

Organic Agriculture: Impacts on GHG Emissions, Soil and Biodiversity

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I thank the 'Nishnabe Attiwandat,' known in our language as the neutral people.

I appreciate that they cared for the land in this region of Earth, prior to our arrival.



Wasted Food

- Households in Canada spend \$153/wk on food. Assuming 20% of food is wasted in households, then tossing cost is **\$31/wk**
- Organic shoppers spend **\$27/wk** more than those who buy non-O.
- **Stop wasting, then buy organic, save \$4/wk**

www.guelphfoodwaste.com

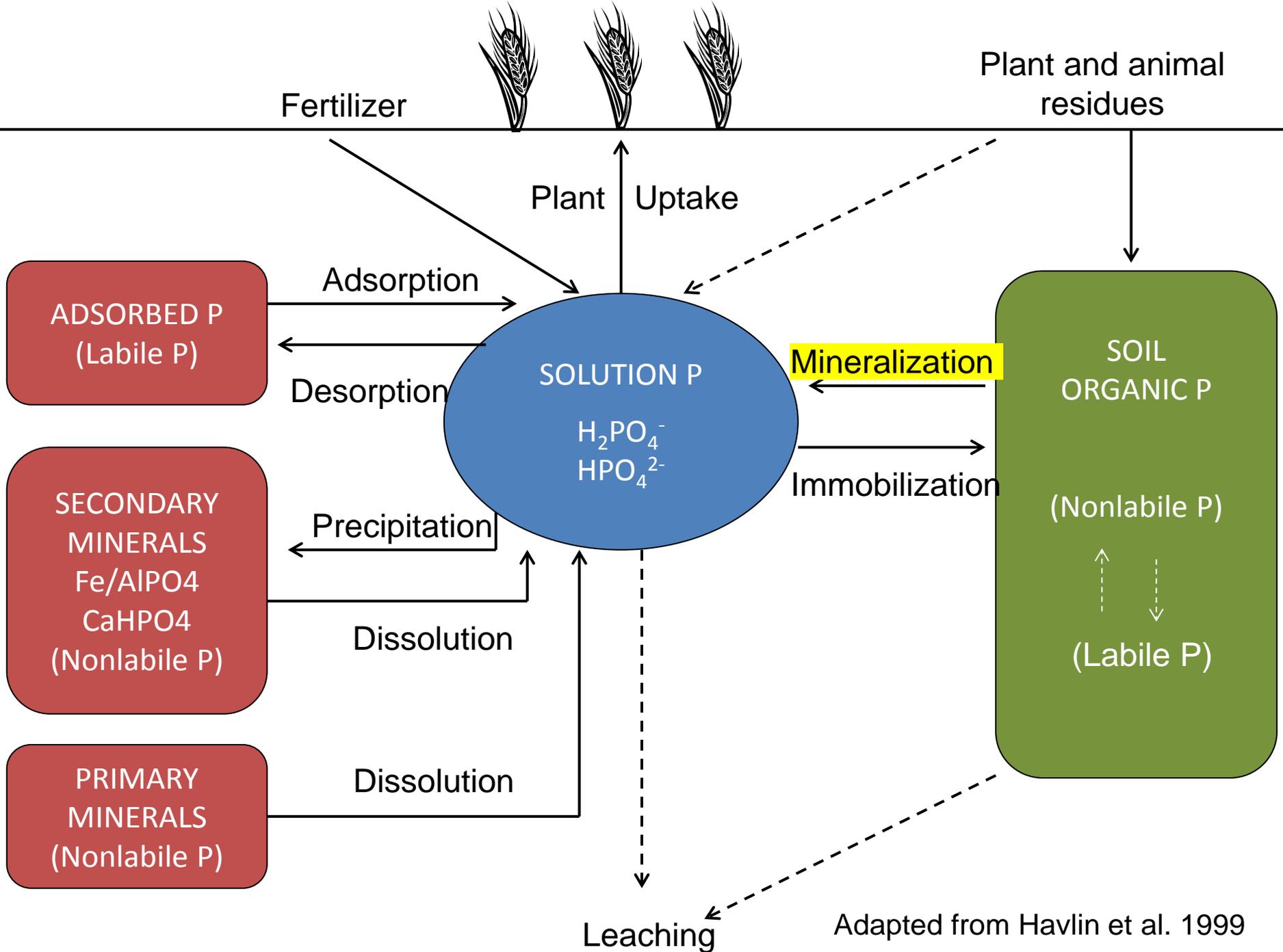


In 40 years, global food production increased **2x**,
while synthetic N use increased **7x**

