Measuring Carbon Footprints of Agri-Food Products: Implications for Trade

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OECD Trade and Agriculture Directorate

IATRC Meeting
16 December 2025

Food systems exert important pressures on the environment

Land use

50%

of all ice- and desert-free land is used for agriculture

Deforestation

73%

of tropical and sub-tropical deforestation (2000-10)

Biodiversity loss

80%

of threatened land species are in danger due to habitat loss driven by agriculture

Water use

70%

of global freshwater use

Water pollution

78%

of global eutrophication

Climate change

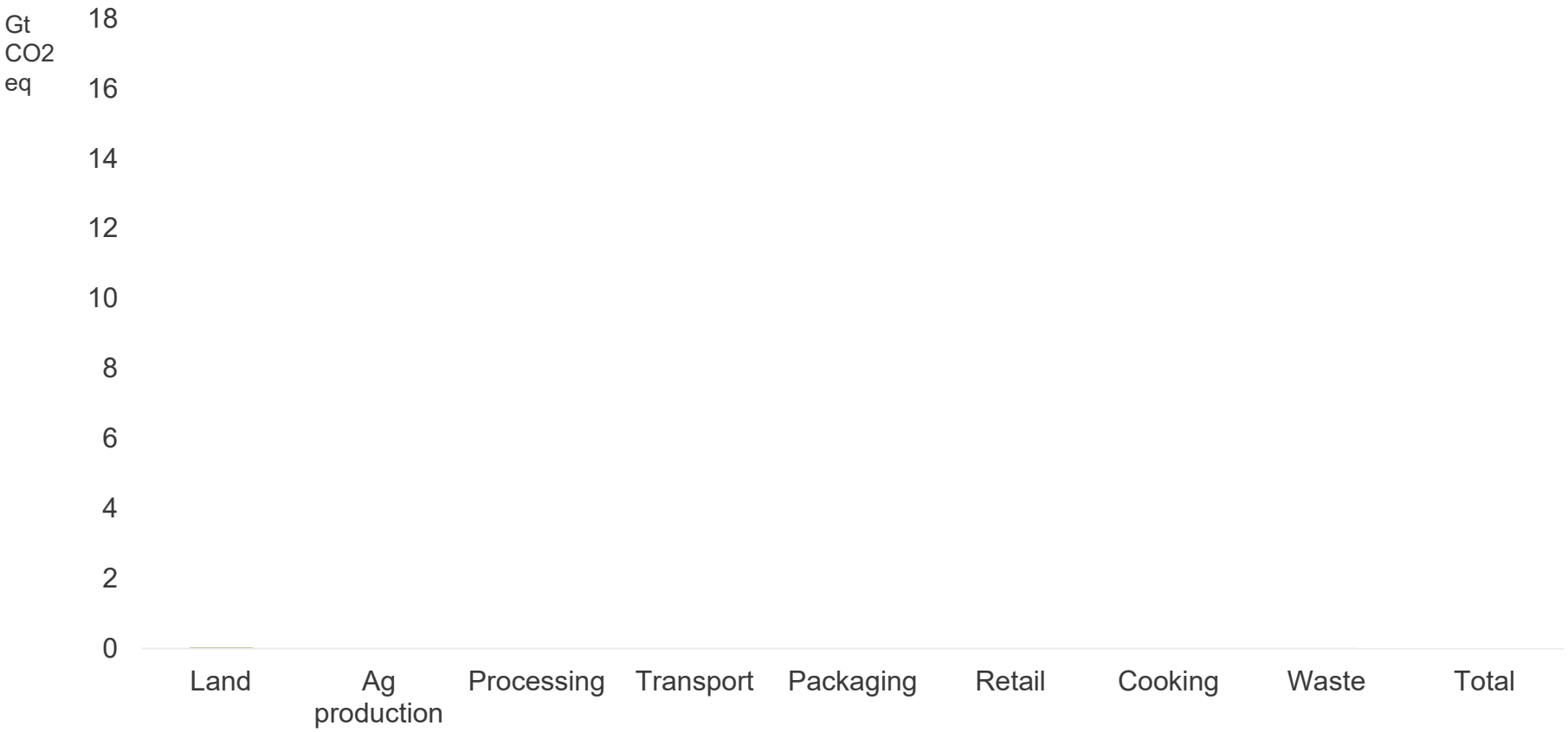
34%

of man-made GHG emissions

Source: OECD (2021), Making Better Policies for Food Systems; OurWorldInData; Crippa et al. (2021)

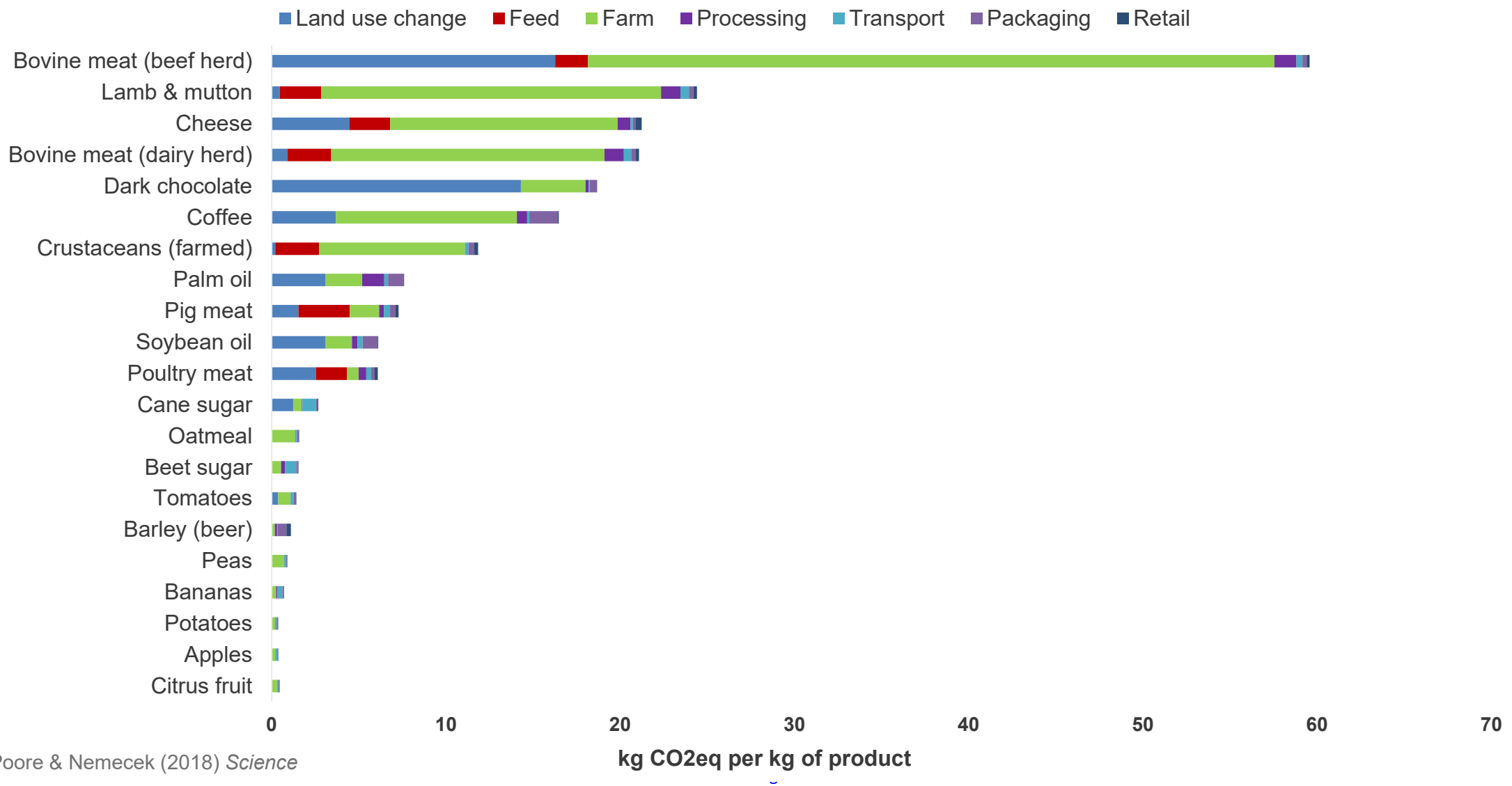
Globally, most GHG emissions from food occur through land use change and agricultural production

