Carbon Footprints for Food Systems

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

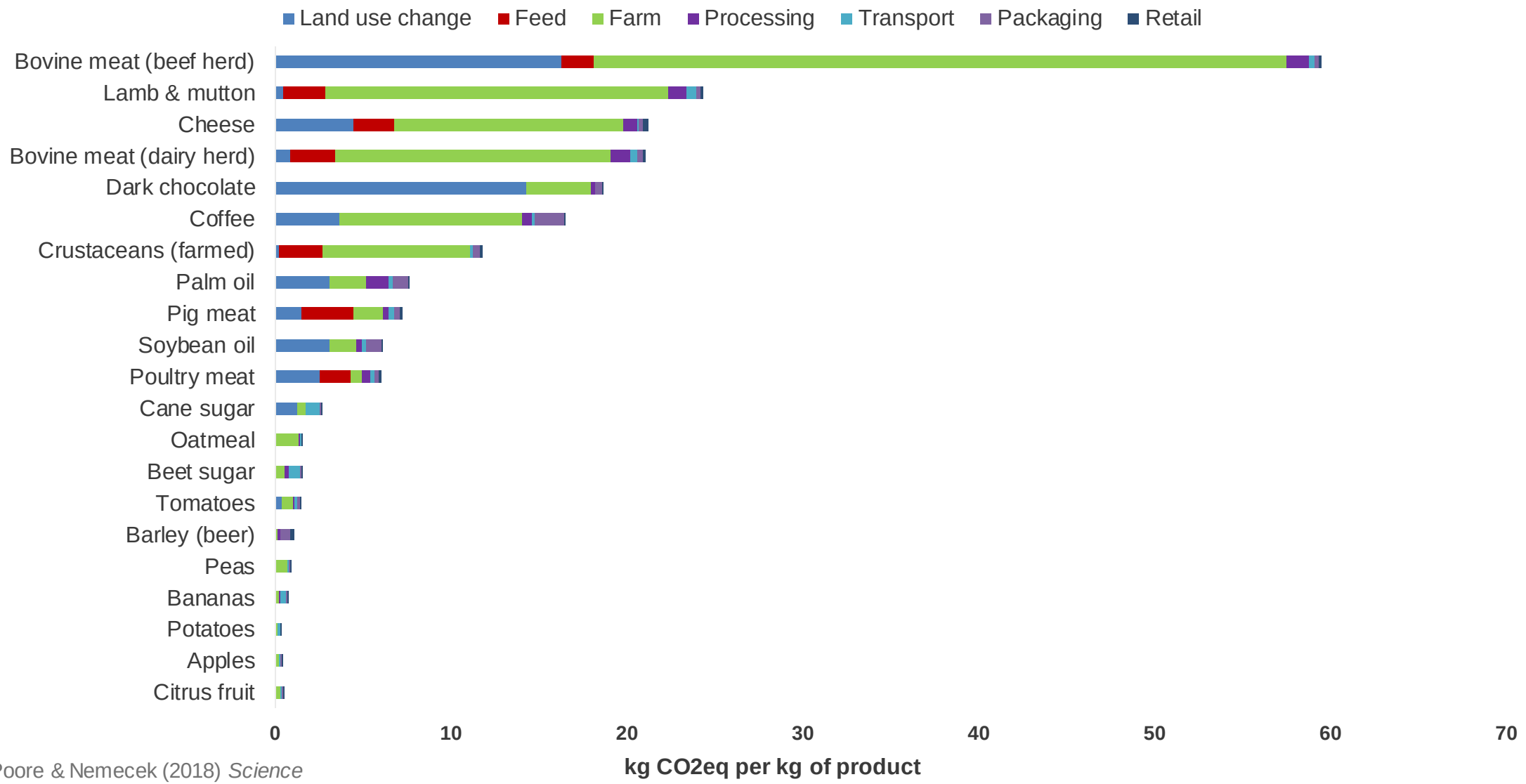
Source: OECD (2021), Making Better Policies for Food Systems; OurWorldInData; Crippa et al. (2021)

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

Food systems GHG emissions by supply chain stage

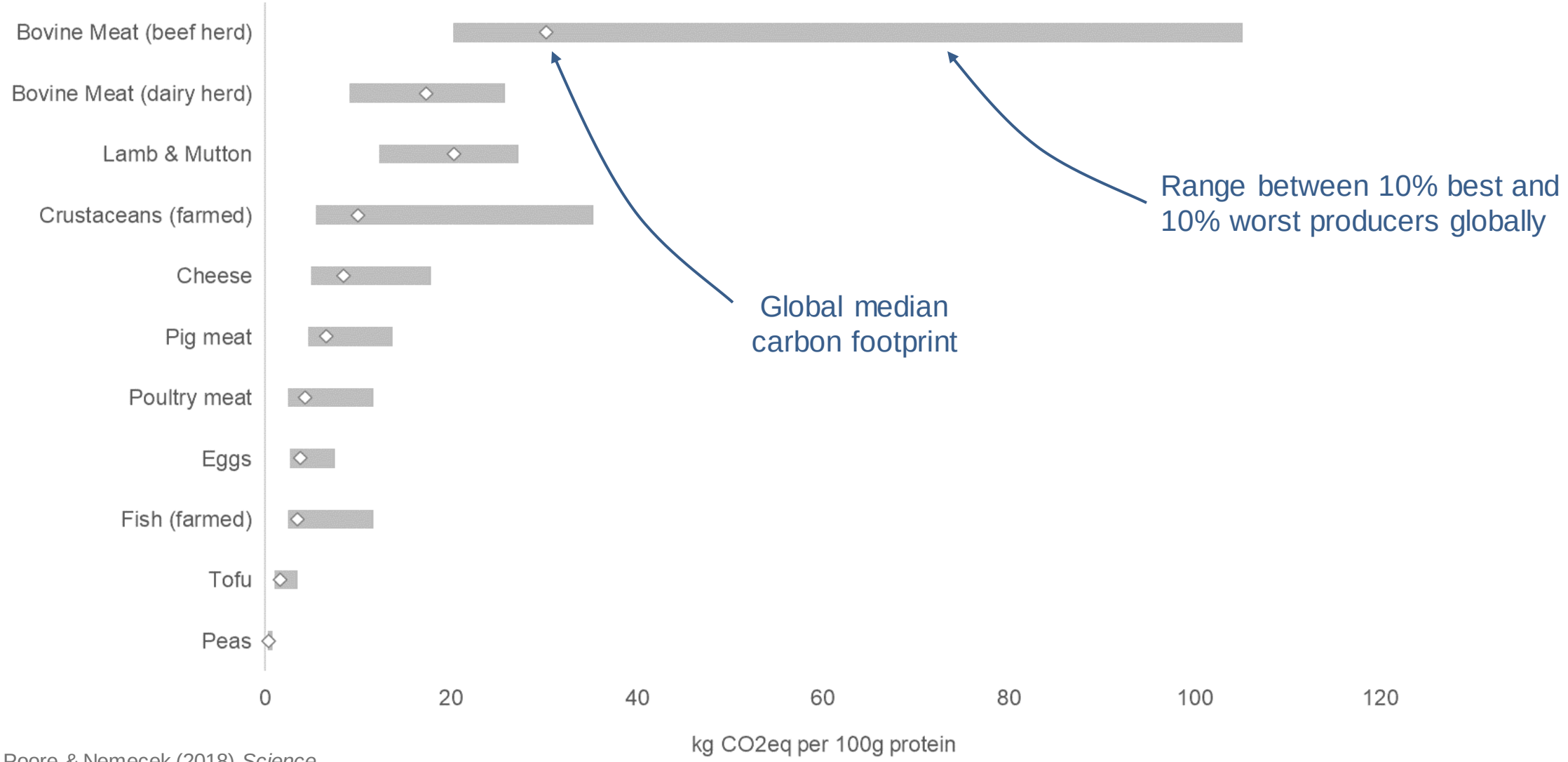
Source: Crippa et al. (2021), *Nature Food*. Also see Tubiello et al. (2021) and IPCC (2019)

