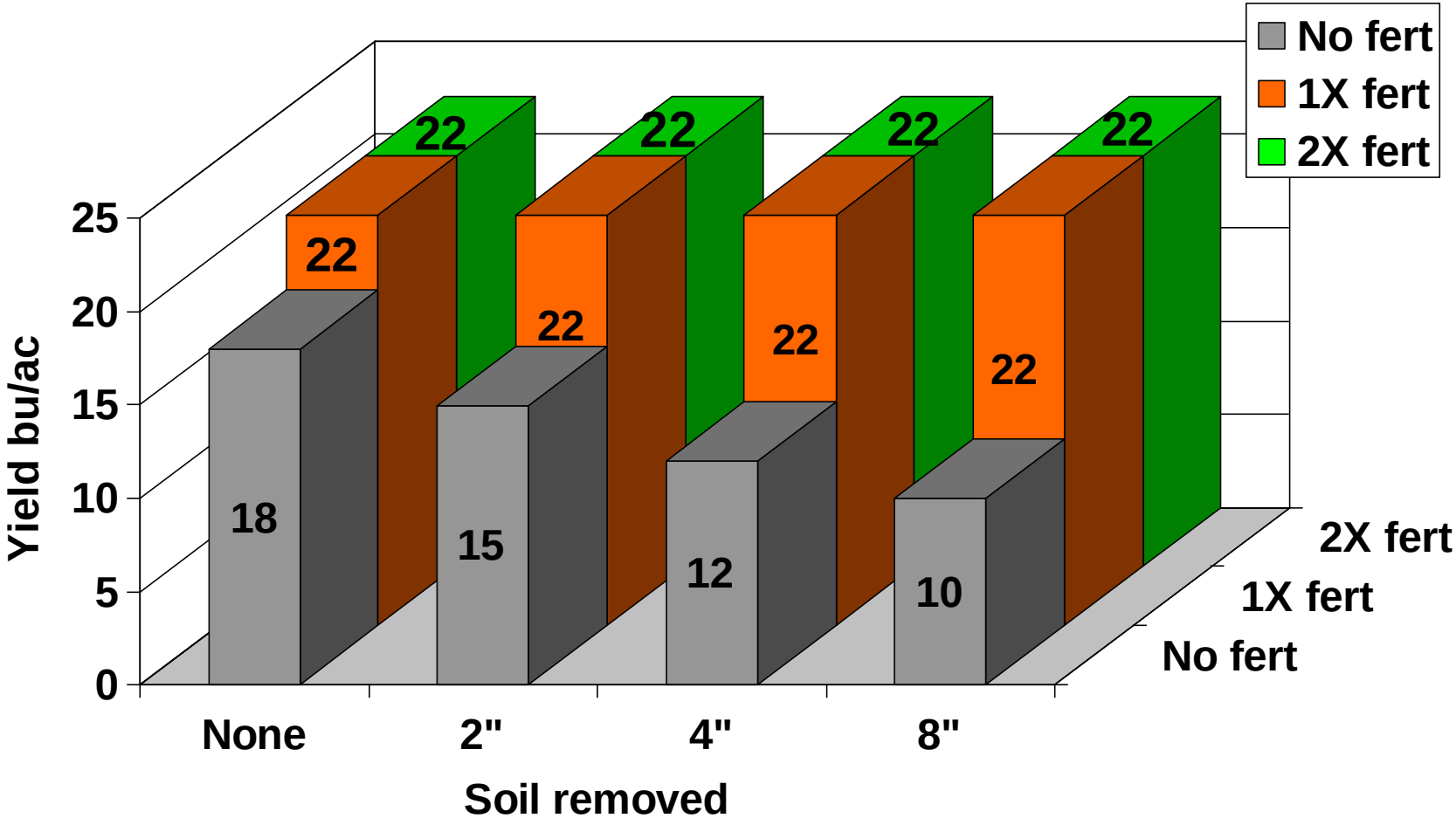
Complete loss of A horizon from hilltop



There is a need for effective and preventative and corrective action!