Food systems GHG emissions by supply chain stage, 2015



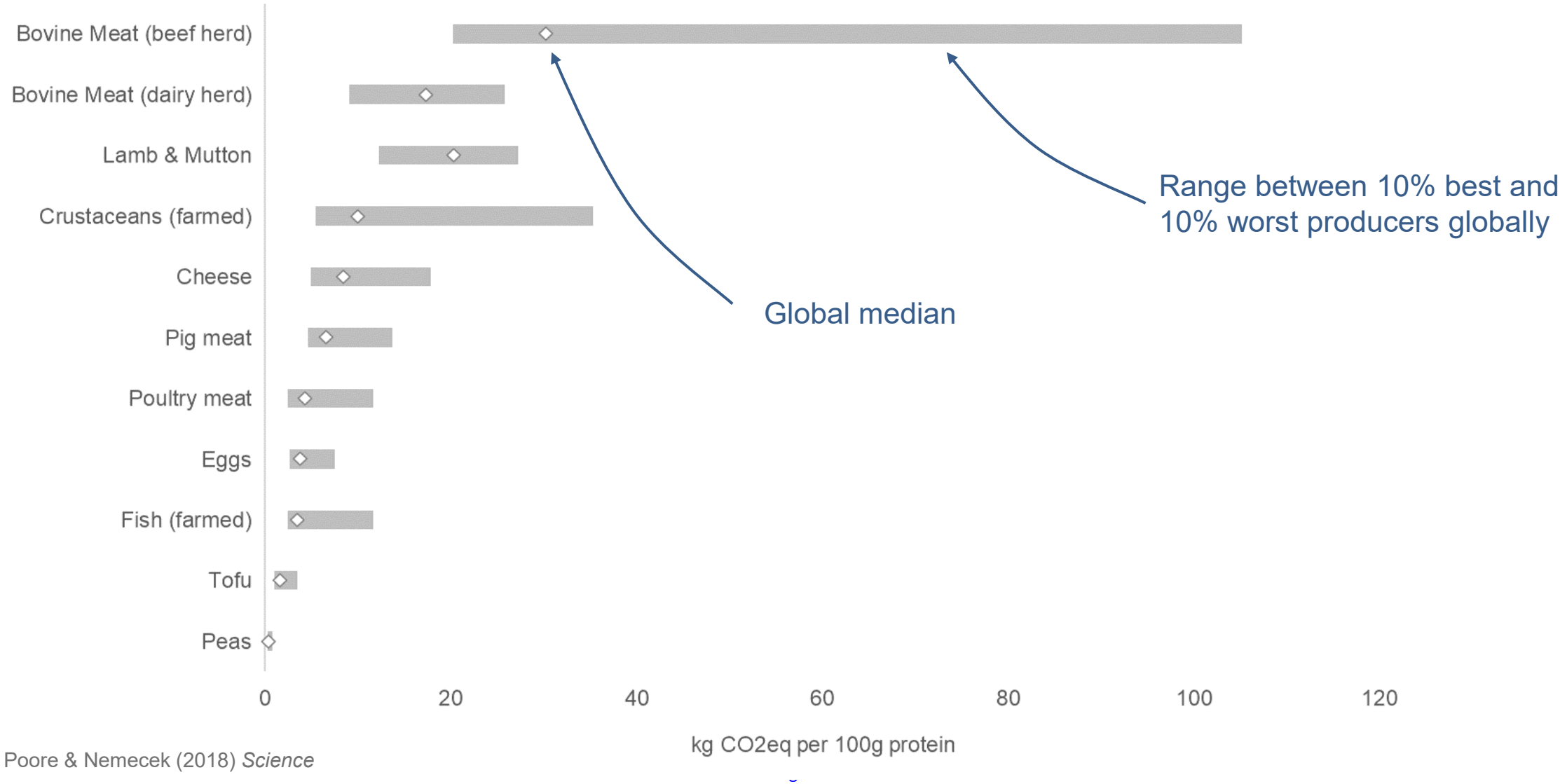
Source: Crippa et al. (2021), *Nature Food*. Also see Tubiello et al. (2021) and IPCC (2019).

Products differ strongly in terms of average impact



Source: Poore & Nemecek (2018) *Science*

But there is also enormous variability across producers



Source: Poore & Nemecek (2018) *Science*

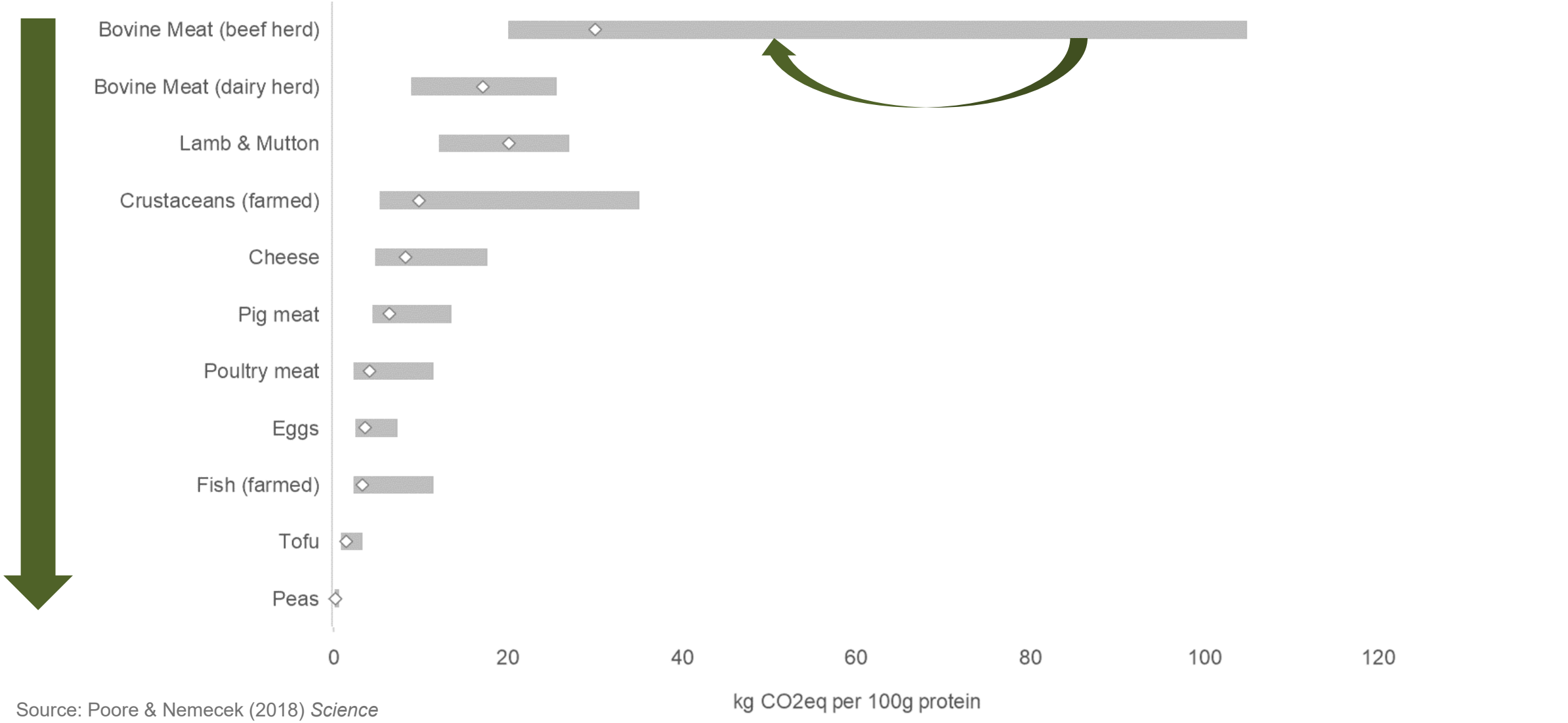
Three levers to achieve lower emissions

Shift to lower-emissions *product categories*

Shift to lower-emissions *producers* (within each category)

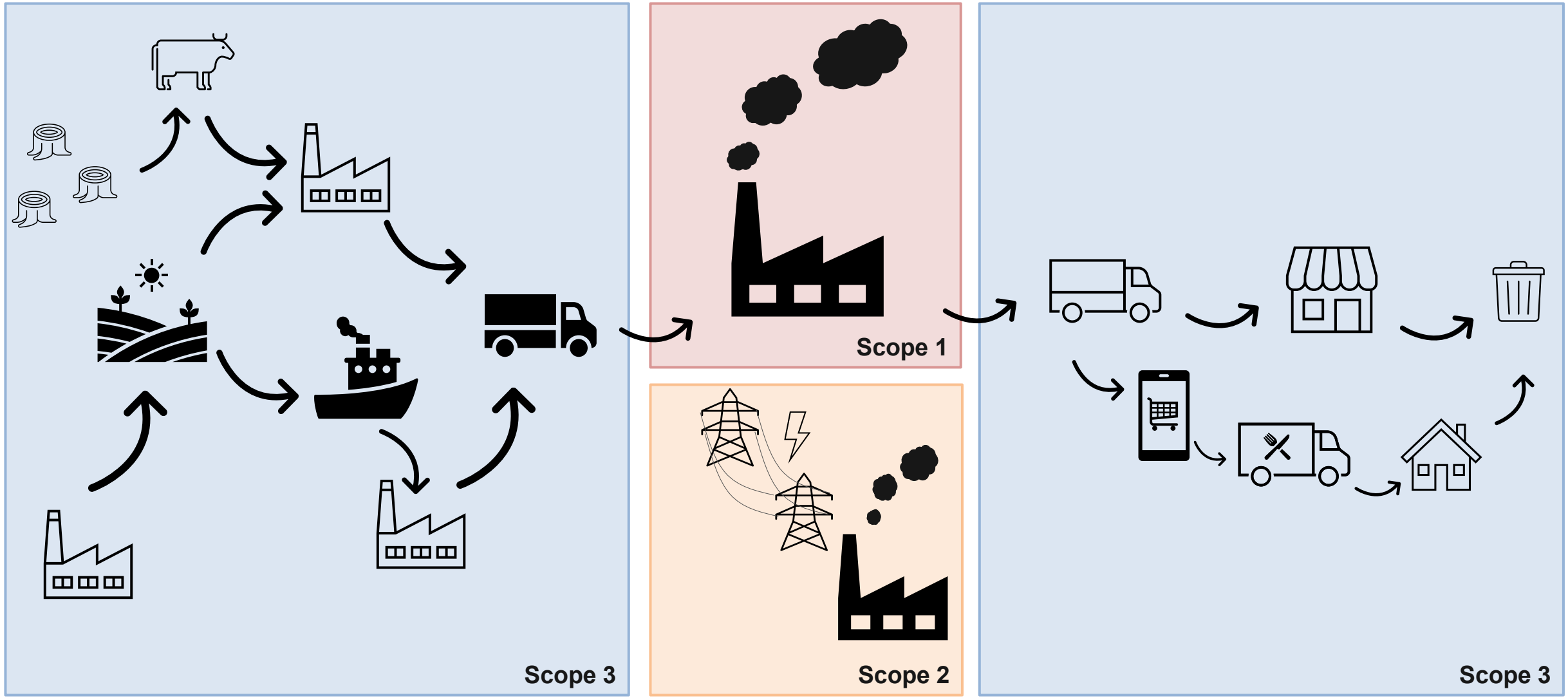
Shift to lower-emissions *techniques* (everywhere)