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*

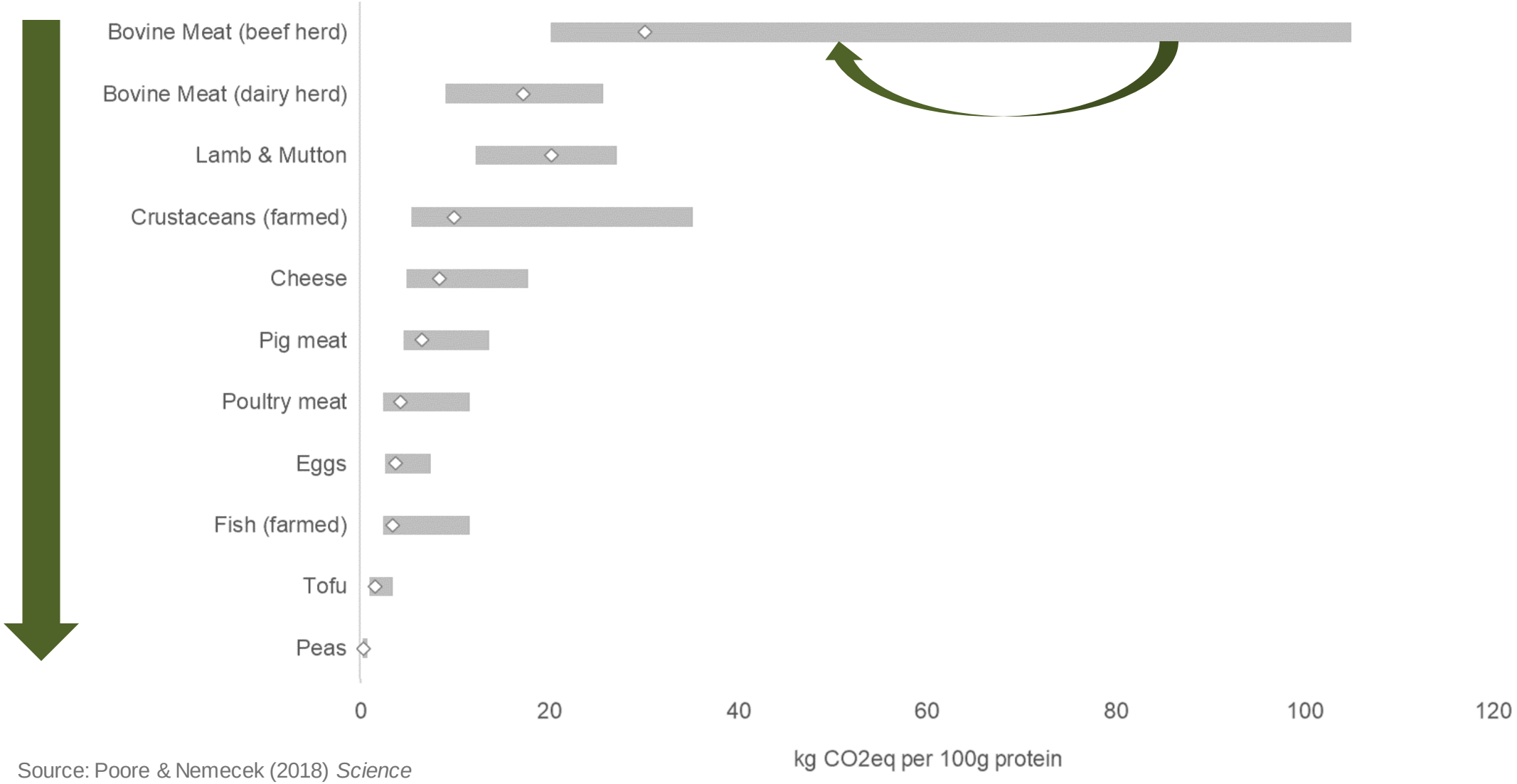
Three levers to achieve lower emissions in food systems

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 in food systems



Source: Poore & Nemecek (2018) *Science*

But you can’t mitigate what you don’t measure…

Product-level emissions
(at all stages of the life cycle)

Firm-level emissions
(farm & non-farm)

Project-level emissions
(impact of actions)

Carbon footprints for food systems

“This is science fiction”

- *“It’s too expensive to do this”*
- *“There are too many farms to make this practical”*
- *“It’s unclear what and how to measure and report”*
- *“It’s difficult to transmit this information along the supply chain”*
- *“There’s no demand for this information”*

… really?

A great acceleration, driven by several factors

Demand

- Consumers
- Investors
- Governments
- Civil society

Supply

- Calculation tools
- Evidence and data
- Platforms
- Technological solutions
- Reporting standards

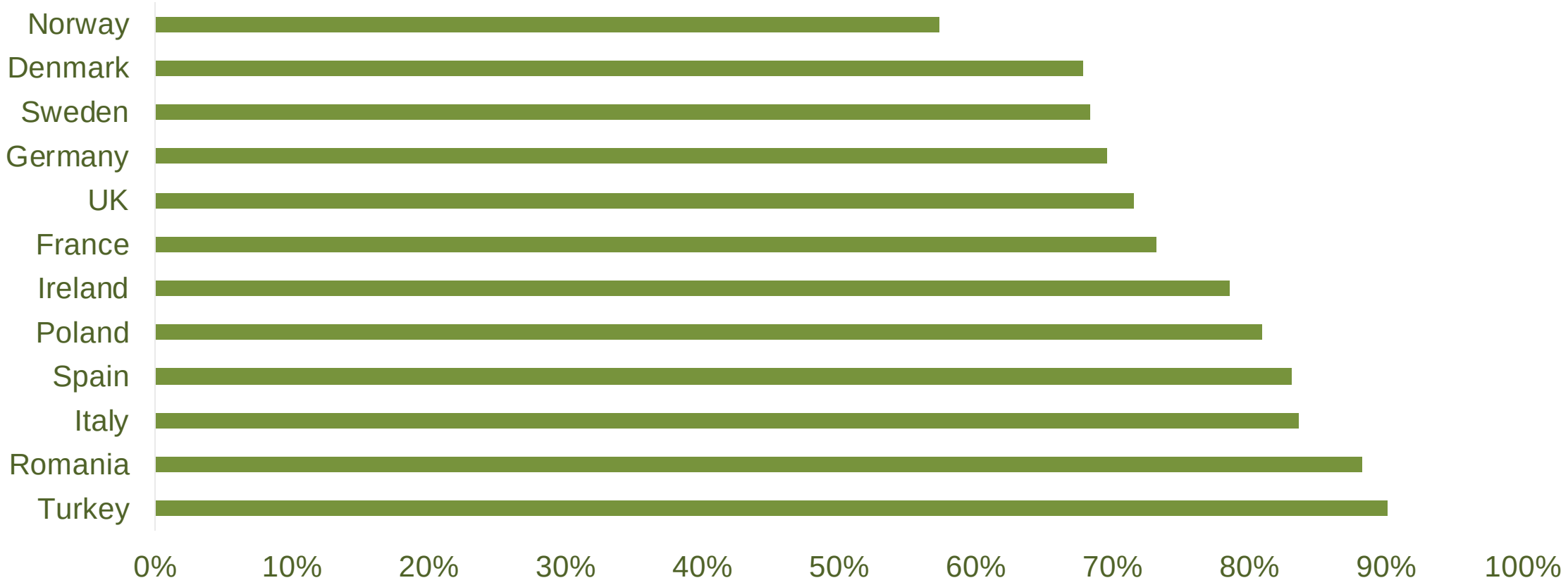
Broader trends

- Supply chain thinking
- Transparency & traceability
- Growing focus on outcomes (rather than practices)

