

## Grass + Beef = Sustainability

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### Take-home Messages

1. The fate of a toothbrush predicts the fate of agriculture
2. Agricultural unsustainability is staring us in the face
3. Don't blame the farmers
4. The fix is known; the will is weak
5. Your guiding influence as a consumer is to reward those who farm sustainably

### The Toothbrush Analogy

Q. Why does it take 500 years for a toothbrush to decompose in a landfill?

A. Because toothbrushes were not *designed* to break down any faster. A toothbrush was engineered to achieve various goals - what I will call **design-drivers** - but *time to break down in a landfill* was not one of them.



I put it to you that this simple analogy explains what is happening in agriculture today – and further, what we can do to make things right.

### Agriculture is Not Sustainable

Your *Vital Conversations* document from 15 Dec 2021

([https://cscf.ca/media/uploads/pdfs/cscf\\_vital\\_conversation\\_report\\_march\\_31\\_2022\\_-\\_final.pdf](https://cscf.ca/media/uploads/pdfs/cscf_vital_conversation_report_march_31_2022_-_final.pdf)) identifies a number of concerns bearing on farming and sustainability – including overdependence on inputs such as corn/soy rotation, pesticides, and fossil fuel energy; and unsatisfactory outcomes such as faulty water cycling due to tile drainage, and loss of SOM as CO<sub>2</sub> – a greenhouse gas. How long can we pretend that our agriculture is sustainable?

And what does this have to do with toothbrushes?

Q. Ask yourself, *why* is today's agriculture not sustainable?

A. **Sustainability was never a design-driver for agriculture.** Agriculture was designed to export bulk, raw commodities back to the home country – now ADM, Cargill, Greenfield etc. Agriculture is literally not sustainable today because it was never *designed* to be sustainable.

Some would challenge my bold assertion that agriculture is not sustainable, but in truth, the inconvenient evidence is plain to see.

Routine agricultural practices in eastern Canada, and in Central ON in particular, are burning through soil organic matter (**Figs 1 and 2**; soil organic carbon is 58% of SOM) and pumping GHG into the atmosphere (**Fig 3**). Simply put, agricultural practices that destroy SOM – with wide ramifications ranging from tilth and erosion, climate resilience and water holding capacity, to soil biota and crop health – and that release GHG that promote global warming are simply not sustainable. Undeniable.

Figure 1. Changes to Soil Organic Carbon over 30 years, 1981-2011 – Canada (Cerkowniak et al., 2016)

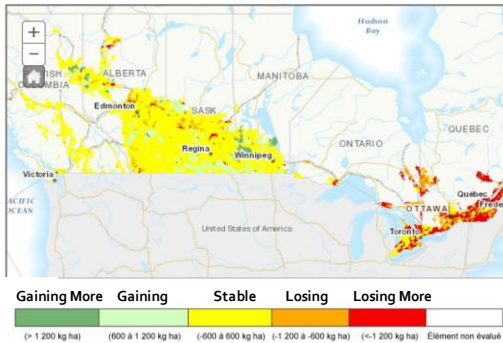


Figure 2. Changes to Soil Organic Carbon over 30 years, 1981-2011 – Central Canada (Cerkowniak et al., 2016)

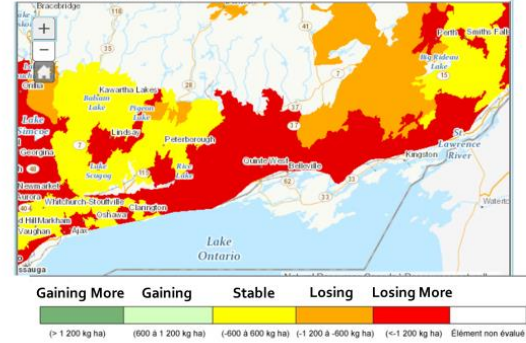


Figure 3. Net GHG emissions (kg CO<sub>2</sub>-equiv. per ha) – 2011 (Worth et al., 2016)

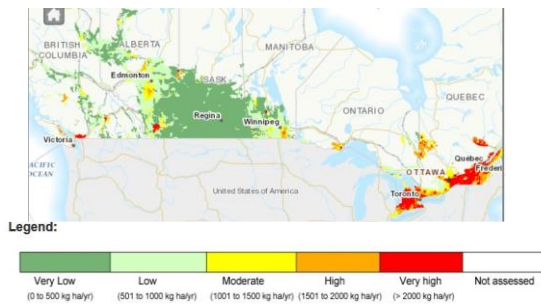
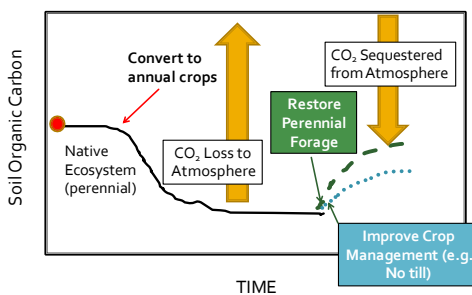