(Hirel et al. 2007 <https://doi.org/10.1093/jxb/erm097>)



Photo by K. Lightburn



Adapted from Havlin et al. 1999

Benefits of Organic Agriculture

Rodale Institute

- N from manures or forage legumes can produce similar yields as conv., while **preserving C** in the soil & reducing N losses
- 50% reduction in energy use in “organic”

*Drinkwater et al., 1998.
Nature, vol. 396*

21-year study at FiBL

- organic yields 80% of conv., using up to 56% less energy per unit yield
- Nutrient inputs (N, P, K) were 34 - 51% lower
- 40% more roots colonized by fungi
- 3x more earthworms and 2 x more spiders

*Mäder et al., 2002. Science,
v: 296*



Photo by W. Pfenning

With organic premiums, O ag was significantly more profitable (22–35%) and had higher benefit/cost ratios (20–24%) than non-O ag.

Breakeven premiums necessary for O profits to match non-O profits were only 5–7%, even with O yields being 10–18% lower.

Morris Van De Walle

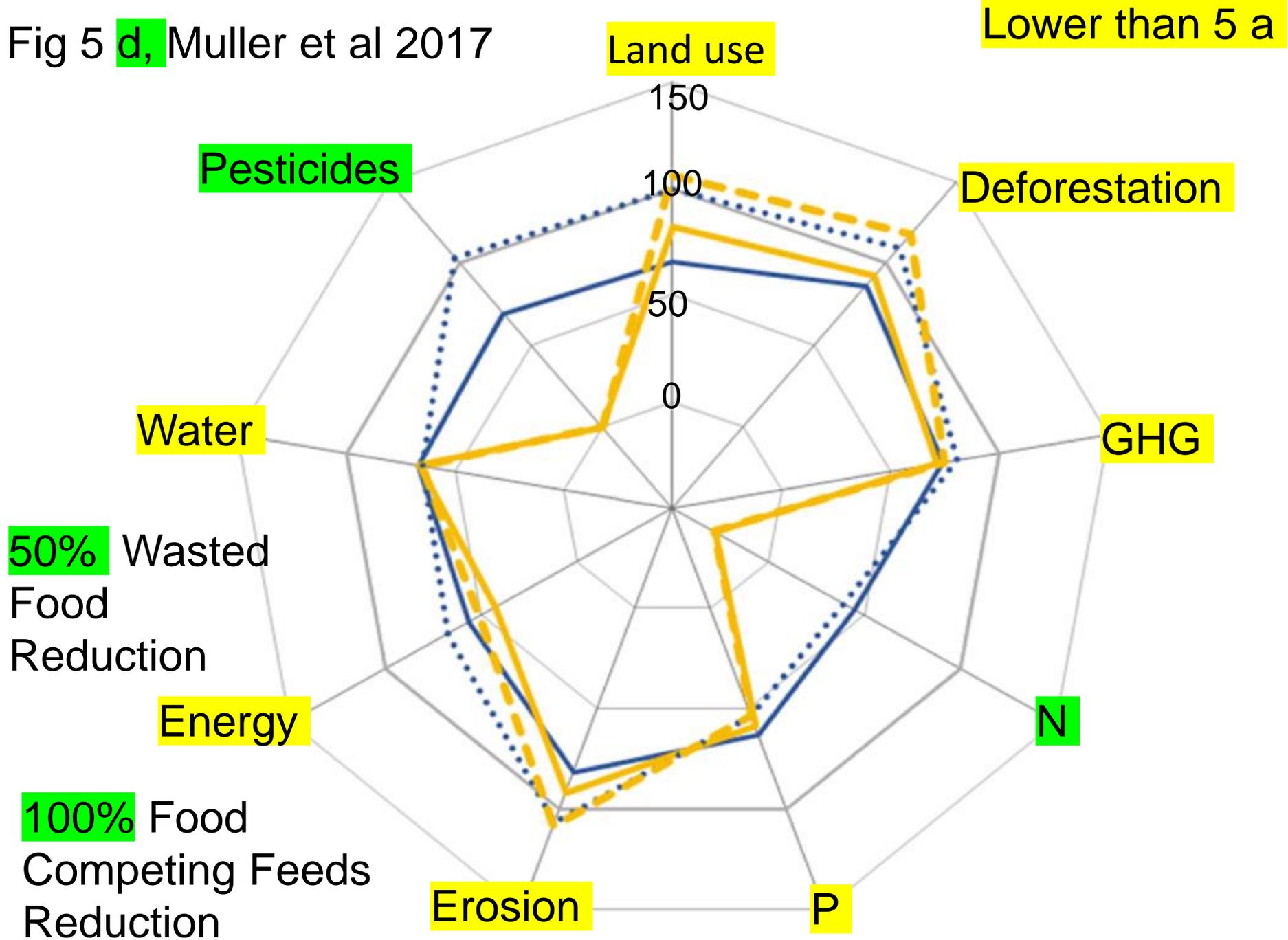
Organic NT Soy

- May 21-18 rye was waste ht by May 29 crimp/plant w 8600 lbs/ac rye
- Planted soy at 200,000/ac – 2 in. depth planted in same direction as crimped rye –
- 250 lbs down pressure – straight tillage to cut throw – not leave opening
- Some rye bounced back
- Yield of 63 bu/ac – lower yield on headlands where more turning



Photo by M.
Van De Walle

Fig 5 d, Muller et al 2017



- Year 2050 relative environmental impacts of a full conversion to O Ag in combination with complementary food systems strategies. Environmental impacts of O (100% O Ag, yellow lines) and conventional (0% O Ag, blue lines) scenarios with concomitant changes in