Consumers want better information

Demand *Consumers*

Consumer support for carbon footprint labels on food items (February 2023)



Source: https://www.yara.com/corporate-releases/strong-european-consumer-demand-for-sustainable-food/

Carbon footprint claims and labels are proliferating

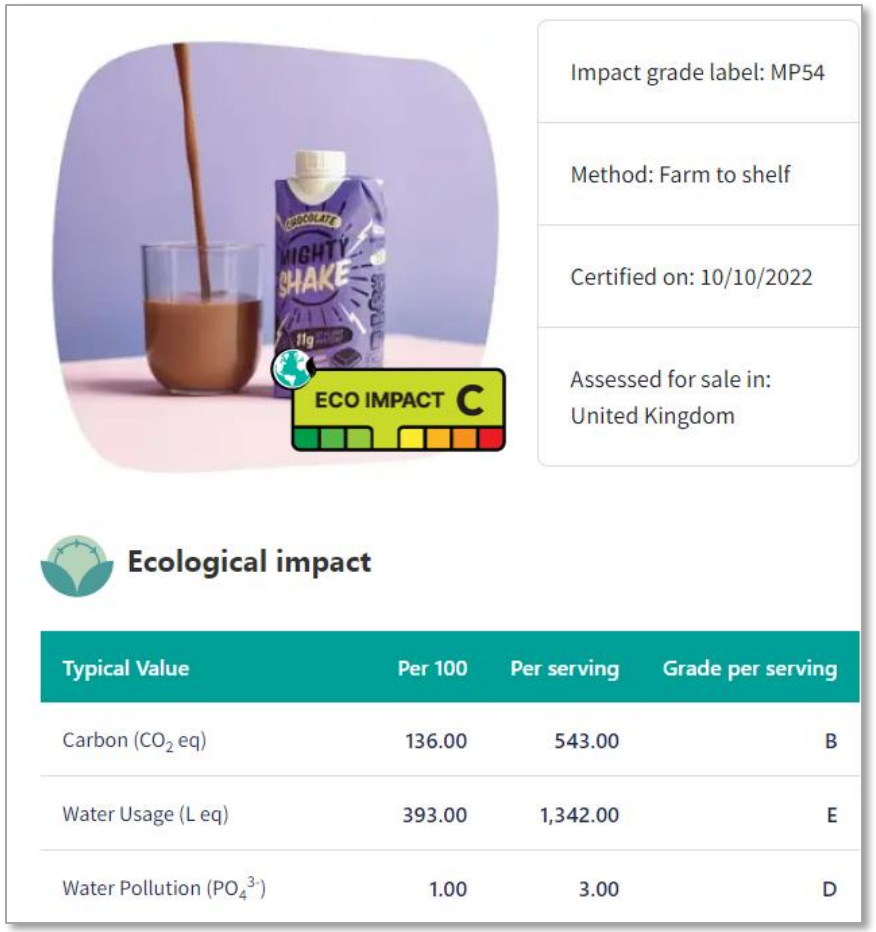
Demand | Consumers

Labels covering multiple impacts are emerging, too

Demand | Consumers

Eco-score and other initiatives in France

Foundation Earth (UK)



Typical Value	Per 100	Per serving	Grade per serving
Carbon (CO_2 eq)	136.00	543.00	B
Water Usage (L eq)	393.00	1,342.00	E
Water Pollution (PO_4^{3-})	1.00	3.00	D

Investors are demanding greater information

Demand | Investors

FAIRR
A COLLER INITIATIVE

Members include:

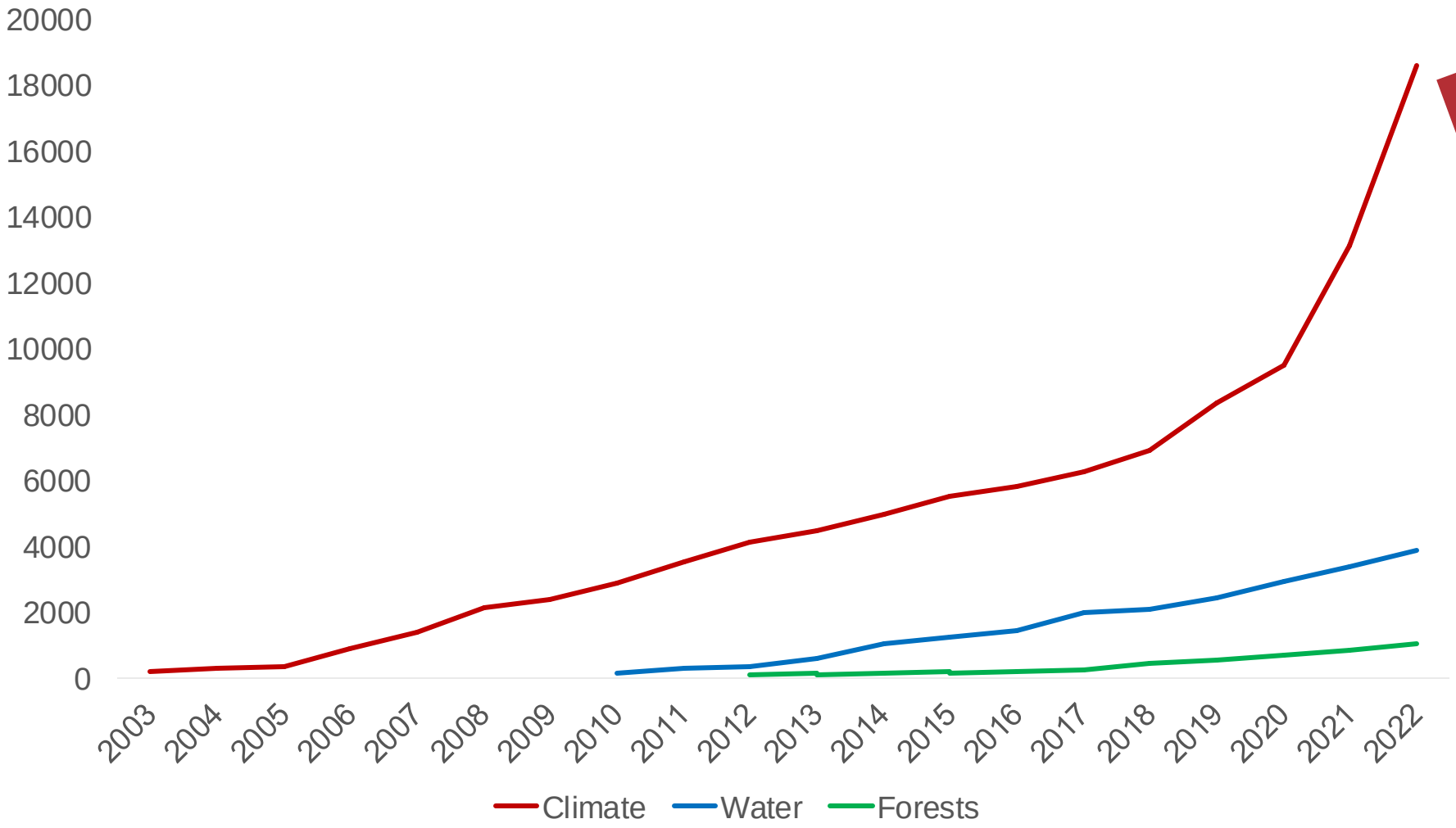
BlackRock
AXA Investment Managers
J.P.Morgan ASSET MANAGEMENT
HSBC
Fidelity INVESTMENTS
BNP PARIBAS ASSET MANAGEMENT
The sustainable investor for a changing world
Morgan Stanley INVESTMENT MANAGEMENT