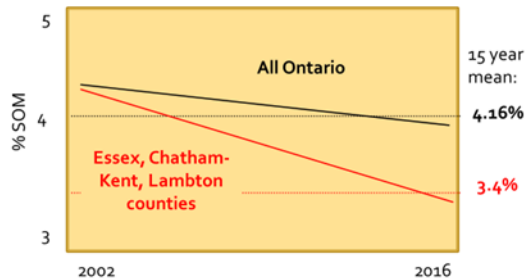
Figure 4. SOM is lost when perennials are replaced by tillage to grow annuals (adapted from Paustian, 2014)



Now you may quite reasonably ask – what about no-till, a practice that has been studied and promoted to ON farmers for decades? Tillage to control weeds, incorporate residue, and prepare a seedbed for seeding has the unintended side effect of promoting breakdown of SOM (**Fig 4**). Many have reasoned that rigorous adoption of no-till cropping could reverse this deleterious process and sustain annual cropping.

But no. No-till or reduced tillage in general works better in drier prairie soils growing small grains than in our heavier, wetter soils growing corn and soybeans. In SW Ontario, where no-till has been most aggressively adopted, SOM is declining even faster than in the rest of the province (**Fig 5**). So no, no-till won't save us.

Figure 5. SOM declined between 2002 and 2016 in ON v. southwest ON soils (adapted from Brown, 2017)



These quick examples reinforce the concerns you've raised about simple rotations, pesticides, and C sequestration – in other words, about the way we are farming today.

I would suggest to you that sustainability is unachievable because we are working from a flawed design – just as expecting a toothbrush to degrade in a landfill in less than 500 years is unachievable because it wasn't designed to do so. If we want our kids and grandkids to keep eating, agriculture needs a different set of design-drivers explicitly including sustainability.

### So Now What Do We Do – or more clearly - *Not Do*?

First, step back and recognize that farmers are not at fault for the unsustainability of agriculture. *Don't blame the farmers.* Your Vital Conversations summary mentions incentivizing farming practices that are not harmful to our shared environment. Farmers are referred to as *the elephant in the room*, for using farming practices that are not always sustainable. Let's briefly unpack and elaborate upon some of these points:

1. **Farmers do what they are told** – by government, academia, and industry. Government policy has channeled ON farmer expertise in specific directions – namely, toward ever higher yields of corn and soy - via inputs such as pesticides and fertilizers, tile drainage, and concentration in ever fewer and ever bigger farms. This is not an accident – it is intentional – with the goal of producing cheap, bulk, raw product for industry, either here or abroad (GFO, 2018; 82% of ON corn is used for feed or ethanol/industrial products; 74% of ON soy is likewise used for feed, biodiesel and industrial additives).

**\*\* so farmers are not the ones you need to challenge;** rather you should be addressing your concerns to those crafting the farm policies that direct farming practice

2. **Farmers are being driven out of business.** While farmers have indeed done what they are told and massively increased yield over the last 50 years, the farmers themselves are not benefitting from their hard work (**Fig 6**; see also Birchfield et al. 2022 for the same trend in the US). The vendors of the inputs (banks; seed, fertilizer, and pesticide sales; machinery etc.), the few remaining corporate buyers of the outputs (ADM, Cargill, JBS etc), and the processors/packagers and marketers/transporters of our food are reaping the benefits of farmer expertise.

Figure 6. Farmers retain less than 5% of gross revenue (Qualman, 2019)

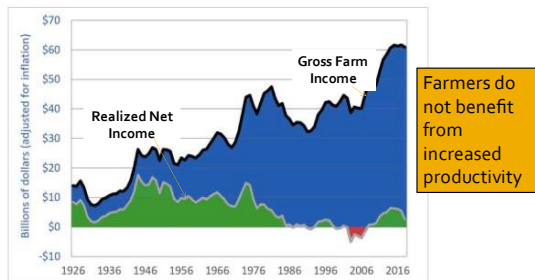


Figure 1-1. Gross farm revenue and realized net income, net of government subsidies, Canada, 1926-2018  
Sources: Statistics Canada Tables 32-10-0045-01 (formerly CANSIM 002-0001); 32-10-0052-01 (002-0009); 32-01 (002-0076); and 32-10-0153-01 (004-0002)