Three levers to achieve lower emissions



Source: Poore & Nemecek (2018) *Science*

There is growing pressure on firms to report **Scope 3** emissions, in addition to Scope 1 and 2



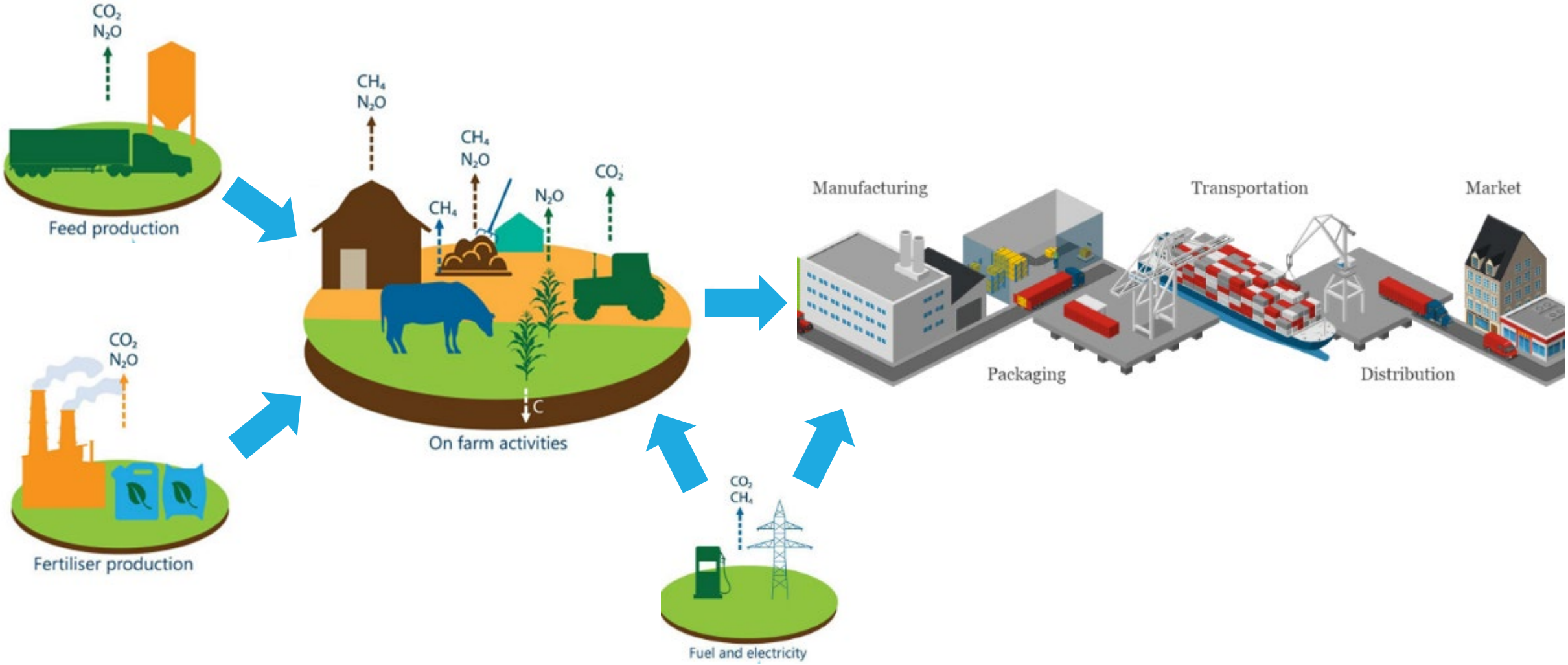
Leading retailers are setting **Scope 3 targets** – which will directly impact ag/food suppliers

SCIENCE BASED TARGETS

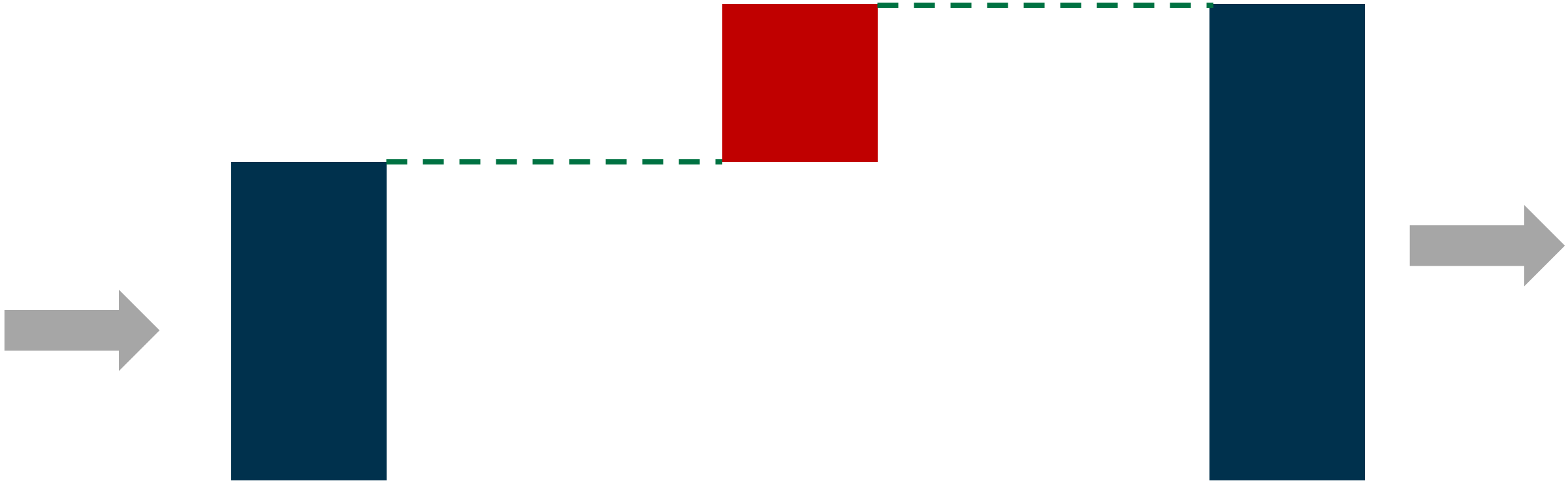
AEON	**Aeon** (Japan)	• 80% of suppliers (by emissions) will set science-based targets	K	**Kesko** (Scandinavia, Baltics)	• 67% of suppliers (by spend) will have science-based targets by 2026
Ahold Delhaize	**Ahold Delhaize** (Belgium, Netherlands, USA)	• **Reduce Scope 3 emissions by 37%** (2030 vs 2018)	MIGROS	**Migros** (Switzerland)	• 67% of suppliers (by emissions) will have science-based targets by 2026
ALDI ALDI	**Aldi** (N & S) (Europe, USA)	• 75% of suppliers (by emissions) will have science-based targets by 2024	TESCO	**Tesco** (UK, EU)	• **Reduce Scope 3 emissions to net zero by 2050**
Carrefour	**Carrefour** (Europe, LatAm, MENA)	• **Reduce Scope 3 emissions by 29%** (2030 vs 2019)	Walmart	**Walmart** (US, Canada, LatAm, Asia)	• Reduce Scope 3 emissions by one billion tonnes (2030 vs 2015)
ICA	**ICA** (Sweden, Norway, Baltics)	• 70% of suppliers (by emissions) will set science-based targets by 2025	Woolworths	**Woolworths** (Australia)	• Reduce Scope 3 emissions by **19%** (2030 vs 2015)

Source: https://sciencebasedtargets.org/companies-taking-action
and https://www.aholddelhaize.com/news/ahold-delhaize-sets-updated-co2-emissions-reductions-targets-for-its-entire-value-chain-in-line-with-un-goal-of-keeping-global-warming-below-1-5-c/

So the demand for data is growing…
but what would it take to **move beyond averages**?



