

SO YOU THINK YOU'RE GREEN?

FOCUS ON FOOD

MARCH 18 2021

WEBINAR



LUXEMBOURG INSTITUTE OF SCIENCE AND TECHNOLOGY



LIFE CYCLE SUSTAINABILITY ASSESSMENT GROUP



LIVE POLL !



1. CARBON FOOTPRINT

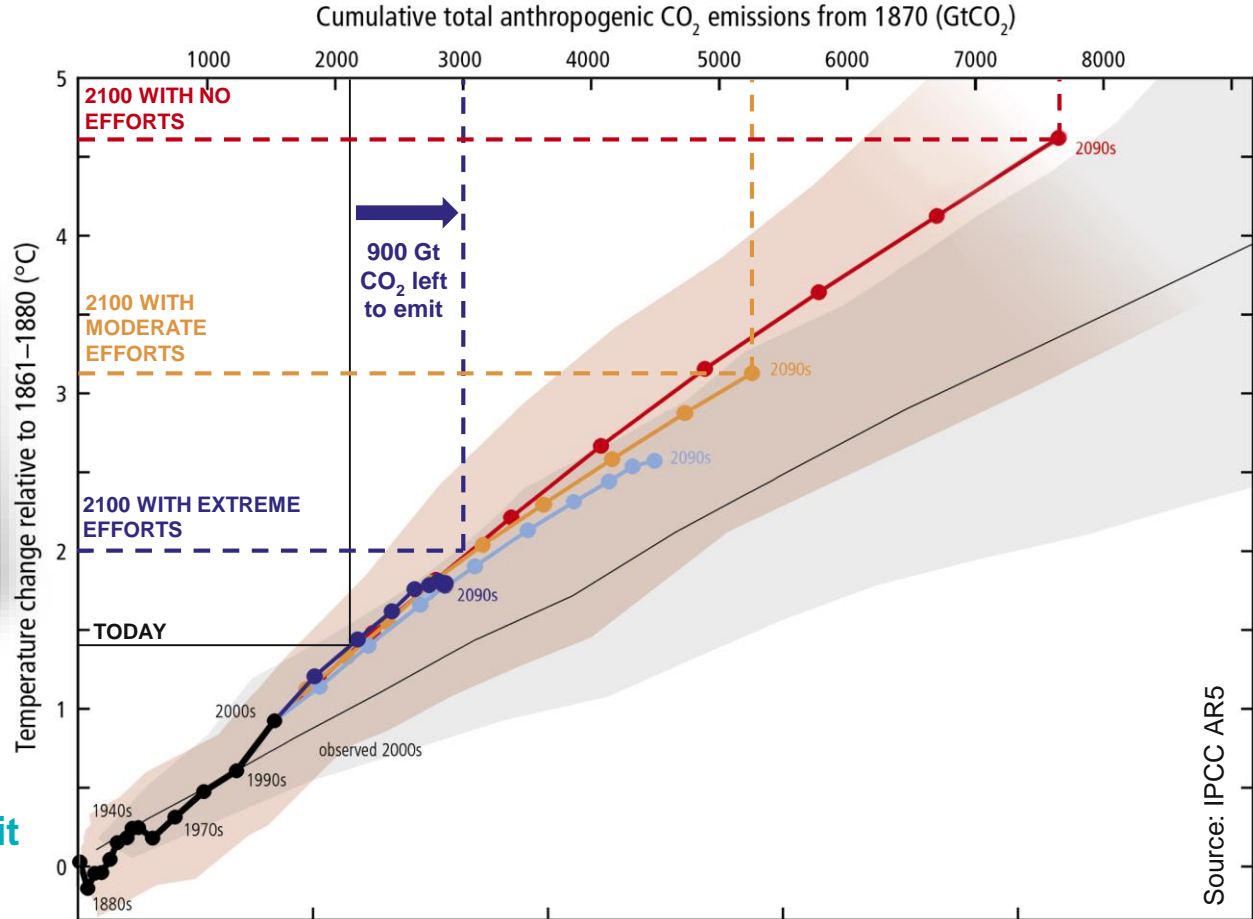


Temperature and CO₂ emissions?