As a result, primary agriculture is arguably no longer a viable source of family-supporting income, which is why **mean age of ON farmers has increased from 49 y in 1996 to 57 y in 2021**. Aging farmers mean two things: a) little money or incentive to adopt/try out new methods/ideas in the absence of targeted, pro-active, and reliable government support, and b) yet more evidence of the unsustainability of what

we are now doing – **you cannot sustain agriculture without farmers.**

## Now For the Hopeful Stuff: We Already Know *How* To Make Agriculture Sustainable

This has been known for centuries – not rocket science and not high tech. Getting back to the toothbrush analogy, **what would agriculture look like if sustainability were a design-driver?**

So what is the secret? The fundamental flaw in the design of agriculture as we know it was the transformation of a continental landscape that evolved **perennials** – plants that live for many years and don't need reseeding, like grasslands, apples, and pine trees - into **annuals** like corn, soybean, and canola (**Fig 7**). The same is true in most of the world – perennials rule!

The annual growth habit – specifically, corn, soy, and other grains, but also carrots, cantaloupes, and cauliflower - is in fact ill-suited to environments – like Iowa, Saskatchewan, and Ontario - which are wet enough to have evolved perennials as the dominant ground cover. **Growing annuals in an environment suited to perennials is the root cause of many of the problems you've identified – and of the unsustainability of agriculture as now practiced (Table 1).**

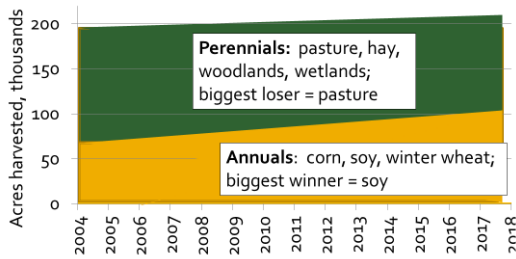
Figure 7. Native vegetation here – and in the major grain belts – is perennial



We rightly criticize Brazil and other nations for destroying rainforests (perennial) to grow soy (annual) and beef, but we *are doing* the same thing here – and for the same reason (**Fig 8**).

Crop growth habit – annual v. perennial – is not a pedantic issue. **Table 1** illustrates some of the problems – we can call them *Ecosystem Disservices* – inherent to the annual growth habit in places wet enough for perennials.

Figure 8. Annuals (big 3) increased from 30% of NC farm area in 2004 to 50% in 2018 (adapted from OMAFRA, 2016a and b)



So what is the answer? **Re-balance the agricultural landscape to include a better mix of perennials**, whether as grass for pasture/hay or as trees/bushes for permaculture, orchards, or agro-forestry. Not wholesale, back-to-Nature replacement, of course, because we need our oatmeal, green beans, and beets. But re-design agriculture to acknowledge the root cause of contemporary unsustainability, and recognize the benefits conferred by perennials.

Or in terms of the toothbrush example, **broaden the design-drivers for agriculture – in your own mind as a consumer and (perhaps?) in that of agricultural policymakers and planners - to include environmental management, C-sequestration, nutrient and water retention, and human health** as done by the EU (Plate 1).

Table 1. Specific examples of ecosystem disservices caused by the annual growth habit

Annuals ....	....cause Ecosystem Disservices
Introduces periodicity into nutrient sinkness	<p>*Annuals live for a few months at most, and actively take up soil nutrients (N, P, K, S etc.) for a few weeks early in the lifecycle; yet nutrients continue to be released into the soil solution by mineralization of SOM long after nutrient uptake by annuals has ceased. Gaps between nutrient release and uptake, early and late in the year, coincide with times when precipitation exceeds evapotranspiration and the net direction of water movement is downwards. Downward water movement means leaching.</p> <p>*A perennial grass sward is a living, continuous crop, more effectively covering off these leaky intervals with active nutrient sinkness earlier and later in the year</p>
Requires bare soil	<p>*The bare soil required to protect annuals from weed competition means ceaseless war with Nature, whether through tillage or herbicides. Nature has evolved strategies, such as the soil seedbank, seed rain, and laterally encroaching vegetation to keep the ground covered.</p> <p>* Perennial swards maintain continuous soil cover, mimicking Nature</p>
Requires monoculture	<p>*Annuals are almost always sown in monocrops, impoverishing the plant biodiversity. Biodiversity confers many of the resource utilization and bio-control functions that sustain natural ecosystems, including controlling pestiferous populations.</p> <p>*Perennials are always sown in a mixture of species, which becomes progressively more diverse over years, due to accumulating recruitment from the seedbank, seed rain, and neighbours. Plant diversity occupies the many niches present in every field, and thus, stabilizes performance.</p>
Precludes succession	<p>*Annually re-setting a field back to the pioneer stage loses the accumulating advantages of succession, which include building soil organic matter and nutrients, with follow-on benefits in water conservation, risk management, and disease/pest control.</p> <p>*Perennials intrinsically capture these advantages, which is why withholding land from cultivation under a perennial grass sward actually builds and regenerates soil damaged by annual cropping (various, reviewed by Clark, 2009)</p>
Linearizes nutrient flow	<p>*Exporting annual grains and vegetables <b>linearizes</b> nutrient flow, extracting nutrients to deficit while concentrating them to excess elsewhere, creating both scarcity and excess.</p> <p>*Implied nutrient export from an acre devoted to meat, milk, or eggs is a small fraction of that same acre if devoted to grain or vegetable crops. Cycling annual crops and wastes through on-farm livestock retains nutrients and mimic's Nature</p>
Destroys SOM	See above Figs 1 and 2