70 Trillion USD
assets under management

*"Working closely with investors, we produce and analyse data from the world's largest protein producers and manufacturers to **help minimise risks and maximise profits**."*

Firms are increasingly disclosing their environmental impacts, including GHG emissions

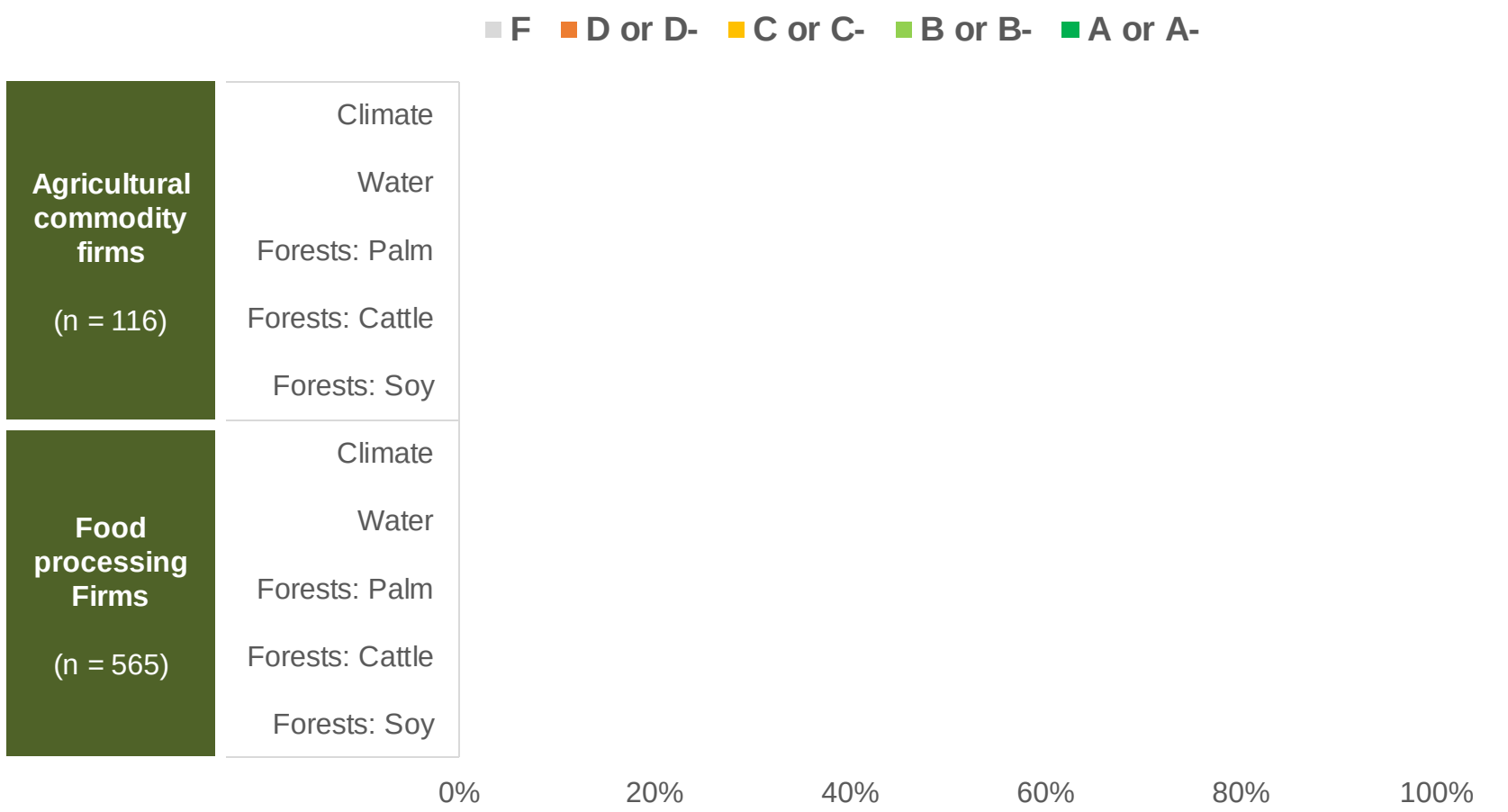
Number of firms disclosing impacts through CDP



18 000+ firms disclosing their GHG emissions in 2022

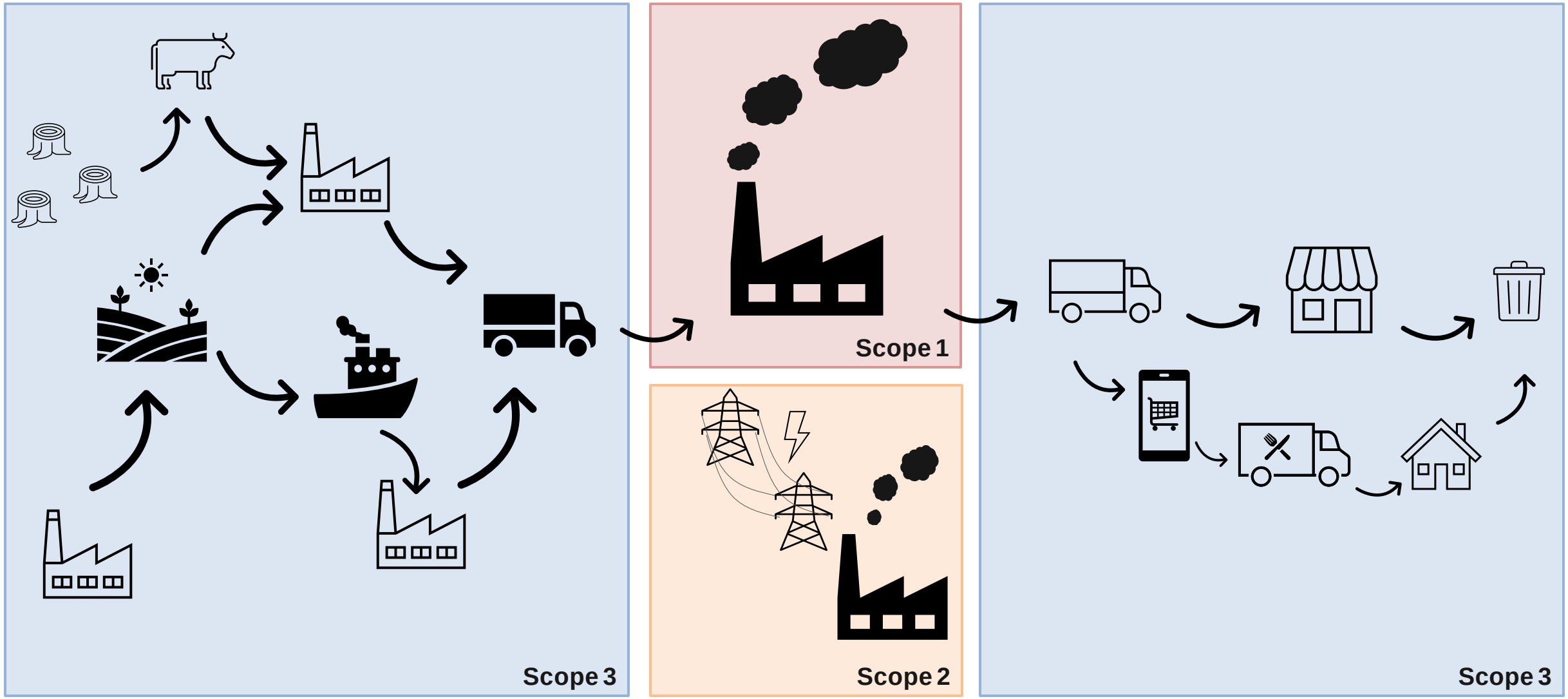
(+ 42% year over year)