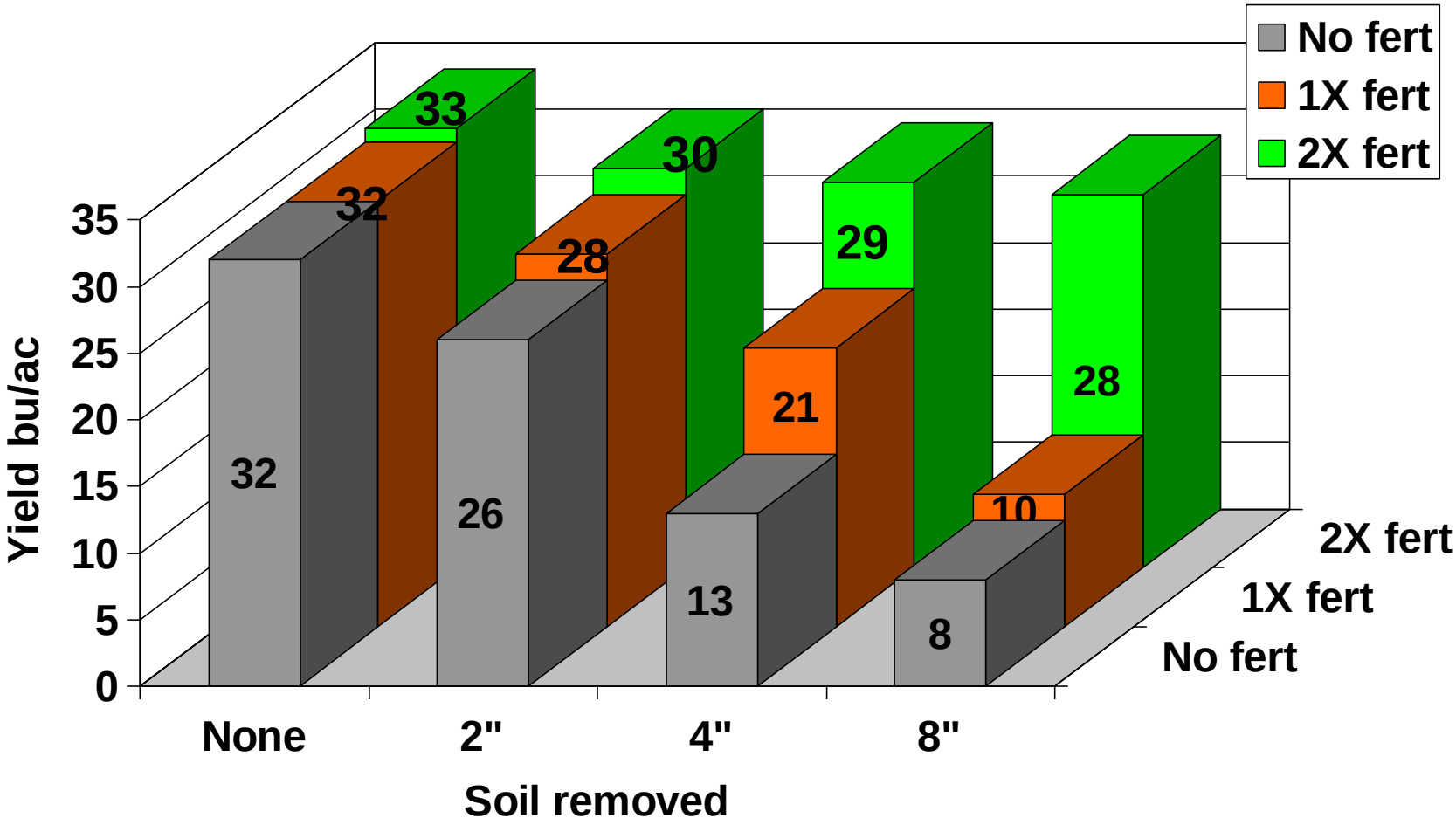
Image: David Lobb, University of Manitoba

Wheat yield – Pembina clay loam



Kapoor and Shaykewich, 1990

Wheat yield – Reinland loamy fine sand



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Kapoor and Shaykewich, 1990

Minimizing Erosion

- Practices that help maintain soil structure and protect from wind/water
  - Zero Tillage
  - Cover Crops
  - Perennial Forages

Minimizing Erosion

- Building Soil Organic Matter to improve structure

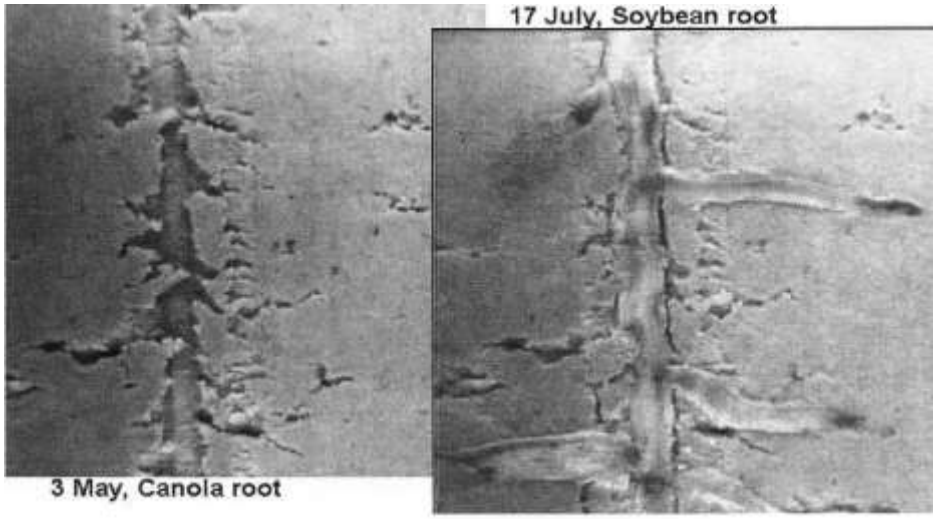
Higher SOM soils retain structure when wet