livestock feed and food waste strategies. All scenarios are shown relative to the reference scenario (i.e. 0% O Ag, no changes in livestock feed and food waste; dark grey line), with (dotted lines) and without (solid lines) impacts of climate change on yields; Calories are kept constant for all scenarios.

Muller, A., Schader, C., El-Hage Scialabba, N., Brüggemann, J., Isensee, A., Erb, K.H., Smith, P., Klocke, P., Leiber, F., Stolze¹, M. and Niggli, U. 2017. Strategies for feeding the world more sustainably with organic agriculture. Nature Communications |8: 1290. DOI:10.1038/s41467-017-01410-w



- A 100% conversion to O Ag needs more land than non-O Ag but reduces N-surplus and pesticide use.
- However, if reduce wasted food and food-competing feed (FCF) from arable land*, with correspondingly reduced production and consumption of animal products, then land use under O Ag remains below reference scenario.

*Livestock use resources that otherwise would not be available for human food consumption, i.e. grazing lands, and by-products from food production (Muller et al 2017)



Photo: A. Peregrine

In Ontario, O sector has 2% of food sales and 0.4% of OMAFRA research funds.
Why not **5 x 0.4%** in research funds?



Why do O farm check-off fees go to non-O orgs?
If those funds went to OCO

www.organiccouncil.ca/

then OCO would have money to leverage government grants

O Ag is a long term contrast to mainstream ag.

With the **precautionary principle** and being slow to accept potential harm, O ag provides options.

Options may be needed by main stream ag if harm, lack of efficacy or a cost-price squeeze develops.