The agri-food sector is lagging behind (so far)



- A growing number of agri-food firms is disclosing through CDP
- But so far, they are often submitting **incomplete or insufficient** information

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

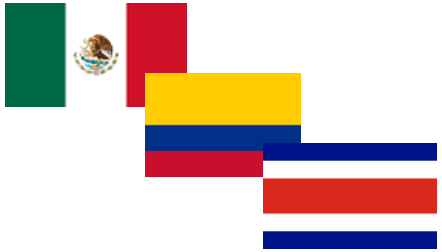
Source: https://sciencebasedtargets.org/companies-taking-action
and https://www.aholddelhaize.com/news/ahold-delhaize-sets-updated-co2-emissions-reductions-targets-for-its-entire-value-chain-in-line-with-un-goal-of-keeping-global-warming-below-1-5-c/

Public policy is increasingly pushing for greater environmental disclosure at both firm and product level

Demand *Governments*

- Proposal for **firms with securities traded in the US** to disclose Scope 3 emissions
- Proposal for **suppliers to the federal government** to disclose emissions and set targets

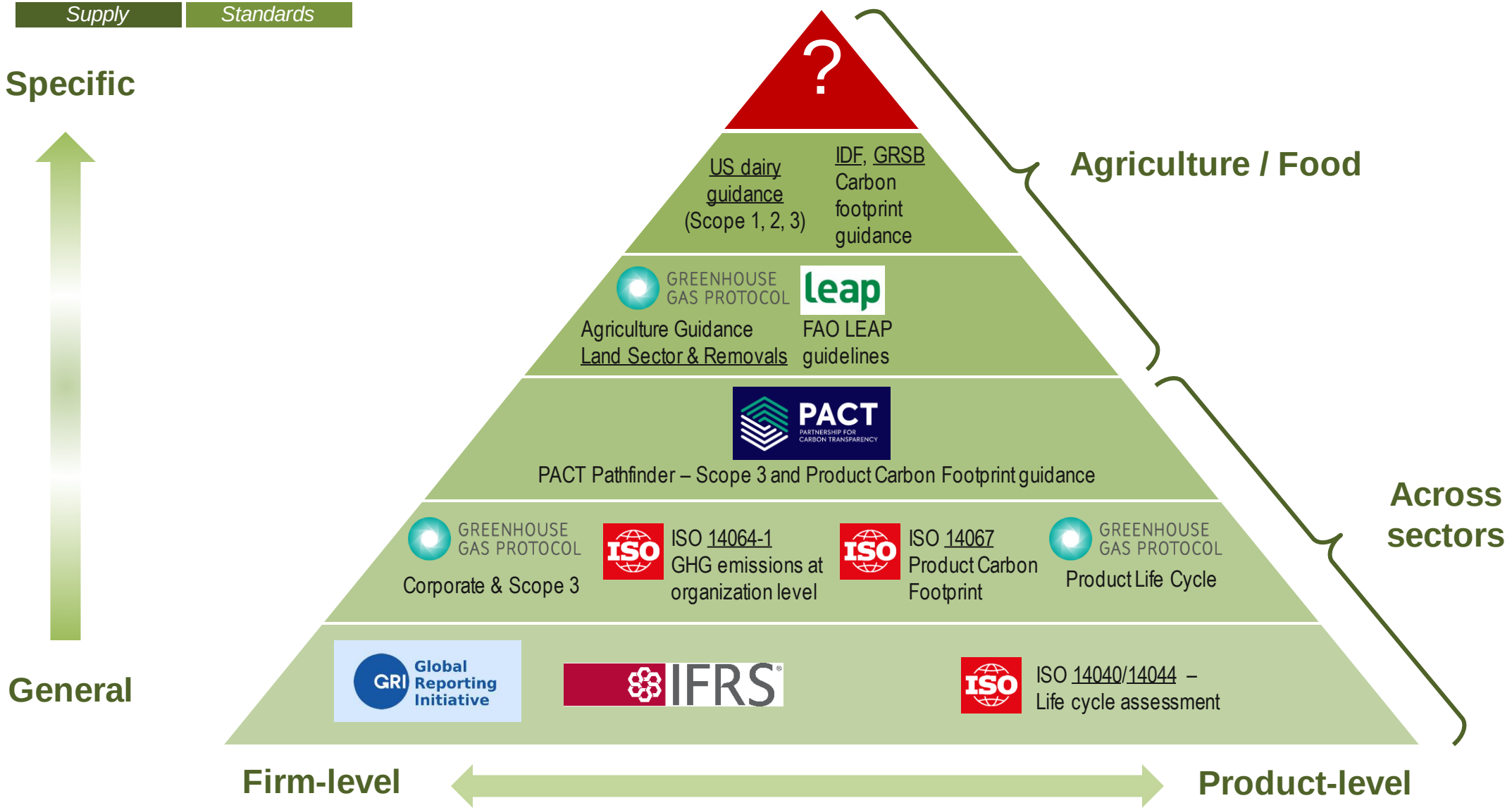
- Corporate Sustainability Reporting Directive will likely require **Scope 3** disclosure
- **Green Claims** initiative will require use of life-cycle assessment to support green claims



- Mexico, Colombia and Costa Rica created the Environmental Alliance of the Americas to **promote environmental impact labels** through **mutual recognition**
- Ecuador and Paraguay have since joined

A landscape of **reporting standards and guidelines** has emerged

Supply | *Standards*



Calculation tools are used to estimate emissions
Example: FARM ES tool (US dairy)

Supply | Calculation 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/

Calculation tools are used to estimate emissions
Example: FARM ES tool (US dairy)

Supply | Calculation 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/

Calculation tools are used to estimate emissions
Example: FARM ES tool (US dairy)

Supply | Calculation 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/

Calculation tools are used to estimate emissions
Example: FARM ES tool (US dairy)

Supply | *Calculation 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.	%

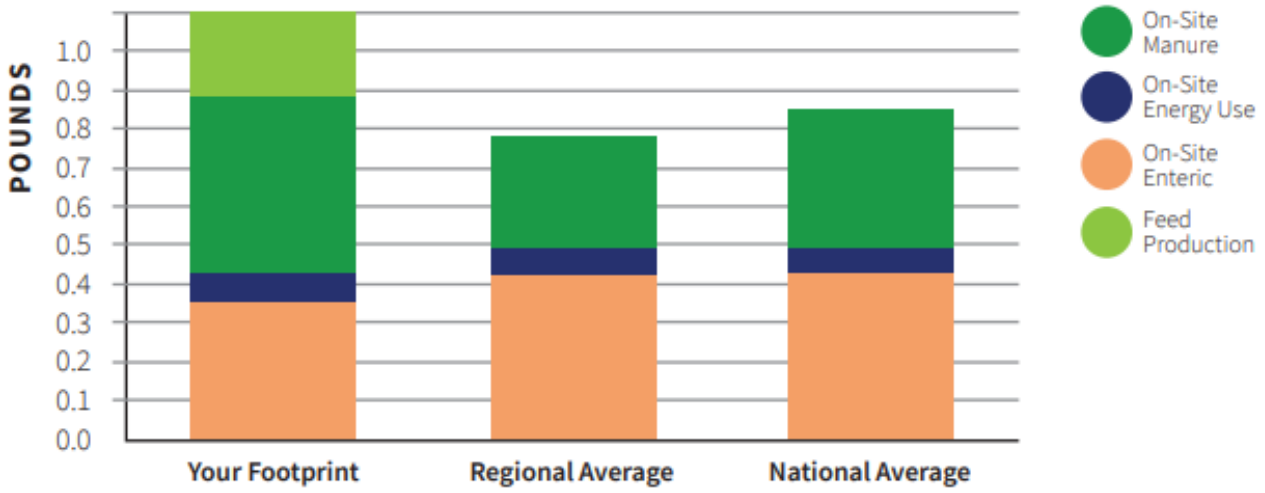
Source: https://nationaldairyfarm.com/dairy-farm-standards/environmental-stewardship/

Calculation tools are used to estimate emissions
Example: FARM ES tool (US dairy)

Supply | Calculation tools

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

Supply | Calculation tools

Choose your metric below and start using the Cool Farm Tool Today.