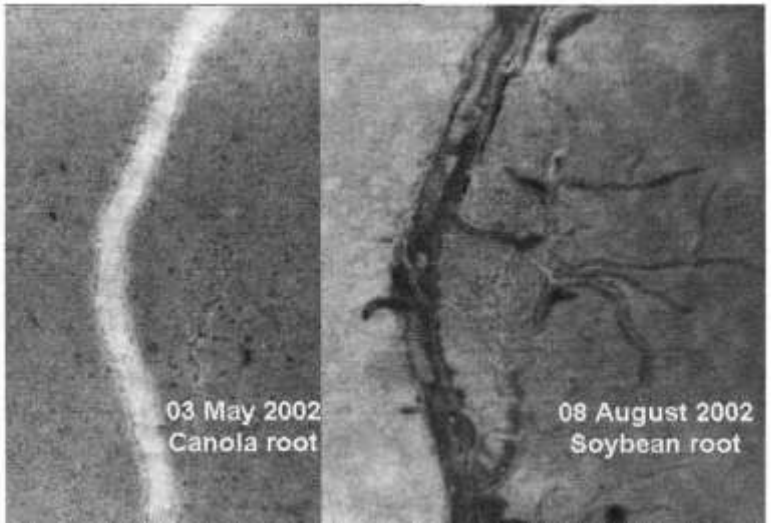
Lower SOM soils will not

Photos: J. deJong-Hughes

Reduce Tillage

- Does not disturb root channels (“biopores”)
  - Roots will follow channels made by previous crops
  - Note: tillage breaks up the path of these channels
- Biopores can help soil absorb more water during wet periods





Williams and Weil (2004) SSSA Journal

How do I reduce tillage?

- Tillage passes are not the only “tillage” operations
  - Fall fertilizer passes, seeding, etc all disturb soil
- True no-till may not be suitable for all operations
  - Vertical tillage, strip tillage may be used to manage residue or decrease field-wide tillage

Know your Soil

- Soils with poor internal drainage may need light tillage just before planting
  - Dries the surface enough to plant, but doesn't dry too much
- Soils with good internal drainage may be best managed with zero tillage

Know your Soil

- Cultivating a well-drained soil when wet can cause problems – possibly making it a poorly drained soil
  - Compaction can collapse large pores which allow for internal drainage
  - A soil that is dry enough to till crumbles through your fingers when squeezed
    - Less prone to compaction when soil is dry…or excessively wet


About 80% of compaction happens on the FIRST PASS
Wheel Traffic Compaction

Know your Soil

- Cultivating a well-drained soil when wet can cause problems – possibly making it a poorly drained soil
  - Clods can dry out on surface, making for a poor seedbed
  - Spring of 2020 saw a lot of tillage to dry out wet soils…resulting in sidewall compaction, surface crusting, poor emergence

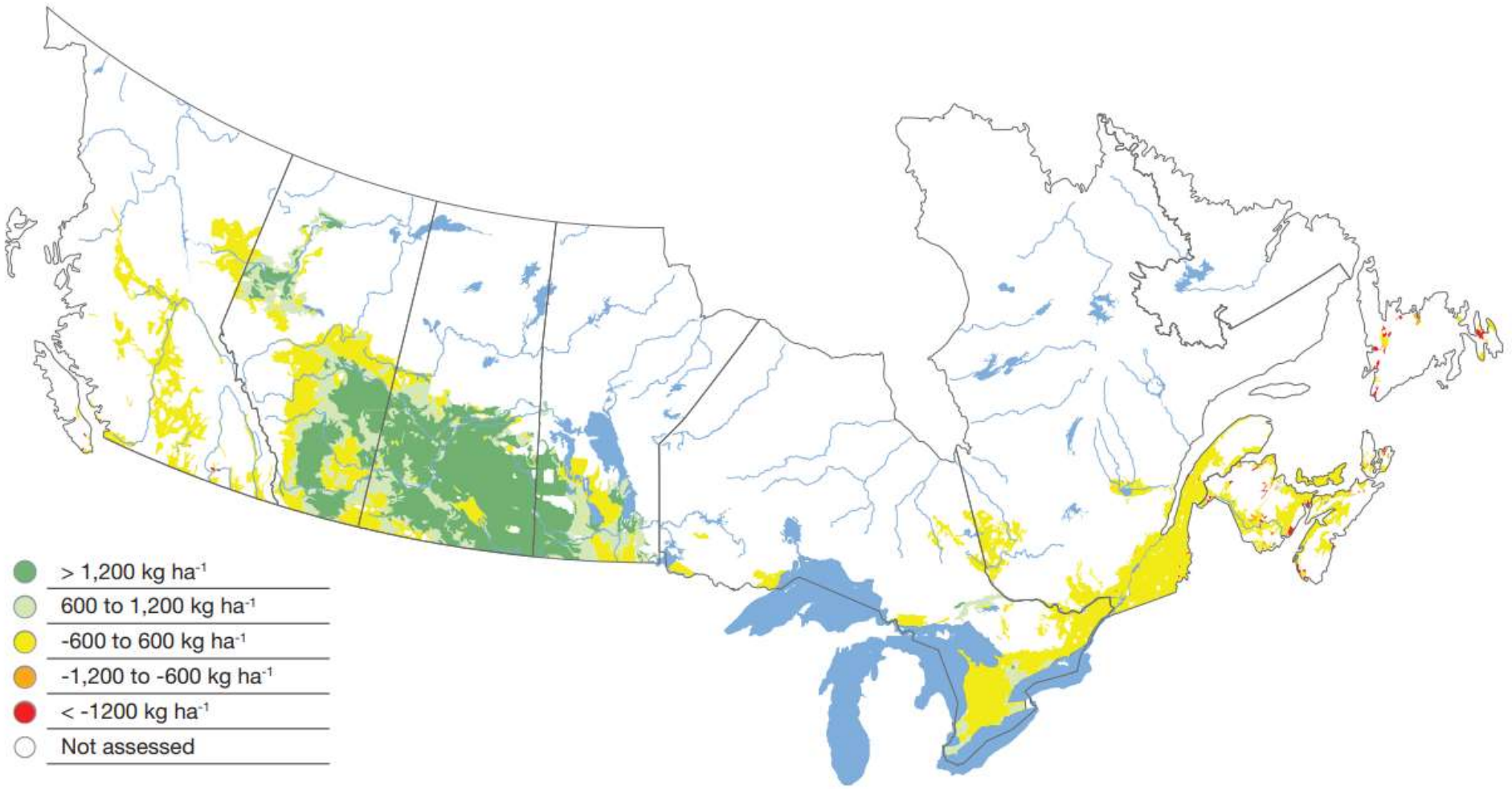
How do we deal with this?