The Paris agreement is a pledge to remain under 2°C of warming



This translates roughly into an additional 800-1000 Gt CO₂ left to emit



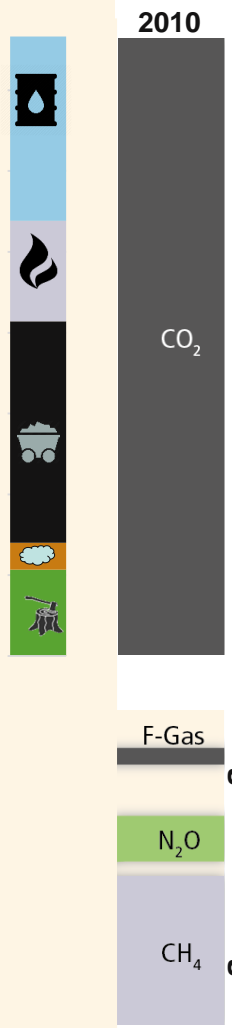
Carbon footprint

Carbon dioxide (1 kg = 1 kg CO₂ eq.)

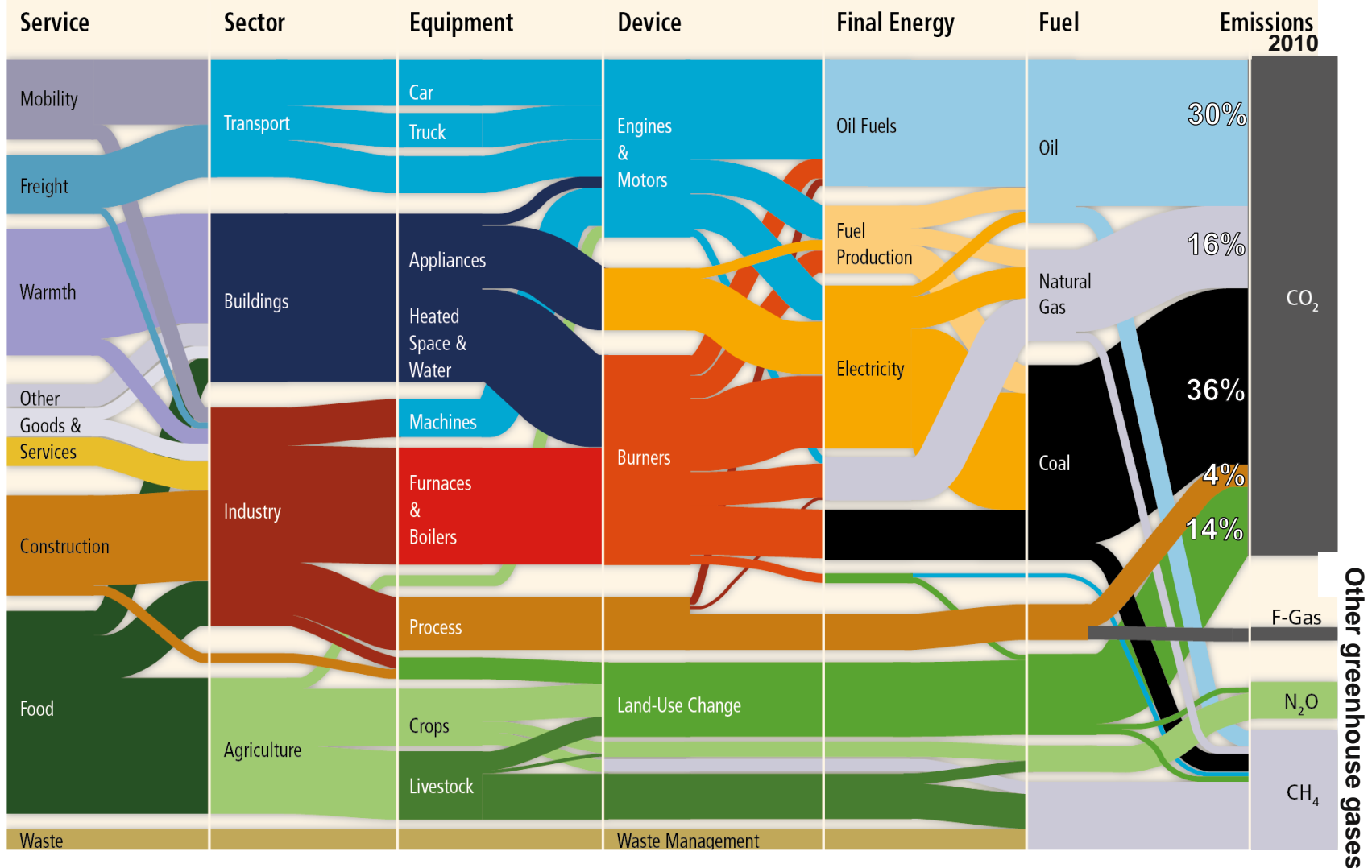
Fluorinated gases (1 kg = 8000-23000 kg CO₂ eq.)