Greenhouse Gases

Field level assessment including nutrients, energy, and land use. Start using the Cool Farm Tool to measure carbon.

Biodiversity

Quantitative scoring of whole farm management. Start using the Cool Farm Tool to measure biodiversity management.

Water

Crop irrigation requirements and blue and green water footprints. Start using the Cool Farm Tool to measure water.

The number of **calculation tools** is growing

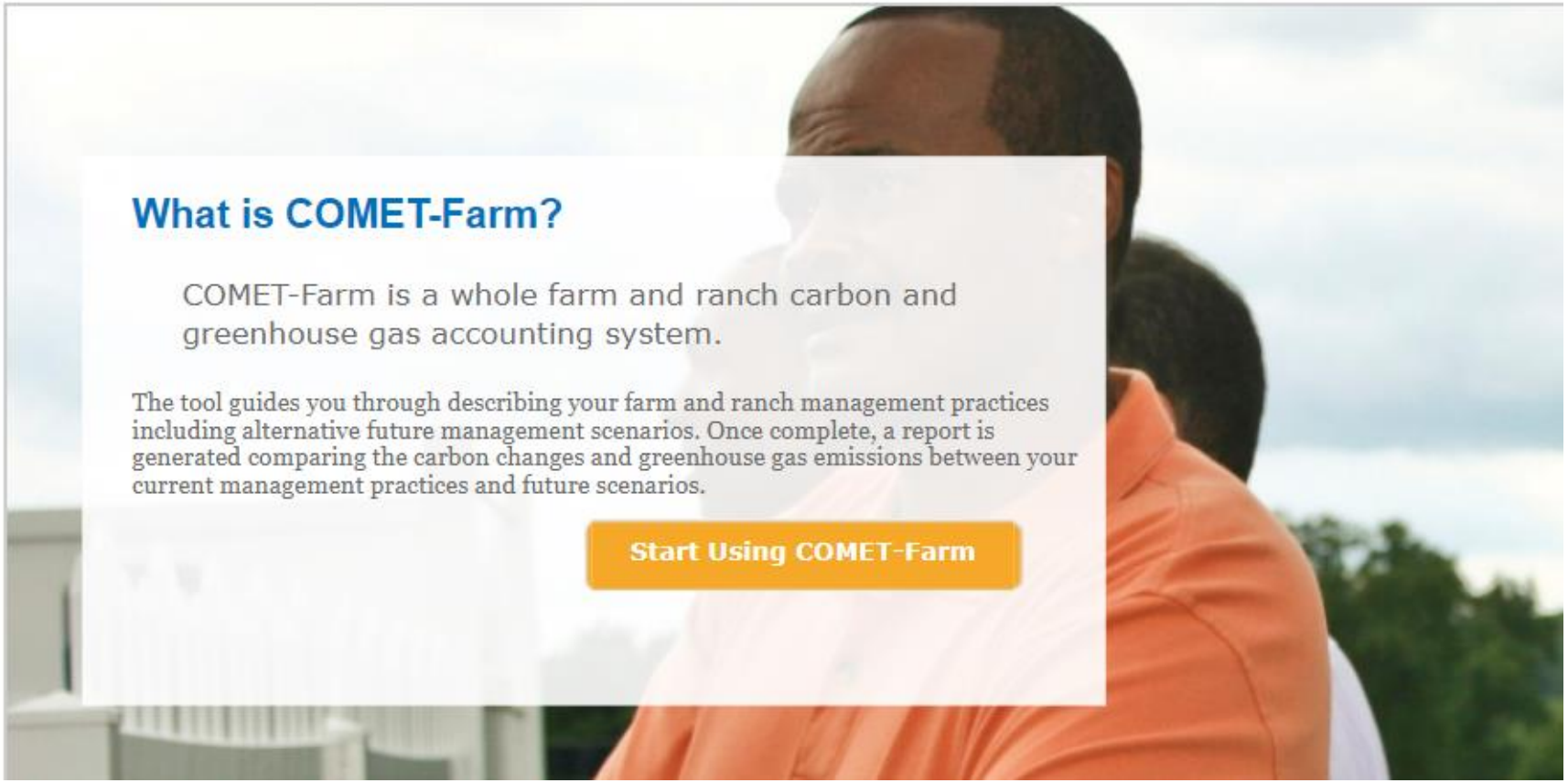
Supply | *Calculation tools*

COMET Farm

USDA United States Department of Agriculture
Natural Resources Conservation Service

Colorado State University

Whole Farm and Ranch Carbon and Greenhouse Gas Accounting System.



Example: scaling up farm-level carbon footprints in Ireland

Supply | Calculation tools

- **Carbon footprints** as part of the Origin Green sustainability assurance scheme.
- Since 2013, **nearly 300,000** carbon footprints have been calculated.
- Model developed by Teagasc, accredited by the Carbon Trust.
- Inputs:
  - Farm data
  - Government data
  - Information from processors

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

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

Supply | *Datasets*

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 b
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.

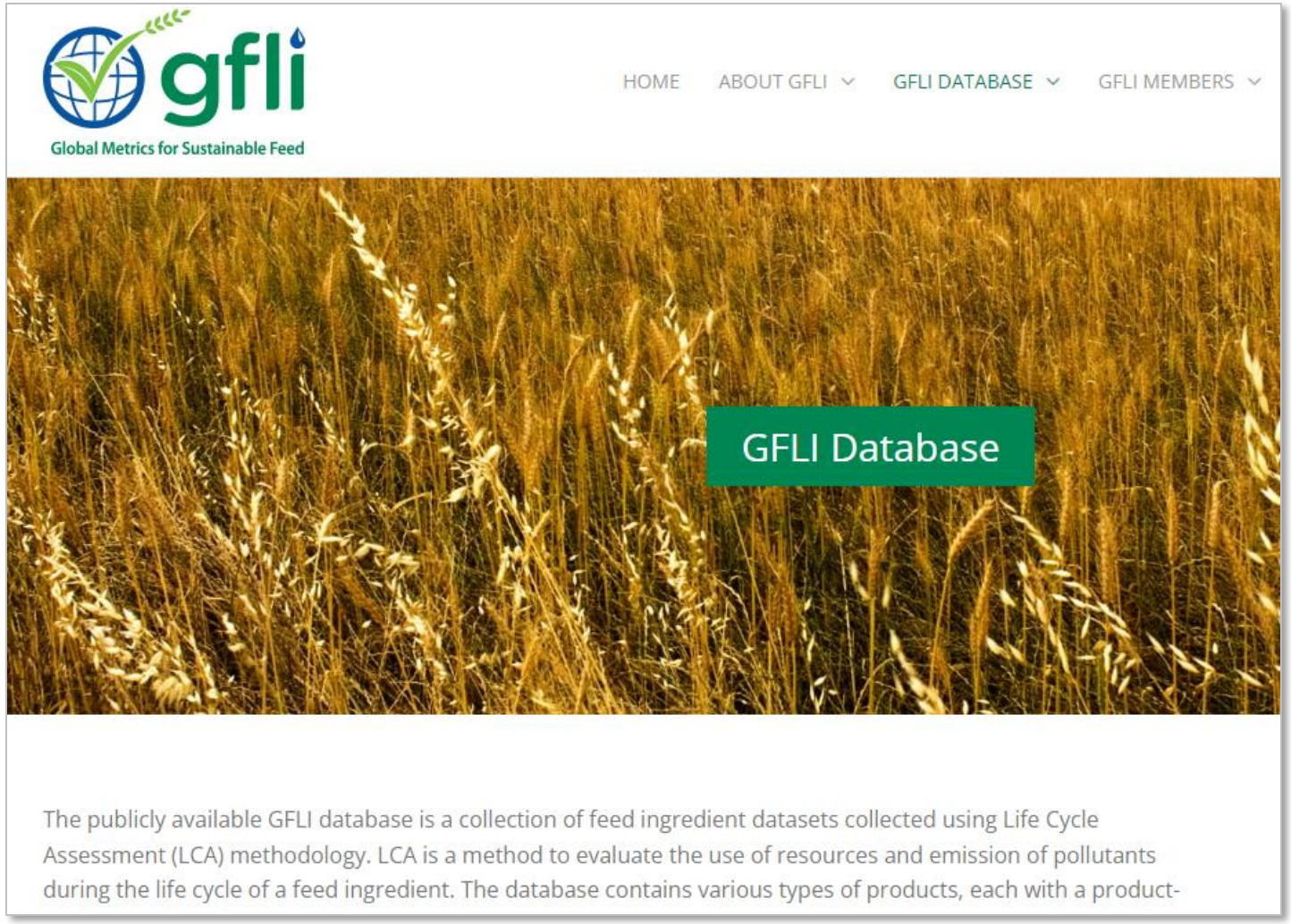
food system sustainability | environmental impact of food | ecolabelling