## Actionable Future

OK – so I’ve argued that agricultural unsustainability is built in – unavoidable – as a direct result of government policy that encourages annual crops to dominate the agricultural landscape. And be very clear that this is by no means limited to Ontario or Canada– this design flaw is global.

So what can we do? We – you and I – are *not* going to convince a group of near retirement age farmers to rethink practices they’ve spent their lives perfecting.

Nor is Canada going to reverse centuries of agricultural development centering on annual grains and return to a perennial-dominant landscape. Nonetheless, it is not a coincidence that the notion of **cover crops** – a weak proxy for perennials – and **grasslands/grazing** of perennial forages appear in the initiatives of several countries who see the writing on the wall and are striving to do more than rearrange deck chairs on the Titanic (**Plate 1**).

### Plate 1. Grass and Sustainability

Grass (meaning herbaceous forages), whether in the form of annual cover crops or perennial hay and pasture, is recognized in sustainability-focused policies and grant or subsidy programs. Those of Canada and the US are more short-term and piecemeal to achieve other agenda goals, while that of the EU is more encompassing and pro-active:

1. Canada. Agricultural Climate Solutions (3 y; <https://agriculture.canada.ca/en/agriculture-and-environment/agricultural-climate-solutions>)
2. US. USDA’s Grassland Conservation Reserve Program (10-15 y contracts; <https://www.fsa.usda.gov/news-room/news-releases/2022/usda-encourages-producers-to-enroll-grasslands-into-working-land-conservation>) and Partnership for Climate-Smart Commodities (up to 5 y; <https://www.usda.gov/climate-solutions/climate-smart-commodities>)
3. EU. The newly released **European Green Deal** (2019-24) focuses on transforming society, effectively, **to change the design-drivers for agriculture and for the EU in general**. Agriculture will no longer be tasked with producing raw, bulk, undifferentiated inputs for industry but will encompass **food security** in an era of climate change and biodiversity loss, reducing the **ecological footprint** of the food system, building **resilience**, and leading what is viewed as a global need for **transitioning toward sustainability**.

They plan to address these issues through a network of initiatives (see [https://ec.europa.eu/food/horizontal-topics/farm-fork-strategy\\_en](https://ec.europa.eu/food/horizontal-topics/farm-fork-strategy_en)) termed the *Farm to Fork Strategy*. Starting Jan 2023, farmers will receive **green direct payments**, for complying with **three mandatory practices** identified as being beneficial to the environment, of which one is **maintenance of permanent grassland**.

So, setting our sights on realistic goals, we can encourage – with our checkbooks - both existing and incoming farmers to rely more heavily on the perennials to which this place is best adapted. Grass-fed beef (and pigs, sheep, chicken, dairy) is one initiative that is already established and growing right here in Northumberland and surrounding counties. You can find

local offerings on the web, and choose to support their decision to redesign their farming practices to the benefit of all of us.

Returning to your *Vital Conversations* findings, producing beef on grass requires very little to no pesticides, keeps the land covered year-around to capture and cycle water and nutrients, and because grass is perennial, is literally the only way to actually build SOM and sequester C in the soil. And the meat tastes GREAT! (see Conflict of Interest statement)

### **Conclusion: Grass and Livestock are Essential**

Grass – and livestock to convert it to human-usable food – is an essential foundation to sustainable agriculture (permaculture may be another). Like the recalcitrant toothbrush, agriculture is charged with tasks for which it was not designed. Strategies we've tried – like no-till – help to make agriculture *less bad*, at least in some places - but not sustainable as we've seen, because of the flawed *design* of annual-based agriculture.

We don't do well on grass – or bark – so this is where livestock and in particular ruminants such as beef come in. Livestock convert grass into human-usable food, hence the title for this talk: **Grass+Beef = Sustainability**. Prioritizing grass-fed beef (or milk, lamb, pork, chicken) is scientifically sound, already here and growing, and available to knowledgeable consumers.

Your role, then, is to reward those farming sustainably, including existing and start-up grass farmers, with your consumer dollars and your vocal support. Politicians don't lead – they follow – so let's get the parade underway!

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