The PACT principle: cradle-to-gate product carbon footprints as basis for Scope 3 reporting

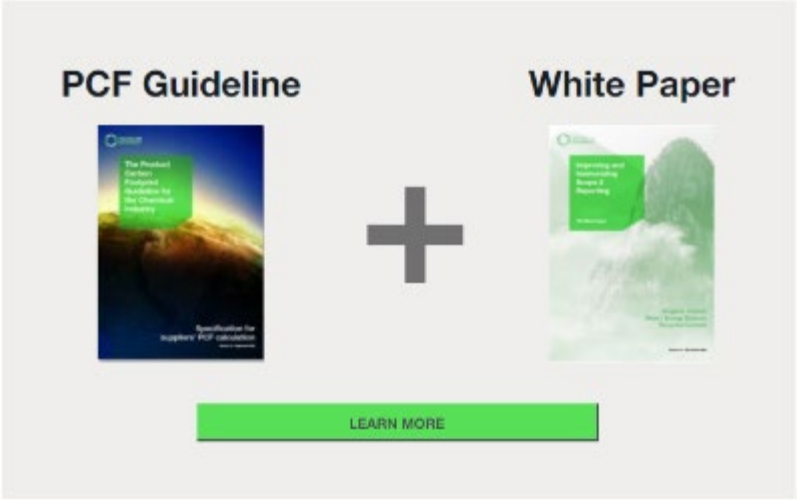


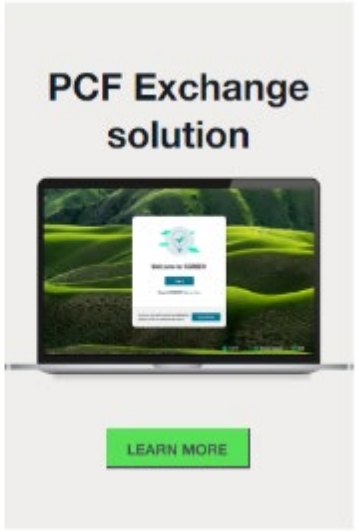
PACT
PARTNERSHIP FOR CARBON TRANSPARENCY

Some sectors are doing it already…

TOGETHER FOR SUSTAINABILITY

- Together for Sustainability (TfS), association of the chemicals industry
- 53 member firms, including AkzoNobel, Dow, Henkel, Merck, and agri-input firms BASF, Bayer, Corteva, Syngenta, SABIC, Yara
  - Together, USD 800 billion in revenues
- Detailed standard for product carbon footprint (PCF) in chemicals
- Developed digital platform to automate the exchange of PCF data
- Consistent with PACT principles

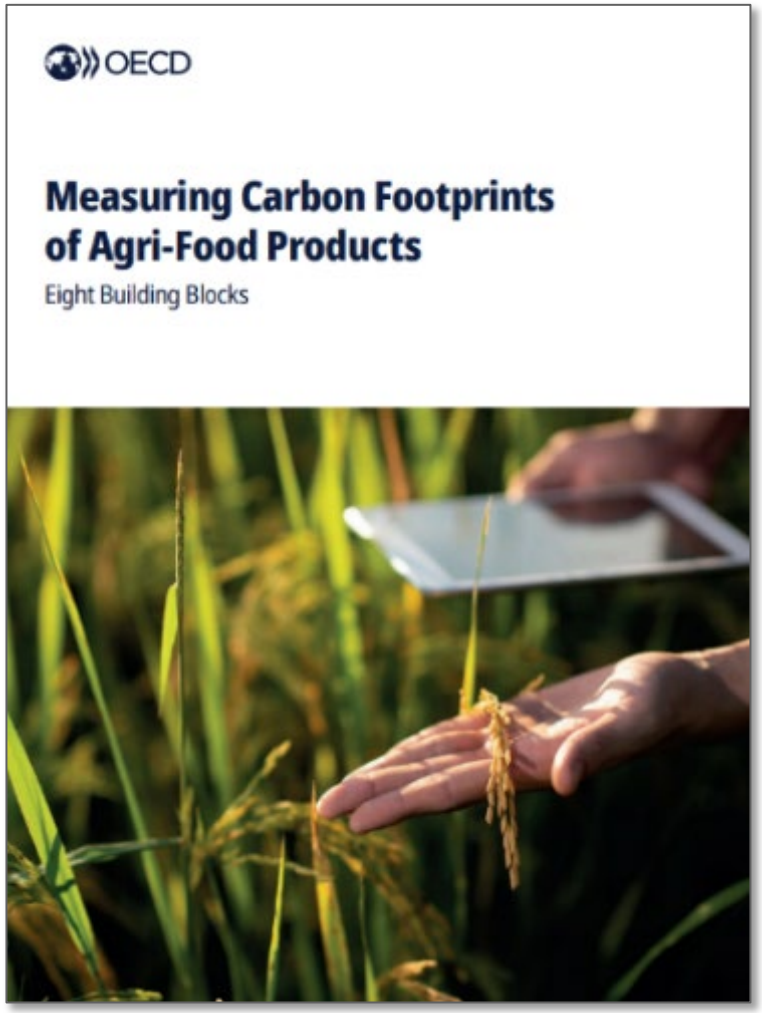




What would this take in food supply chains? At least **eight building blocks**…

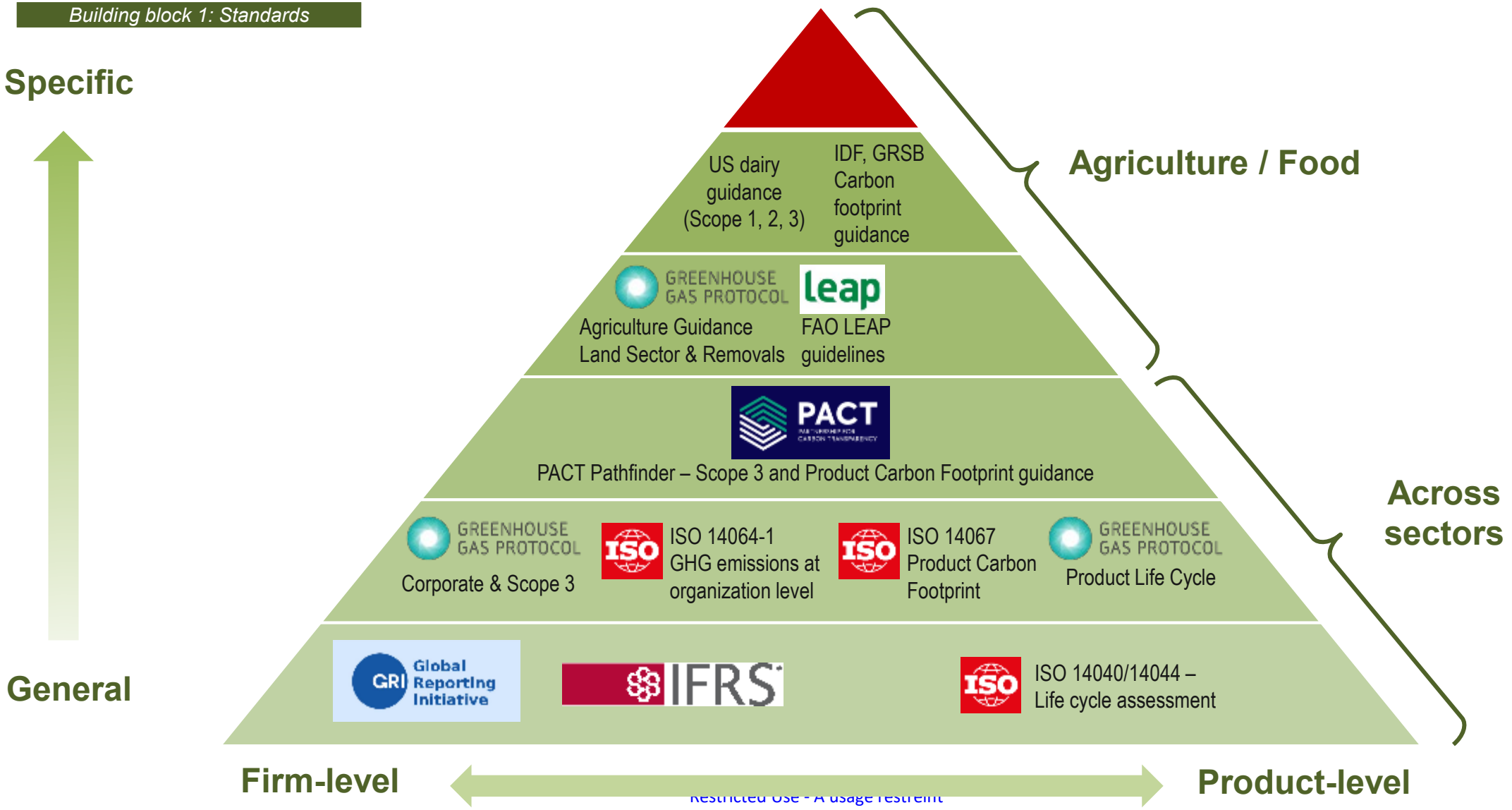
1. Reporting standards and guidelines
2. Up-to-date science-based methods
3. Farm-level calculation tools
4. Databases with secondary data
5. A way of communicating carbon footprint data along the supply chain
6. A way to ensure the integrity and quality of the data
7. A way to scale up carbon footprint calculations while keeping costs low
8. A way to update these elements as new insights and technologies emerge

These building blocks are falling into place!