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

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

Supply | *Datasets*



- **Global Feed LCA Institute** aims to create harmonized database with life-cycle assessments of animal feed
- Consistent with FAO and EU methodologies
- Pilot project to generate **brand-specific** data

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

Supply | *Datasets*

Name	GHG emissions	Acidification	Eutrophication (land)	Eutrophication (freshwater)	Eutrophication (marine)	Land use
Aioli sauce (garlic and olive oil mayonnaise), p	1.9704259	0.031970626	0.13016845	0.71843959	12.291594	34.445554
Alaska pollock, raw	10.967059	0.32564475	0.85728769	0.61187043	78.279278	25.055576
Alaska pollock, smoked	10.865888	0.32547516	0.85742222	0.62857855	78.282736	25.189783
Albacore, in olive oil, canned, drained	15.506086	0.42815469	1.1148051	2.0144205	101.85665	43.783945
Albacore, raw	8.4945663	0.25903952	0.68167988	0.38770504	62.260665	18.66995
Albacore, steamed under pressure	10.434125	0.31675007	0.83325227	0.51375726	76.12426	23.102383
Alfalfa seeds, sprouted, raw	3.7529381	0.10796843	0.4636266	3.1473618	59.17884	575.43581
Almond cake	6.1104917	0.068416632	0.27917344	1.1682187	21.557051	259.27667
Almond drink	1.075705	0.01091272	0.03828102	0.38227105	3.914029	51.960703
Almond paste or marzipan, prepacked	3.874803	0.060017368	0.22923159	1.5067105	20.129328	243.53567
Almond, (with peel)	5.7604477	0.076412983	0.27758114	2.4495156	28.147858	377.30239
Almond, grilled, salted	5.7604477	0.076412983	0.27758114	2.4495156	28.147858	377.30239
Almond, peeled, unpeeled or blanched	5.7604477	0.076412983	0.27758114	2.4495156	28.147858	377.30239
Alphalfa seeds, raw	3.7529381	0.10796843	0.4636266	3.1473618	59.17884	575.43581
Amaranth, raw	0.87194232	0.009915697	0.040761081	0.31048426	8.0635277	105.71683
American bass, raw	11.935636	0.066691369	0.23839496	1.1678344	547.27576	234.04333
American or Canadian sea scallop, without cor	13.590515	0.19597057	0.51985958	1.6646717	49.293918	46.5262
American-style sauce, prepacked	5.6326468	0.044932799	0.17078968	0.73499285	15.687207	166.29974
Anchovy, fillets, in oil, semi-preserved, drainec	1.9706287	0.023747491	0.068897582	0.35521911	10.210578	55.999941
Anchovy, fillets, rolled with capers, semi-prese	1.9706287	0.023747491	0.068897582	0.35521911	10.210578	55.999941
Anchovy, in salt (semi-preserved)	2.1585571	0.037366296	0.099394953	0.2203364	9.1151227	8.7799212
Anglerfish, grilled	13.358315	0.39791383	1.0476451	0.80644991	95.667676	31.020082
Anglerfish, raw	10.967059	0.32564475	0.85728769	0.61187043	78.279278	25.055576
Apple compote	0.82077692	0.005989127	0.021470508	0.11621857	2.3547894	10.482895

AGRIBALYSE®

- Public database in France
- **Harmonized Life Cycle Assessments (LCA)** for **2,500** food products
- Reference database for developing environmental impact labels in France

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

ADEME
AGENCE DE LA TRANSITION ÉCOLOGIQUE

INRAE

It's becoming easier to **share information** along the supply chain

Supply | *Data exchange*

Partnership for Carbon Transparency releases updated technical specifications for standardized exchange of emissions data

New specifications enable companies worldwide to exchange Product Carbon Footprint information, setting a foundation for supply chain decarbonization at scale.

Geneva, 21 February 2023: The Partnership for Carbon Transparency (PACT), hosted by the World Business Council for Sustainable Development (WBCSD), has released updated technical specifications to help organizations exchange Product Carbon Footprint (PCF) information. Technology solutions, ranging from procurement and supplier management systems to carbon management software, can now exchange product-related carbon emissions data using the same standardized technical language. Enabling such data sharing represents a significant step towards carbon transparency and supply chain decarbonization at scale.

- Companies already use carbon accounting software solutions
- New technical standards now make it possible for these tools to **exchange data**
- Demonstrated in pilot projects with Unilever, BASF, Solvay, Chevron, P&G…