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Photo: Southbrook Vineyards

- Extra slides

1 Billion

number of extra people that could be fed if we globally applied the best **current** methods to reduce wasted food

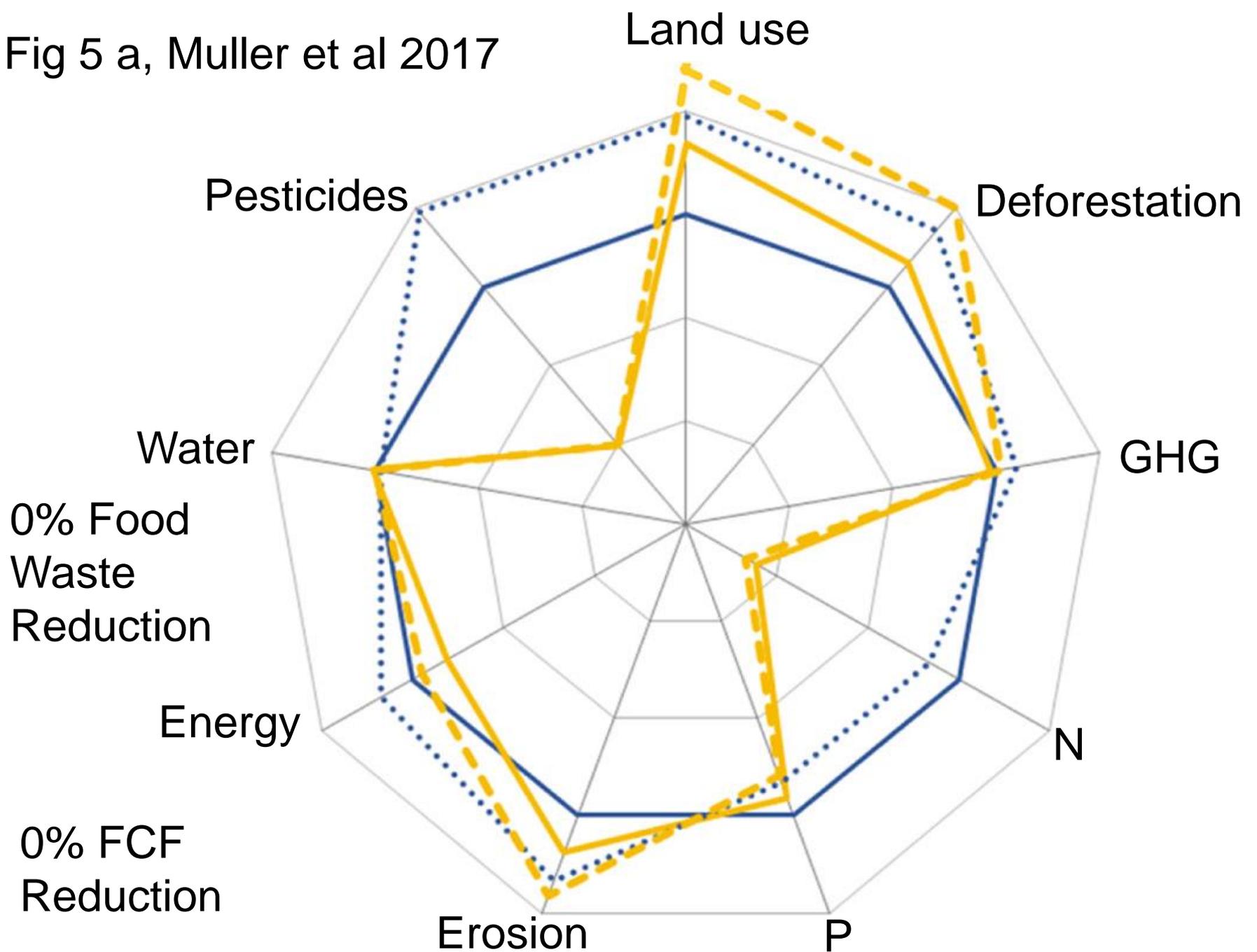
Kummu et al. 2012. <https://bit.ly/2RPtSCW>



www.guelphfoodwaste.com

- \$49.5 billion (3% of Canada's 2016 GDP; could feed everybody in Canada for 5 mo) is value of avoidable FLW in Canada
Gooch et al. 2019. The Avoidable Crisis of Food Waste. Value Chain Mgmt Intern. <https://secondharvest.ca/research/the-avoidable-crisis-of-food-waste/>