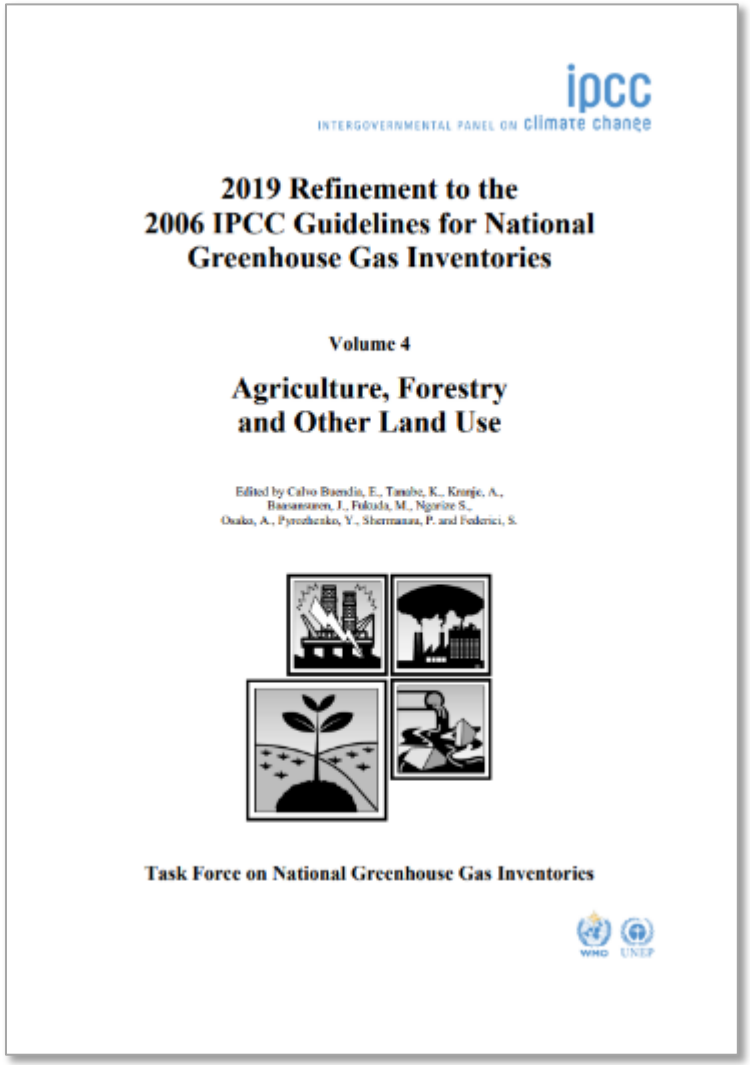
The landscape of **reporting standards and guidelines** for carbon footprints of food products

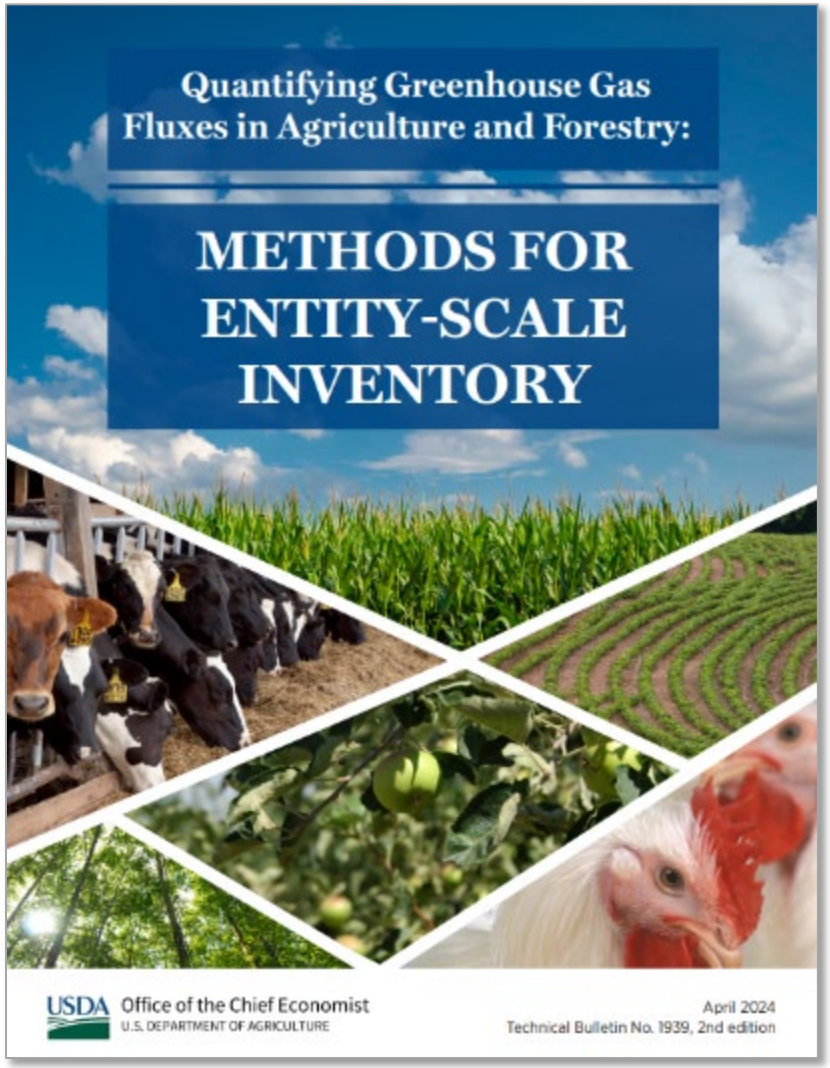
Building block 1: Standards



Science-based methods are reviewed by IPCC and by some governments – but we could use more research

Building block 2: Science-based methods





Farm-level tools are used to estimate emissions
Example: FARM ES tool (US dairy)

Building block 3: Farm level tools

Reporting Guidance

Milk Production

Total annual milk production *Pounds of milk shipped, used ON-farm, or other*	_____ **lbs.**
Average milk protein content *Enter true protein content*	_____ **%**
Average milk fat content	_____ **%**

Report total milk production for a consistent year, including pounds sold, used on-farm or other, as well as the average milk protein content and milk fat content.

Source: https://nationaldairyfarm.com/dairy-farm-standards/environmental-stewardship/

Farm-level tools are used to estimate emissions
Example: FARM ES tool (US dairy)

Building block 3: Farm level tools

Herd Size

Annual average herd size *Lactating and dry cows*	_____ **cows**
Annual average dry cows *% of total cows*	_____ **%**
Annual average number of heifer calves:	
Less than 2 months raised ON-farm	_____ **calves**
Less than 2 months raised OFF-farm	_____ **calves**

Source: https://nationaldairyfarm.com/dairy-farm-standards/environmental-stewardship/

Farm-level tools are used to estimate emissions
Example: FARM ES tool (US dairy)

Building block 3: Farm level tools

Feed Ingredient	As-Fed *lbs./day*	Average % Dry Matter Content	Dry Matter Intake *lbs./day*	Feed Ingredient % of Total DMI *(dry matter basis)*
Corn grain (including cracked, ground and steam-flaked)	X	85%	=	
Corn silage	X	35%	=	
Wet DGS	X	40%	=	
Dry DGS	X	91%	=	
Soybean (raw or roasted)	X	91%	=	

Source: https://nationaldairyfarm.com/dairy-farm-standards/environmental-stewardship/

Farm-level tools are used to estimate emissions
Example: FARM ES tool (US dairy)

Building block 3: Farm level tools

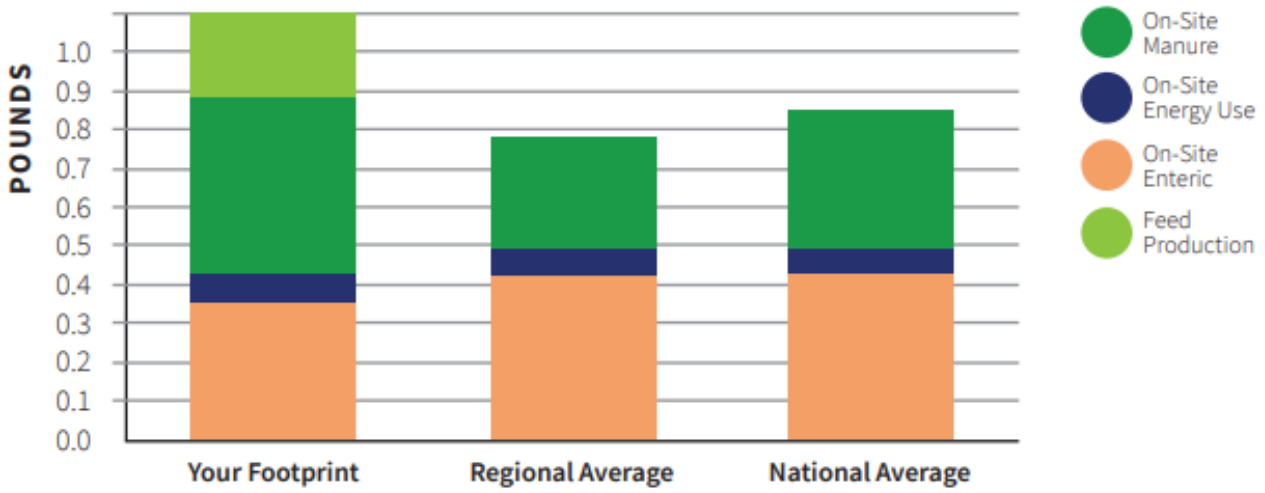
System	Description	% of Manure
Daily spread	Manure is collected and land applied within 24 hours.	%
Solid storage	Storage of manure, often for several months, in unconfined piles or stacks.	%
Dry lot	A paved or unpaved open confinement area without any significant vegetative cover where accumulating manure may be removed periodically.	%
Liquid/slurry with natural crust	Often in earthen structures, basins or tanks. Slurry is usually between 5% and 15% dry matter. There is little added water. A natural crust is allowed to form.	%
Liquid/slurry without natural crust	Often in earthen structures, basins or tanks. Slurry is usually between 5% and 15% dry matter. There is little added water. A natural crust is NOT allowed to form.	%
Uncovered anaerobic lagoon	Lagoons combine waste stabilization, treatment and storage. Water is added. Solids volume is typically less than 5%. Uncovered lagoons are open to the ambient air.	%
Covered anaerobic lagoon	Lagoons combine waste stabilization, treatment and storage. Water is added. Solids volume is typically less than 5%. Uncovered lagoons are open to the ambient air.	%