PACT
PARTNERSHIP FOR CARBON TRANSPARENCY
wbcsd

Source: https://www.carbon-transparency.com/

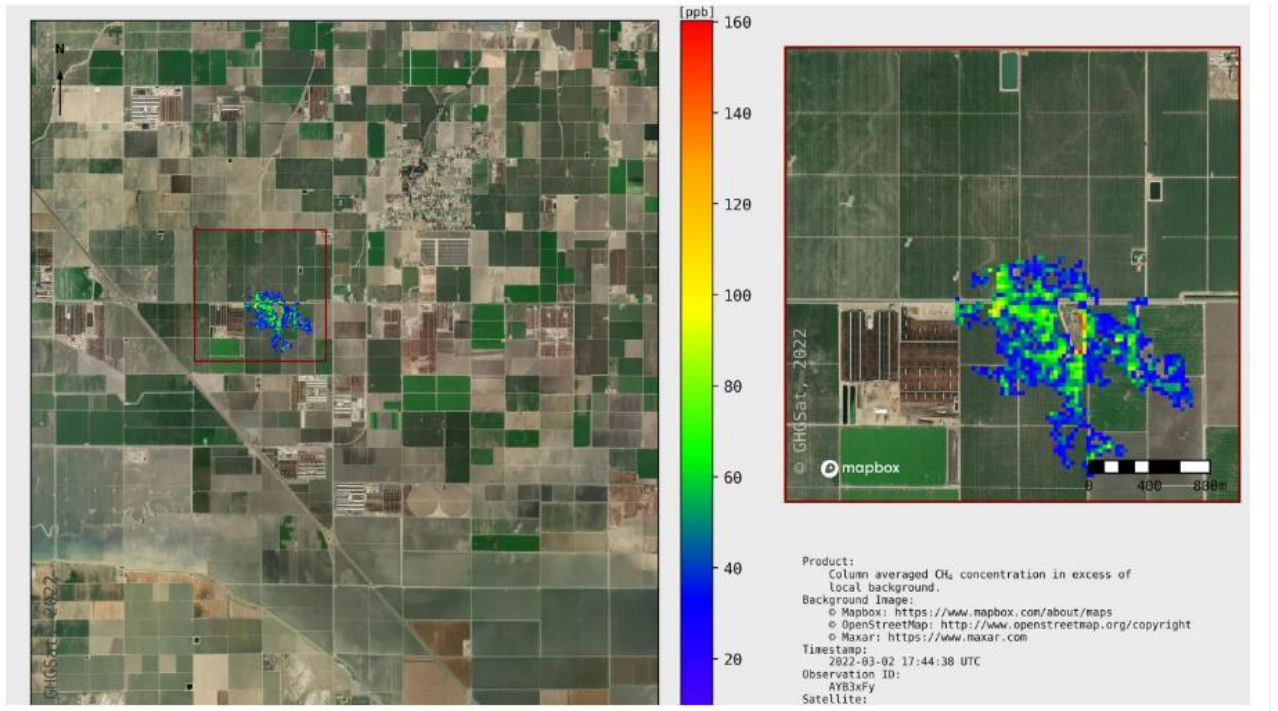
And even **direct measurement** might become an option…

Supply | *Measurement*

Planet-warming emissions from cow burps have been seen from space

By Zoe Sottile, CNN

Published 10:43 AM EDT, Sat April 30, 2022



GHGSAT

- March 2022
- Methane emissions from cows measured through **satellites** for the first time
- Satellites also increasingly used for methane monitoring in oil & gas, landfills, and coal mines
- Satellites already used for monitoring deforestation etc.

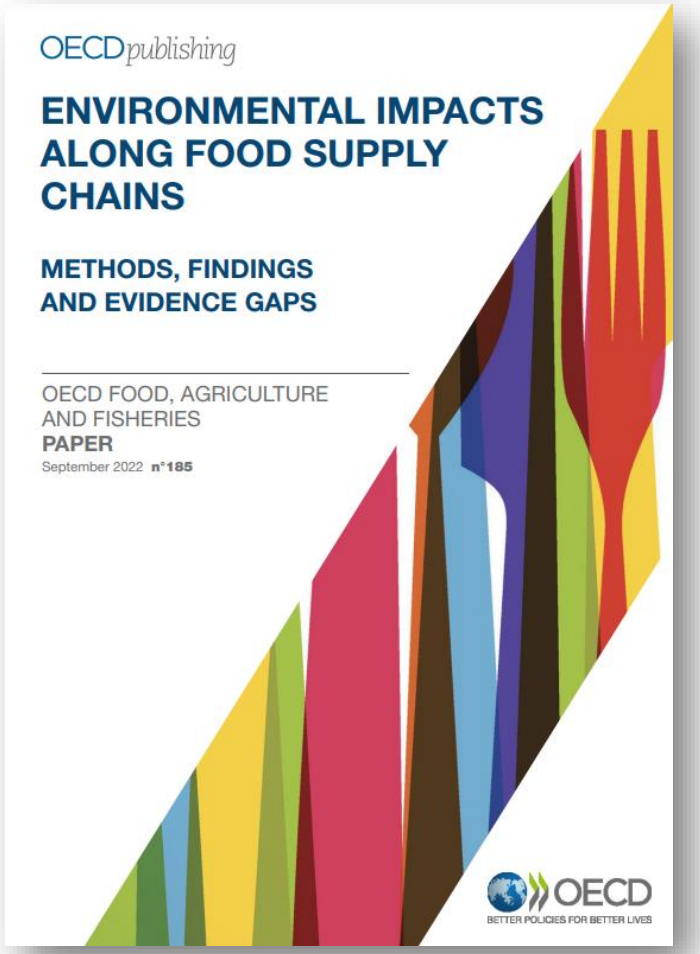
Source: CNN - https://edition.cnn.com/2022/04/30/us/cow-burps-methane-space-climate-trnd/index.html

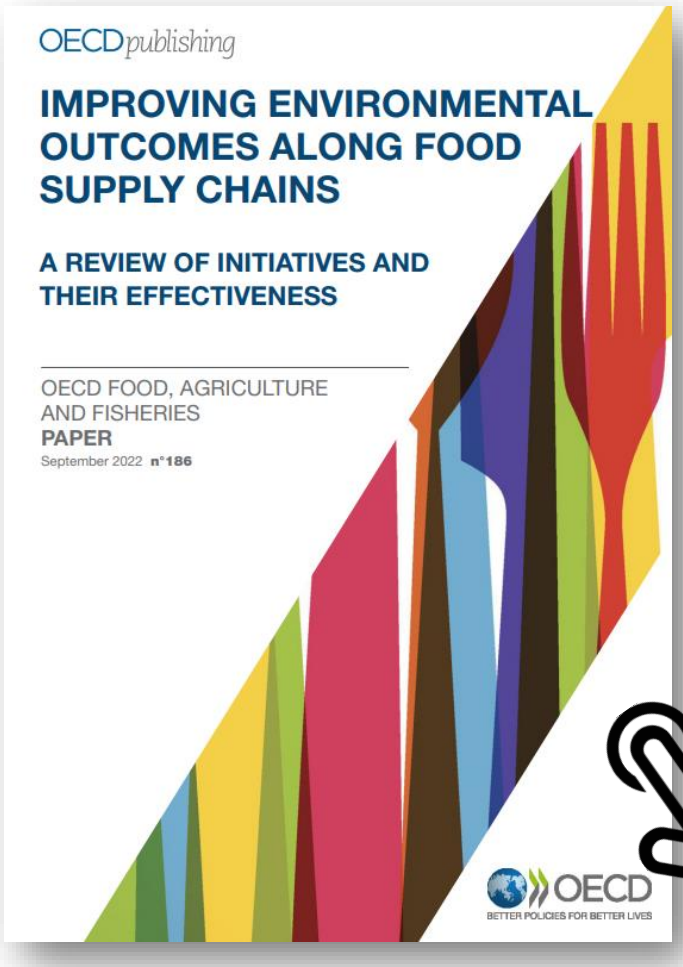

Global Reporting Initiative
LABEL BAS
CARBONE
GHGSAT
gfli
coolfood
The IDF global carbon Footprint standard for the dairy sector
IFRS
SCIENCE BASED TARGETS
COMET-Farm
NRCS USDA NREL Colorado State University
eap
eco
GAS PROTOCOL
Climate Action
business govt.
FOUNDATION
THESIS
BY THE SUSTAINABILITY CONSORTIUM
PNAS
RESEARCH ARTICLE
Estimating the environmental
CARBON TRUST
CARBON NEUTRAL
HESTIA
EPD
trase
THE INTERNATIONAL EPD® SYSTEM
COOL FARM ALLIANCE
estimates of the environmental impact of >57,000 food products
HUKI BA LYSE
CARBON TRUST
PACT
PARTNERSHIP FOR CARBON TRANSPARENCY
CDP
DISCLOSURE INSIGHT ACTION
FAIRR
A COLLER INITIATIVE
wbcsd
ISO
Collaboration or fragmentation?

The road ahead

- Better understand **existing approaches** to measurement, reporting, and communication
- Build **trust**
- Identify **scope for alignment**

Further reading…





<u>Forthcoming:</u>

"Fast and Furious: The Rise of Environmental Impact Reporting in Food Systems"

(forthcoming in *European Review of Agricultural Economics*)