Tillage to Manage Ruts

- Can help smooth out ruts from working in wet soil
- Tillage should be targeted, shallow, and preferably done when frozen

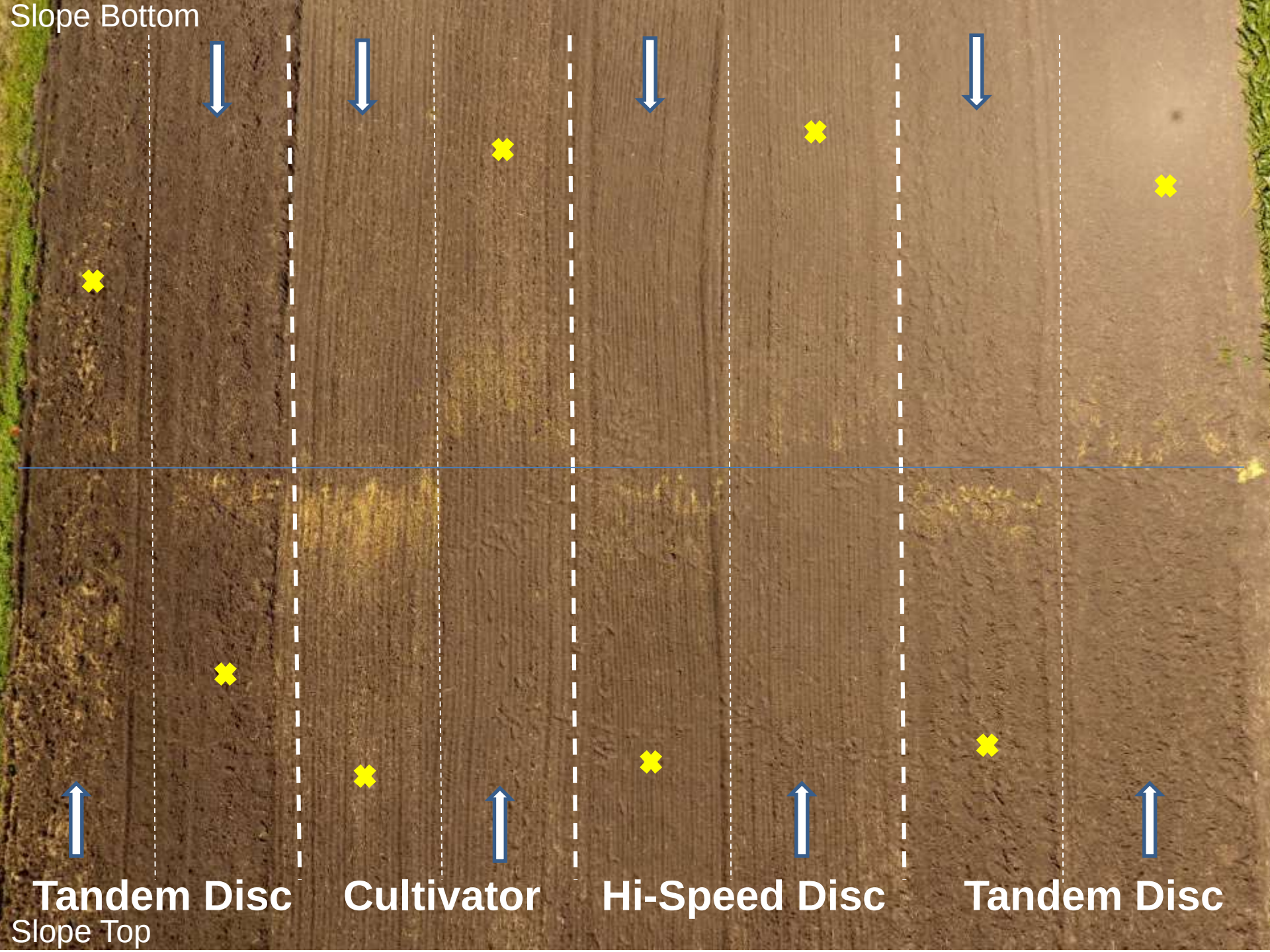
Manitoba

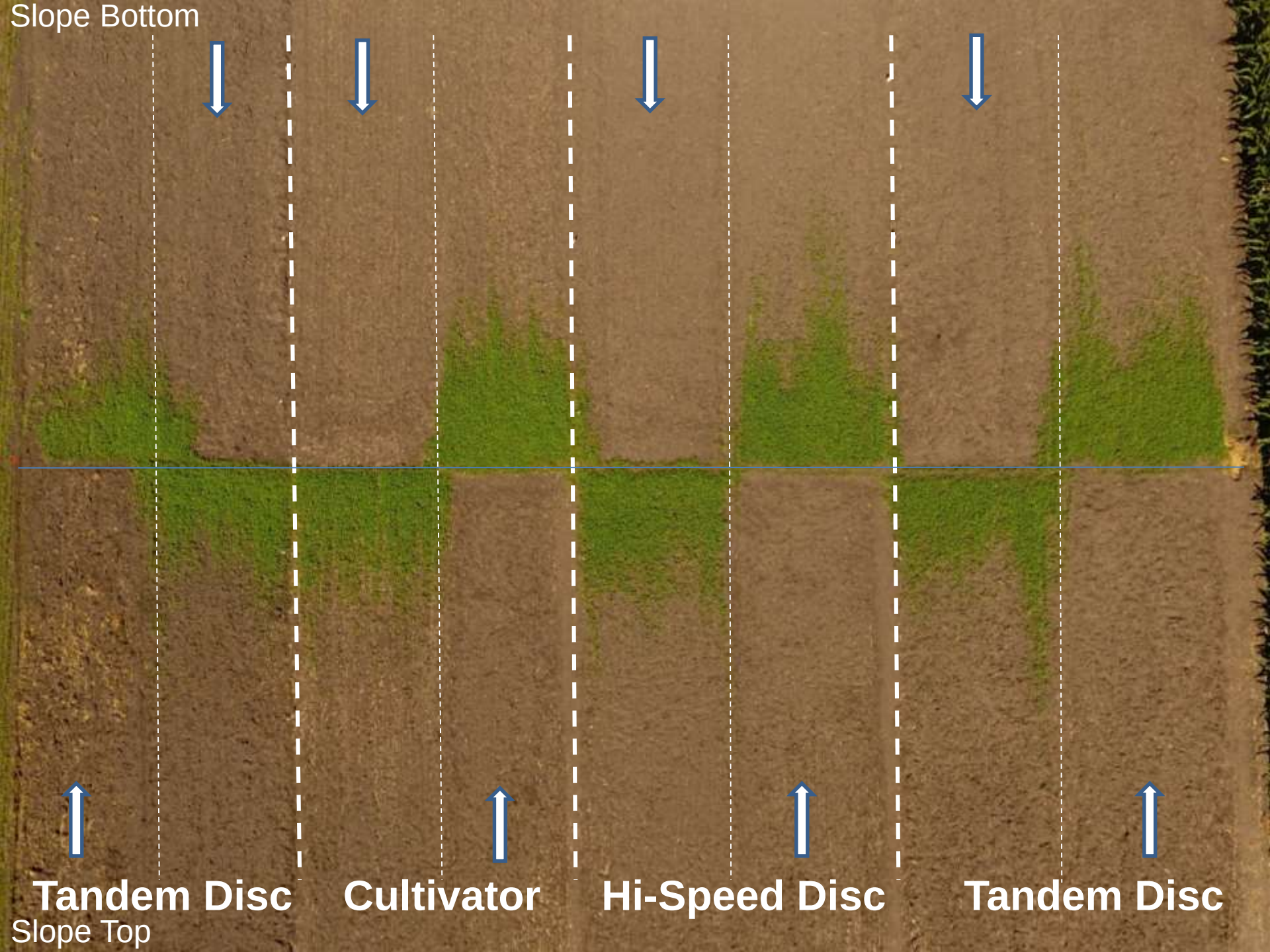
SOC change due to tillage changes (1981-2011)