Source: https://nationaldairyfarm.com/dairy-farm-standards/environmental-stewardship/

Farm-level tools are used to estimate emissions
Example: FARM ES tool (US dairy)

Figure 1. Your Farm Greenhouse Gas Emissions

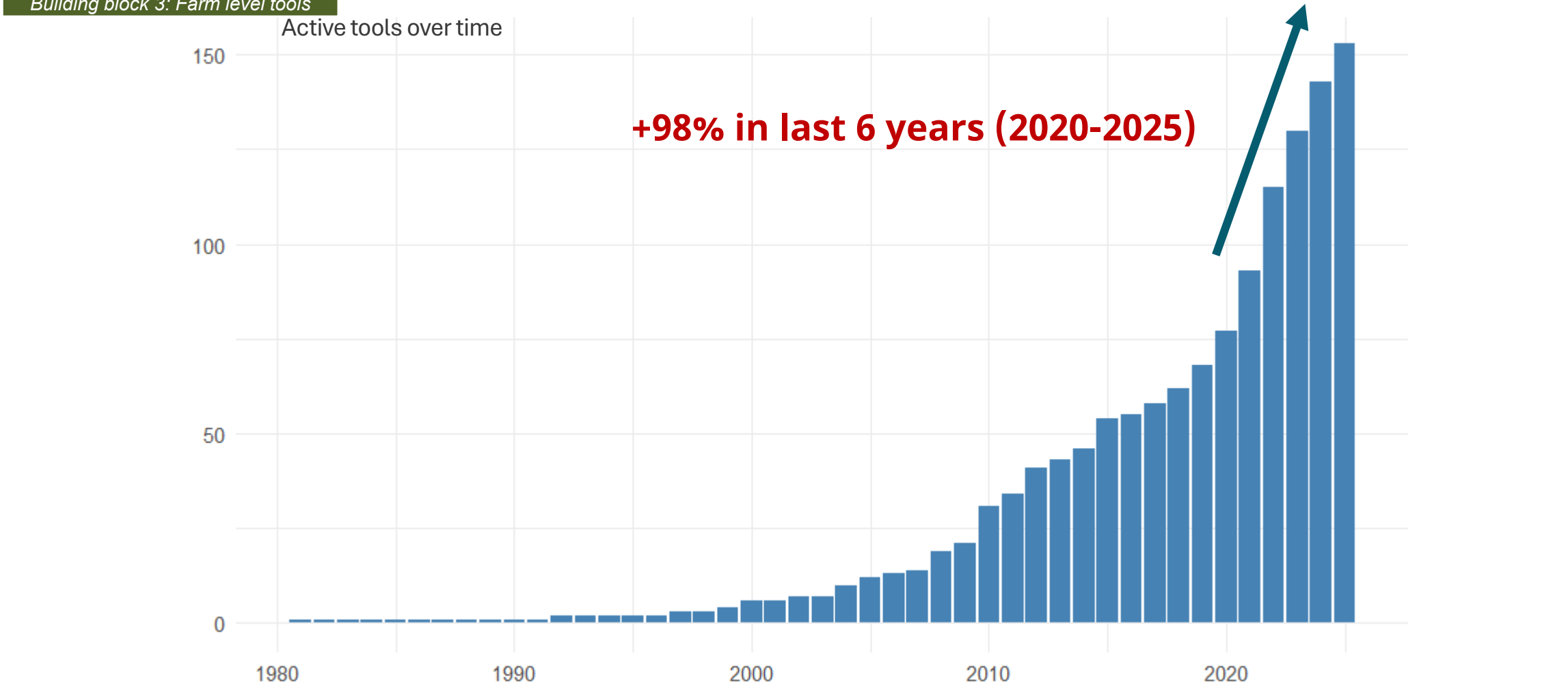
lb CO_2e / lb FPCM produced



	Your Footprint	Regional Average	Regional Difference	National Average	National Difference
Feed Production	0.187				
On-Site Manure	0.467	0.296	*-0.171*	0.358	*-0.109*
On-Site Energy Use	0.057	0.072	*0.015*	0.067	*0.009*
On-Site Enteric	0.367	0.418	*0.051*	0.431	*0.064*
TOTAL (without Feed Production)	**0.891**	**0.786**	***-0.105***	**0.856**	***-0.035***
TOTAL	**1.079**				

The number of **calculation tools** is growing

Building block 3: Farm level tools



Source: Preliminary results from internal OECD research, n = 176 (Year of release is NA: 13)

There is also a growing body of **evidence and data** which can be used as **inputs** for calculations – or as **default** values

Building block 4: Secondary data

Reducing food's environmental impacts throug and consumers

J. Poore[1,2]* and T. Nemecek[3]

Food's environmental impacts are cre
that are effective under this heteroge
indicators; 38,700 farms; and 1600 p
50-fold among producers of the same
However, mitigation is complicated by
impacts, and interactions throughout
reduce impacts. Most strikingly, impa
those of vegetable substitutes, provid
Cumulatively, our findings support an
flexibly meet environmental targets by
impacts to consumers.

Environmental performance of blue foods

Jessica A. Gephart, Patrik J. G. Henriksson, Robert W. R. Parker, Bergman, Gidon Eshel, Christopher D. Golden, Benjamin S. Halpe, Metian, Kathleen Mifflin, Richard Newton, Peter Tyedmers, Wenb

Nature 597, 360–365 (2021) | Cite this article

41k Accesses | 115 Citations | 397 Altmetric | Metrics

Abstract

Fish and other aquatic foods (blue foods) present an opp
diets[1,2]. Yet comprehensive comparison has been limited
foods in environmental impact studies[3,4] relative to the v
provide standardized estimates of greenhouse gas, nitro
land stressors for species groups covering nearly three q
that across all blue foods, farmed bivalves and seaweeds
Capture fisheries predominantly generate greenhouse g
fishes generating lower emissions than all fed aquacultur
generating the highest. Among farmed finfish and crusta

PNAS RESEARCH ARTICLE | ENVIRONMENTAL SCIENCES SUSTAINABILITY SCIENCE | OPEN ACCESS

Estimating the environmental impacts of 57,000 food products

Michael Clark[a,b,c,d,1], Marco Springmann[a,b], Mike Rayner[a], Peter Scarborough[a,e], Jason Hill[f], David Tilman[g,h], Jennie I. Macdiarmid[i], Jessica Fanzo[j,k], Lauren Bandy[a,l], and Richard A. Harrington[a,e]

Edited by B. Turner, Arizona State University, Tempe, AZ; received November 22, 2021; accepted June 21, 2022

Understanding and communicating the environmental impacts of food products is key to enabling transitions to environmentally sustainable food systems [El Bilali and Allahyari, Inf. Process. Agric. 5, 456–464 (2018)]. While previous analyses compared the impacts of food commodities such as fruits, wheat, and beef [Poore and Nemecek, *Science* 360, 987–992 (2018)], most food products contain numerous ingredients. However, because the amount of each ingredient in a product is often known only by the manufacturer, it has been difficult to assess their environmental impacts. Here, we develop an approach to overcome this limitation. It uses prior knowledge from ingredient lists to infer the composition of each ingredient, and then pairs this with environmental databases [Poore and Nemecek *Science* 360, 987–992 (2018); Gephart et al., Nature 597, 360–365 (2021)] to derive estimates of a food product's environmental impact across four indicators: greenhouse gas emissions, land use, water stress, and eutrophication potential. Using the approach on 57,000 products in the United Kingdom and Ireland shows food types have low (e.g., sugary beverages, fruits, breads), to intermediate (e.g., many desserts, pastries), to high environmental impacts (e.g., meat, fish, cheese). Incorporating NutriScore reveals more nutritious products are often more environmentally sustainable but there are exceptions to this trend, and foods consumers may view as substitutable can have markedly different impacts. Sensitivity analyses indicate the approach is robust to uncertainty in ingredient composition and in most cases sourcing. This approach provides a step toward enabling consumers, retailers, and policy makers to make informed decisions on the environmental impacts of food products.