Fig 5 a, Muller et al 2017



Organic No-till Systems

Excellent Book - Organic No-Till Farming

Roll-in or crimp cover crops and green manures

<https://www.youtube.com/watch?v=fkMB5meXMGg>



- Dependence on tillage is strike against O
- Agronomic crop success depends strongly on cc ability to suppress weeds
- At cc biomass of 6 t/ha, too many weeds; at cc 9 t/ha, < 15% weed cover
- Vegetable crop growth more susceptible to the effects of cc mulches, incl. mulch's impact on soil temp and nutrient availability
- Need O plan B; mow weeds, high residue tillage, add mulch

Breach et al 2018.

doi:[10.3390/su10020373](https://doi.org/10.3390/su10020373)



Photo by R. Knight

Weed Surfer Might be Plan B

Lightweight mower, hovers above crop to clip weeds before they produce seed



Thanks to Ben Morgan

<http://www.ctmharpley.co.uk/weedsurfer.html>

Morris Van De Walle Organic NT Soy

- Rye at 100 lbs/ac drilled Sep 20-15
- May 31-16 – crimped – pollen in air
- Crimp at dif angle to what rye was sown
i.e. cover all gaps
- Recrimp if necessary and go against 2nd time
- Planted soy in 7 in rows at 90lbs/ac
- Yielded 50 bu/ac
- ‘Get perennial weeds under control’



Photo by M.
Van De Walle

Organic No-Till

In 2016, Morris Van De Walle applied an organic no-till system to plant soybean into 80 acres of crimped cereal rye. Soybean yield averaged 50 bu/ac. The 2016 season was particularly dry and the mulch held moisture.



May 30, 2016

Photos by Ruth Knight



July 4, 2016

MacRae et al. 2010.

J. Sustainable Agric. 34:549–580

- Organic farming systems demonstrate greater energy efficiency and reduced GHG emissions per land unit and per unit of production compared with conventional



Comparative Yields and N₂O Emissions



<http://www.farmersjournal.ie/WEBFILES/13615-151063.jpg>

Organic system emitted **4.4 kg N₂O -N ha⁻¹** while maintaining acceptable yields of forage and potato crops

Non-organic (i.e. synthetic fertilizer) forage and potato management had emissions of up to **11.6 kg N₂O-N ha⁻¹** (D. Lynch et al)

Balancing Production and Consumption

Suppose that mainstream agriculture had evolved differently, and that we

produced high quality food, with yields 19-25% lower than they are today (Seufert and Ramankutty, 2017

<http://advances.sciencemag.org/content/3/3/e1602638>)

Can we also imagine wasted food at 15%?

In a society of 15% wasted food, would we aspire to produce 25% more food, in order to waste 40%?



Biodiversity - Wildlife

Counted birds on 72 fields across 10 conventional and 10 organic farms

Of 68 bird species – species richness, abundance and frequency of occurrence were significantly higher on organic sites.

Freemark and Kirk. 2001.
Biol. Cons.101:337-350.



Why Organic Certification?

<http://www.inspection.gc.ca/food/organic-products/eng/1300139461200/1300140373901>

- Many customers in GTA want organic food. Why should it come from outside ON?
- Organic standards provide definition. Backed up by CFIA
- Value accrues throughout the value chain



At March 2016 Organic Value Chain Roundtable Adam Cull (of AAFC) presented an environmental scan of organic ag in Canada.

- O farms generally have higher average net operating incomes than non-O farms within their revenue class
- Higher returns can be associated with lower input costs and significantly higher prices even with marginally lower yields.





Founded in 2001, OACC aims to serve Canada's organic sector through science and education.

- **Vision:** Sustainable and science-based organic agricultural systems supporting healthy Canadian communities.
- **Mission:** OACC facilitates and leads research and education supporting organic producers, consumers and other organic sector stakeholders to foster sustainable communities.
- www.dal.ca/faculty/agriculture/oacc/en-home.html