Source: Environmental Sustainability of Canadian Agriculture: Agri-Environmental Indicator Report Series – Report #4

Tillage Erosion Demo
Crop Diagnostic School 2016


Slope Bottom
Tandem Disc
Cultivator
Hi-Speed Disc
Tandem Disc
Slope Top


Slope Bottom
Tandem Disc
Cultivator
Hi-Speed Disc
Tandem Disc
Slope Top

Upper Slope – Eroded
Unfertilized

Upper Slope – Eroded
Fertilized

Business as Usual Tillage

Top of Hill; without starter P (left 2 rows), with starter P (right 2 rows)

Soil Eroded by Tillage

Top of Hill; without starter P (left 2 rows), with starter P (right 2 rows)

Can we repair eroded areas?

- Yes! Put the soil back where it came from!
- Soil-Landscape Restoration

Photos: Curtis Cavers

Soil-Landscape Restoration

Move eroded topsoil back to where it originated

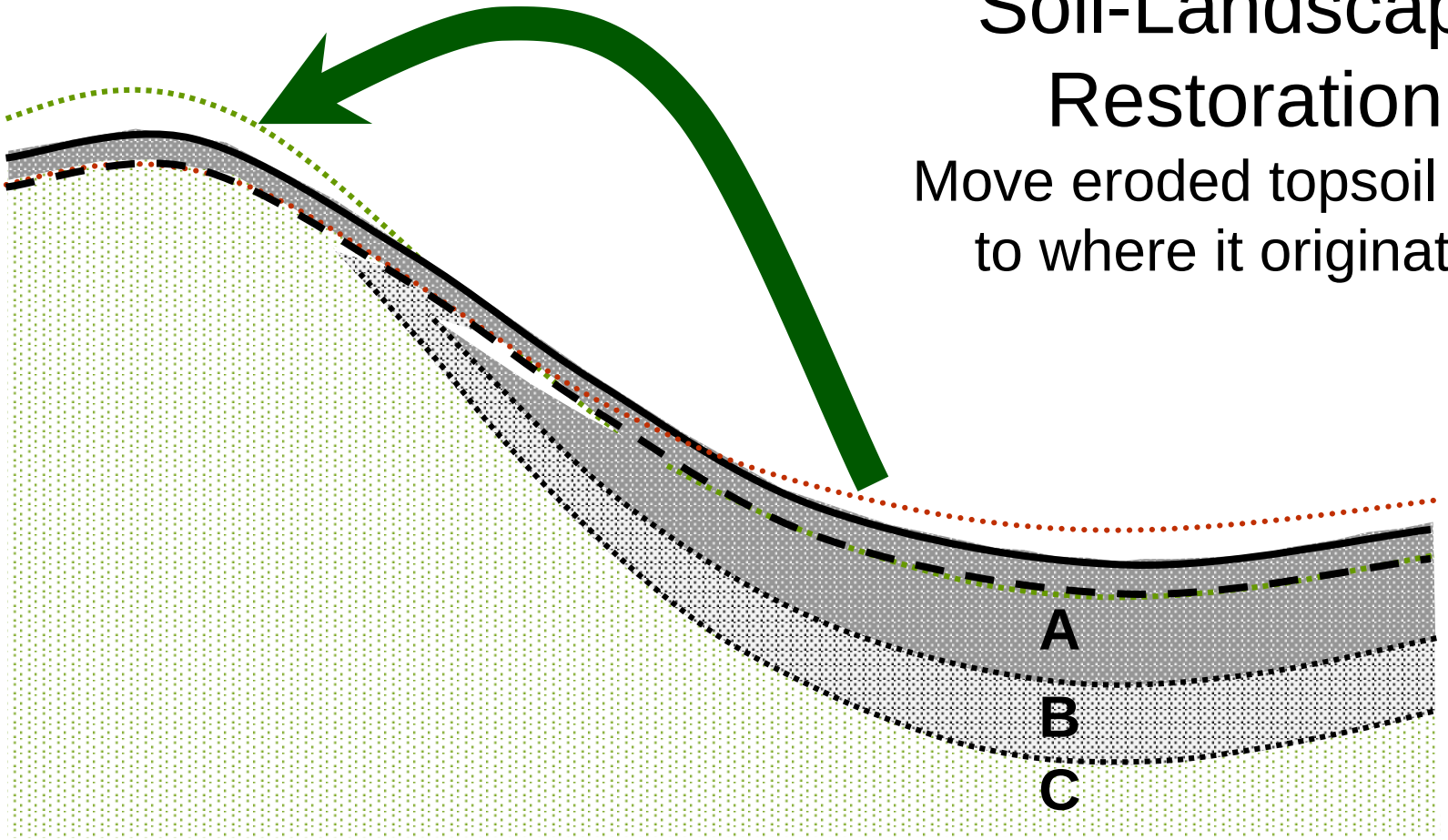


Image: David Lobb, University of Manitoba

Soil Restored

Top of Hill; without starter P (left 2 rows), with starter P (right 2 rows)