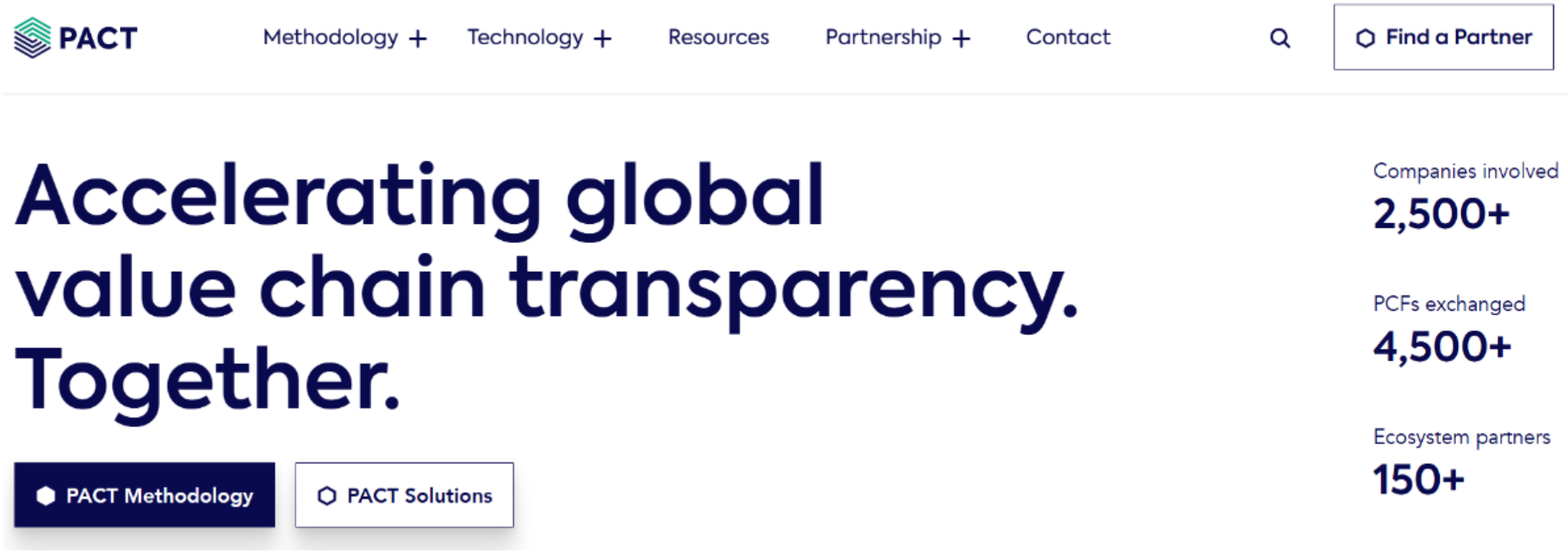
food system sustainability | environmental impact of food | ecolabelling

Significance

One barrier to enabling transitions to more environmentally sustainable food systems is the lack of detailed environmental impact information. We provide an initial approach to overcome this barrier using publicly available information to derive first estimates of the environmental impact of >57,000 food products across four indicators: greenhouse gas emissions, land use, water stress, and eutrophication potential. Pairing it with a measure of nutrition shows a tendency for more nutritious foods to be more environmentally sustainable, and that like-for-like substitutes can have highly

Sharing data along the supply chain – several initiatives are up and running

Building block 5: Sharing data along the supply chain



Sharing data along the supply chain – several initiatives are up and running

Building block 5: Sharing data along the supply chain

Pilot project with PACT to get carbon footprint data directly from suppliers – currently involving top-300 suppliers (almost half of total upstream emissions)

Chemicals industry association (53 companies including BASF, Bayer, Corteva, SABIC, Syngenta, Yara, AkzoNobel, Dow, Henkel, Merck, Solvay) - developed digital platform for automated carbon footprint sharing among the firms

Several platforms exist to enable secure data sharing between farmers and their customers and suppliers, e.g. DjustConnect in Belgium

Farm level tools increasingly have API or other ways of easily sharing results with others

How can we **assure the quality** of the data?

- Options: First, second, or third party verification
- Challenge 1: Currently this does not evaluate methods…
- Challenge 2: Currently expensive and hard to scale…

How to **scale it up**? How to make it easy?
Example: Ireland

Building block 7: Scaling it up

- **Carbon footprints** as part of the Origin Green sustainability assurance scheme
- Since 2013, **some 370,000** carbon footprints have been calculated
- Covers **90%** of beef farms and **95%** of dairy farms

Source: https://www.bordbia.ie/farmers-growers/prices-markets/agri-market-insights/improving-carbon-footprint-reporting/

How to **update and align** all these elements?

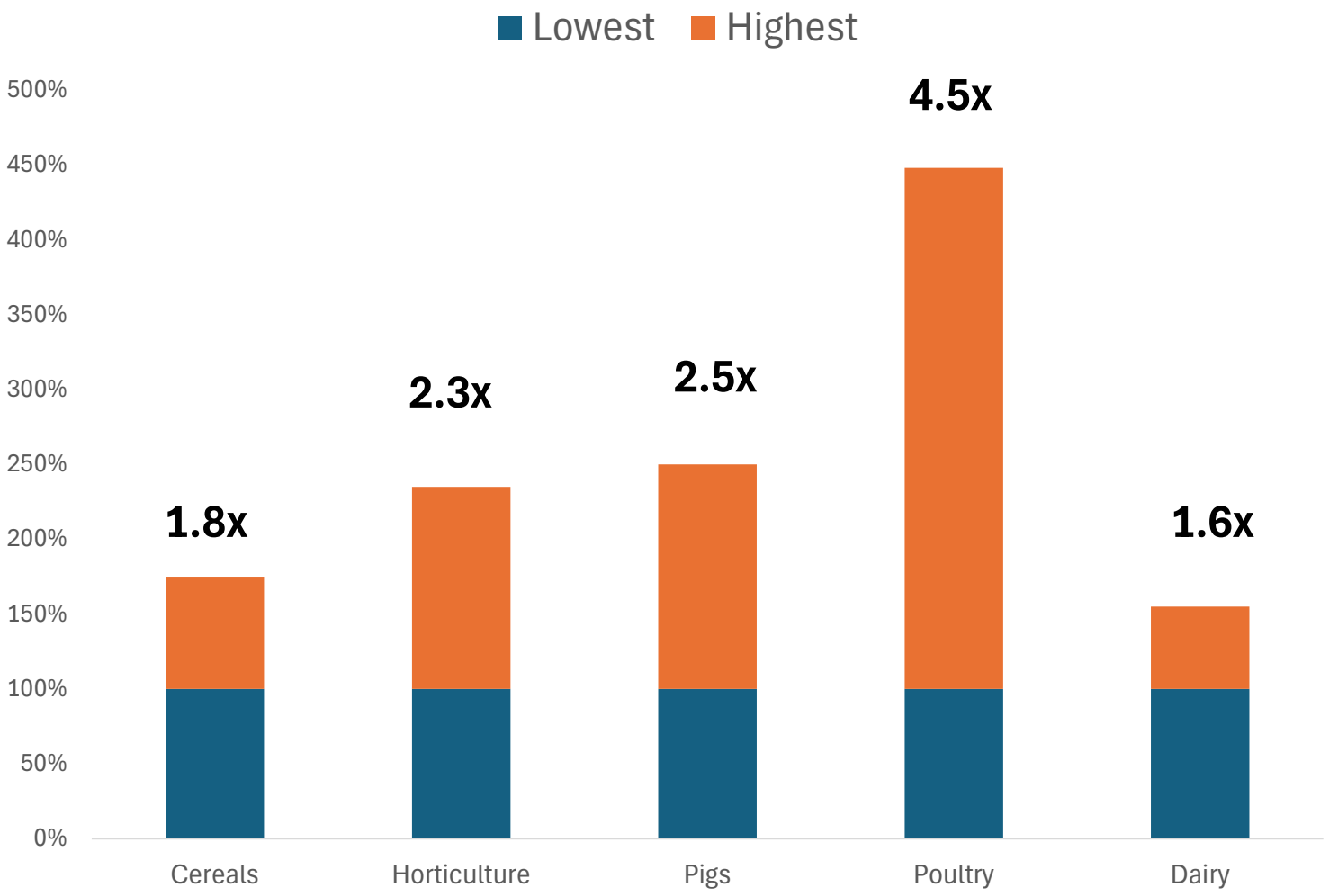
Building block 8: Updating and alignment

- Many moving parts and all need to be **aligned – and updated**
- Example: new reporting requirement (e.g. separate reporting of soil carbon)
  - Farm level tools and LCA databases need to be updated
  - Technology solutions for data transfer may need to be updated
- Example: more precise scientific methods
  - When do we decide to implement these
- We need to think more carefully about **how and when we update** our methods, databases, …
- Could **regular review and update cycles** be a solution?

Collaboration or fragmentation?

The IDF global carbon Footprint standard for the dairy sector

Same farm + different tool = different results…



This causes problems:

- **Confusion** for farmers, consumers, and others
- **Transaction costs** of having to deal with different tools and methods
- Possible **trade barriers** or **disputes**

Source: RSK Adas, 2023, evaluating six commonly used tools in the UK (selected examples)

IRISH FARMERS JOURNAL

New Zealand dairy farming almost 40% more carbon-efficient than in Ireland

New study shows New Zealand dairy farming is by far the most carbon-efficient in the world and almost 40% more carbon efficient than Irish milk production.

A dairy farm on the South Island in New Zealand.

New Zealand milk production is almost 40% more carbon-efficient than milk produced in Ireland, according to a new study by New Zealand researchers.

29 January 2021

IRISH FARMERS JOURNAL

Teagasc calls foul on New Zealand's carbon claims

The Irish agri research and advisory body Teagasc has very quickly responded to carbon claims published in New Zealand.

Comparing carbon budgets is not easy and Teagasc states the New Zealand report got it wrong.

Teagasc has suggested a recent carbon report published in New Zealand contains errors, uses a mix of methodologies, uses old data and fails to reward recent advances in Irish nutrient efficiency.