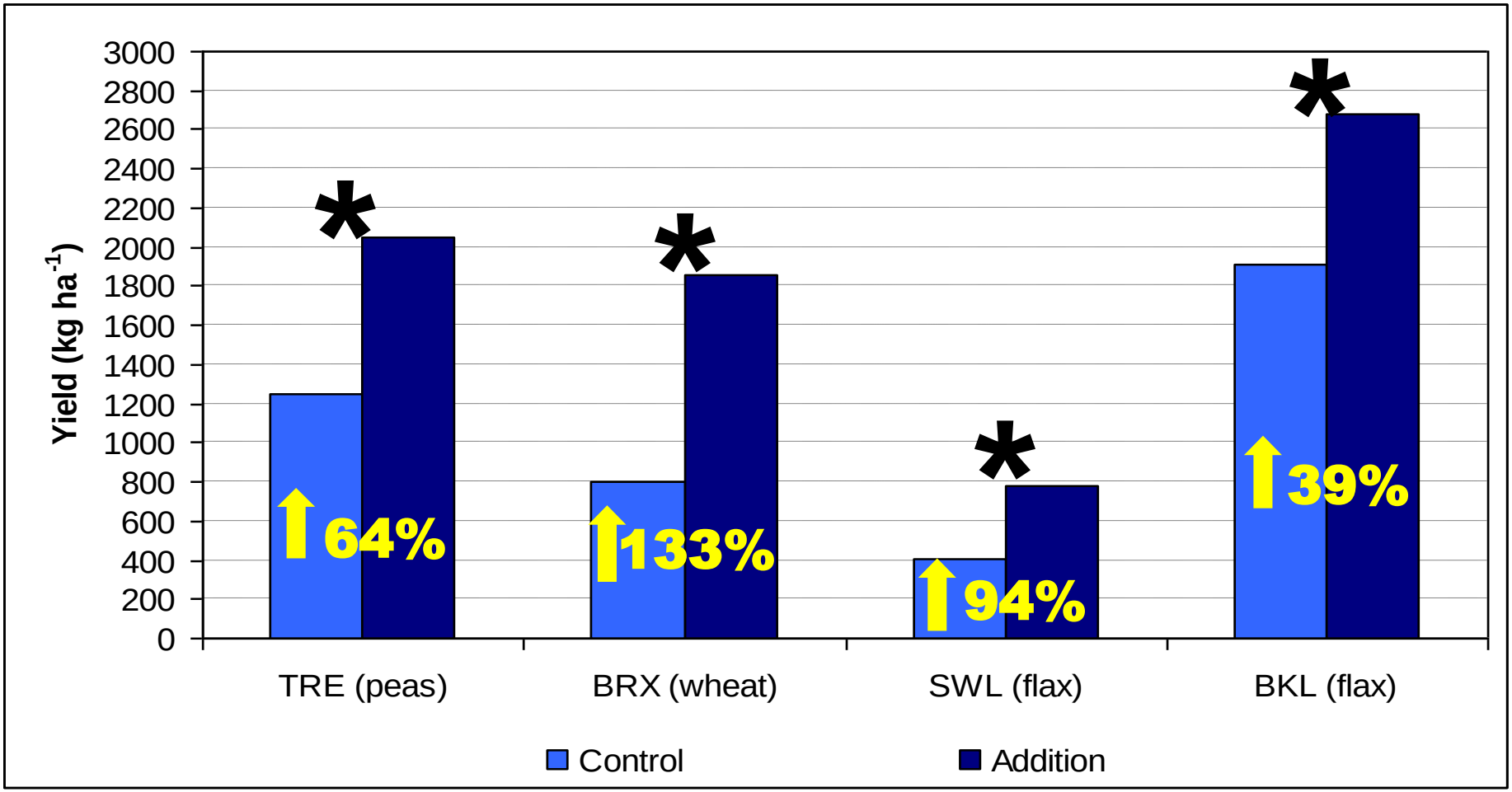
Soil Removed (and placed at top of hill)

Bottom of Hill; with starter P (left 2 rows), without starter P (right 2 rows)

Erosion and Restoration Demonstration

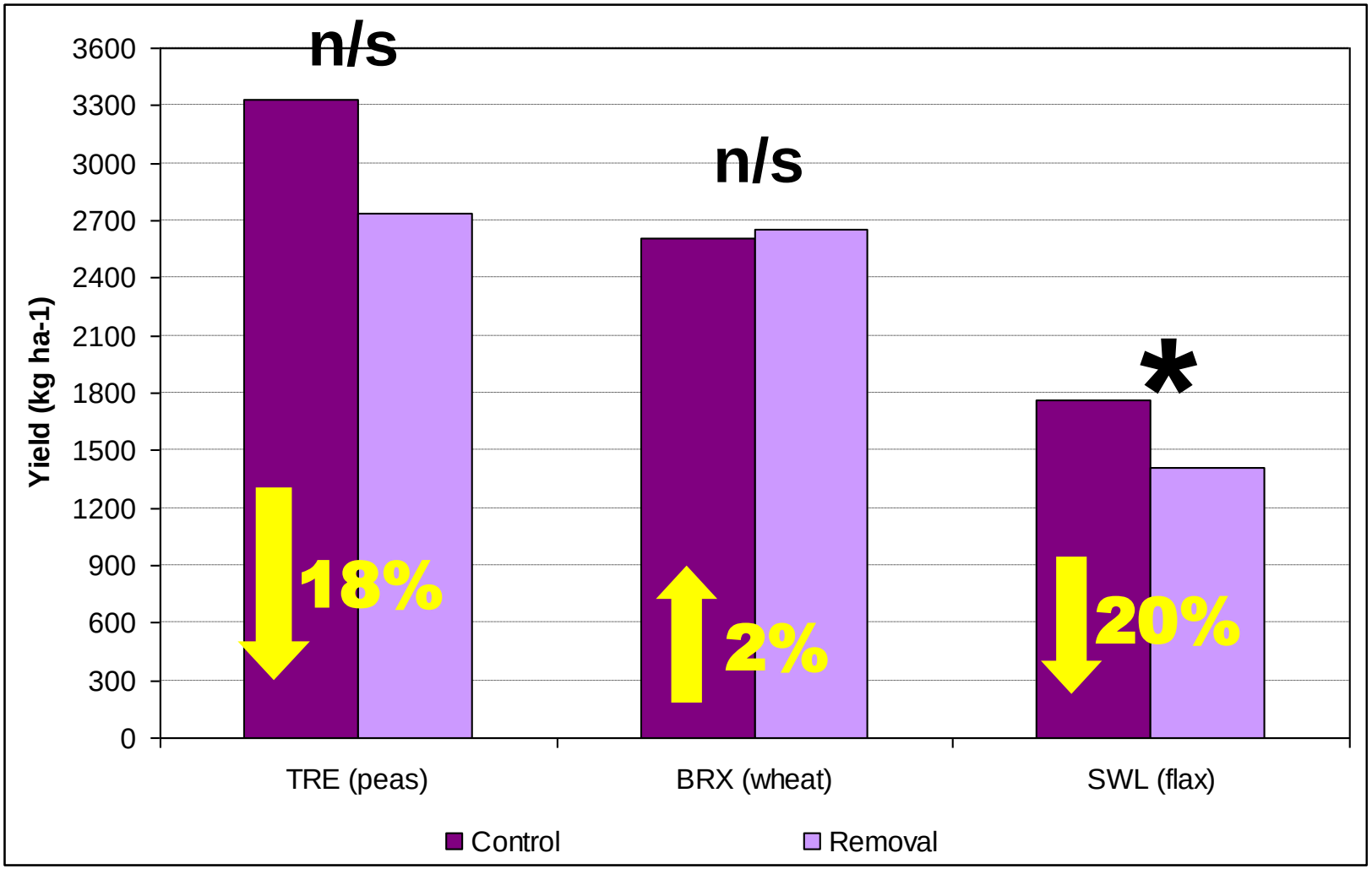
	Upper Slope			Lower slope		
	Eroded	As Is	Restored	Eroded	As Is	Restored
Nitrate-N lb/ac 0-24”	75	93	104	65	70	72
Soil P ppm	3	7	7	21	19	9
Soil K ppm	150	232	282	259	251	178
Zn ppm	0.57	1.01	1.42	2.89	2.89	2.3
pH	7.7	7.7	7.6	6.8	7	7.1
OM	3.5%	4.9%	4.9%	5.6%	5.9%	4.5%

Landscape Restoration – Soil added to knoll



Research by David Lobb, UofM Soil Science

Landscape Restoration – Soil removed



Research by David Lobb, UofM Soil Science

Current Soil-Landscape Restoration Research

- Yield increase ranged from 22, 24 and 50% on knolls where topsoil was added
  - Soybeans, canola, oats
- Yield loss ranges from 2-12% in depressions where topsoil was removed
  - Important to design removal area appropriately as ponding of water may impact yield further

Soil-Landscape Restoration

- Important to note:
  - Add 4” of topsoil to eroded knoll for maximum benefit
  - Don’t remove more than 8” of topsoil from depression
  - Return on investment is 3-5 years
    - Assuming “custom” work – 8 hours/day for 8-10 days/quarter
  - If no-till is adopted after, may never have to restore the landscape again
  - If tillage continues, will pay to do again in 12-15 years

Stop erosion before it starts!

- Soil-landscape restoration makes sense if you already have eroded landscapes
- But taking steps to minimize erosion can save a lot in the long run!
- Remember that long-term sustainability of the soil will require long-term planning

Thank you!

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