2 February 2021

A possible way forward?

Methods

- Countries define a **domestic reference method** for estimating farm-level GHG emissions
- Countries promote **domestic convergence** on this method
- National experts **review** each other's reference methods, possibly leading to mutual recognition

Tools

- International set of **best practices** for farm-level tools, e.g.
  - Use reference method if available
  - Use internationally accepted standards (ISO 14067, GHG Protocol, etc)
- Potentially **certification** against these best practices?

Reporting standards

- Alignment of carbon footprint standards for agri-food products (several initiatives underway)
- Requirement to use appropriate (certified?) tools – using reference methods

OECD is convening policy makers and experts to work together to avoid fragmentation

Our publications so far


European Review of Agricultural Economics Vo
doi:https://doi.org/10.1093/erae/jbad018
Advance Access Publication 2 August 2023

Fast and furious: the
impact reporting in f

Koen Deconinck*, Marion Jar

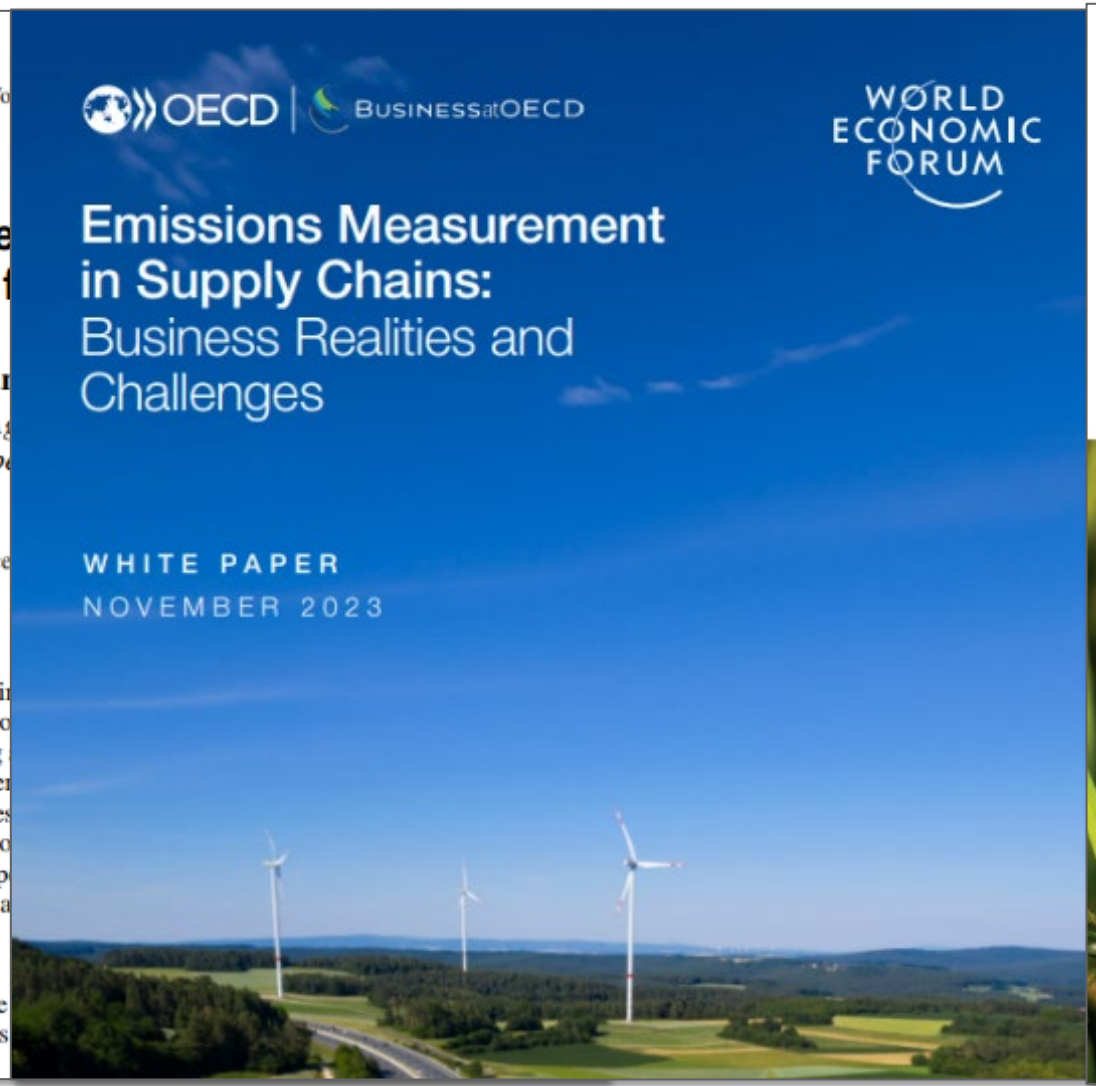
All authors are at the Trade and Ag
Organisation for Economic Co-ope
France

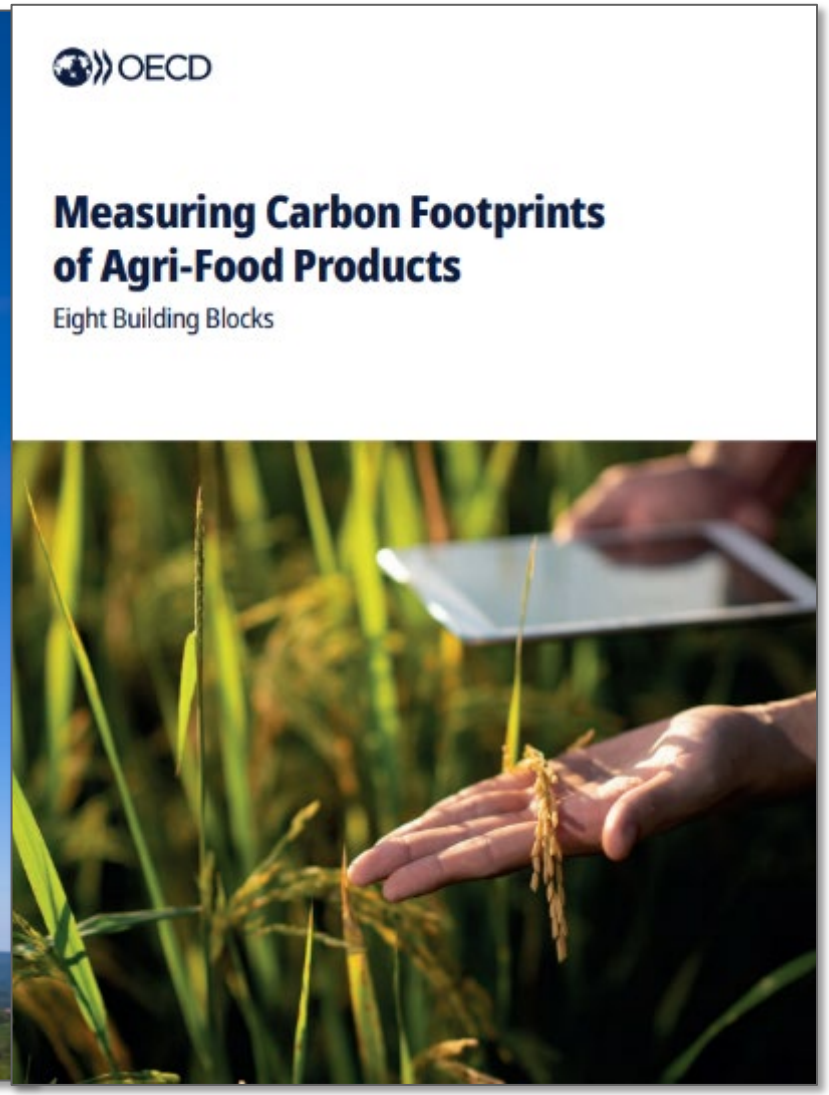
Received January 2023; final version acce

Abstract

Powerful long-term drivers are increasi
environmental impact information in foo
tives underway) and furious (presenting
little attention from economists. Better
efforts to reduce environmental pressures
and reporting requirements could lead to
risk that poor producers will be disprop
drivers, impacts and potential pitfalls, a
questions.

Keywords: carbon footprint, life-cycle
ronmental reporting, food supply chains





We need the perspective of ag / trade economics here

- How would these trends affect agricultural **trade** flows?
- How would these trends affect producers in **low- and middle-income countries**?
- How would these trends affect the **organization of value chains**, and value sharing?
- What is the optimal **institutional setup** to measure and communicate carbon footprints?
- How will **consumers** react in response to labeling?
- Will **farmers** with a better footprint receive a price premium?
- What is the scope for **harmonization** or **mutual recognition**?
- What can we learn from the literature on **standards** (e.g. food safety)?

Economists have some catching up to do…

Scopus search results

‘carbon footprint’ and ‘food’	3897

Subset: Economics	277
Resources Conservation and Recycling	82
Environment Development and Sustainability	20
Ecological Economics	20
Food Policy	13
International Journal on Food System Dynamics	6
Cleaner and Responsible Consumption	5
Clean Technologies and Environmental Policy	5
International Journal of Production Economics	4
Environmental and Resource Economics	4
Cleaner and Circular Bioeconomy	4
International Journal of Agricultural Sustainability	3
…	…

Thank you!

Jan Fabre, ‘The Man Who Measures The Clouds’ (1998)