Dinitrogen monoxide (1 kg = 300 kg CO₂ eq.)

Methane (1 kg = 25 kg CO₂ eq.)



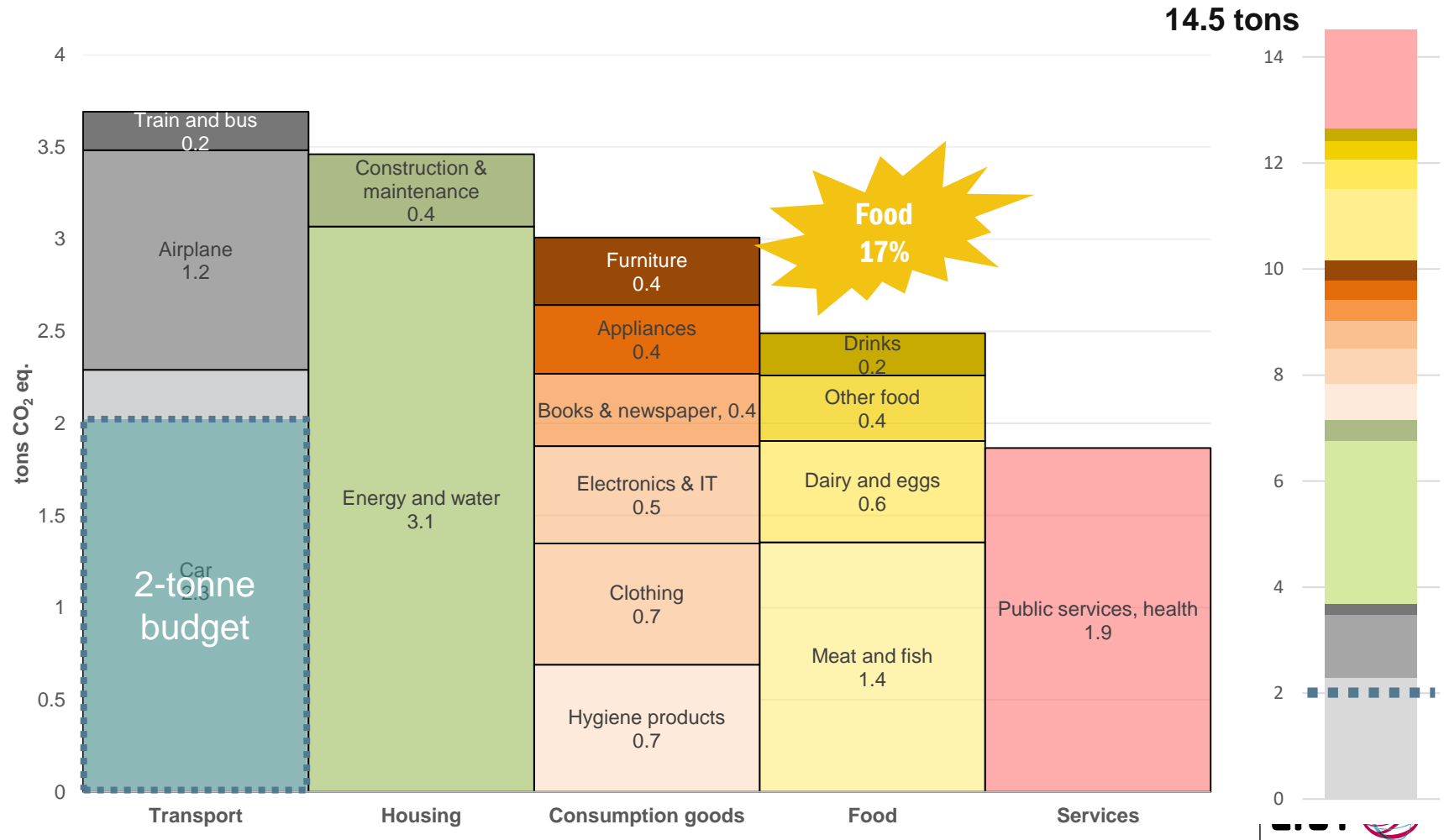
Carbon footprint



LIVE POLL !



Carbon footprint



Outline



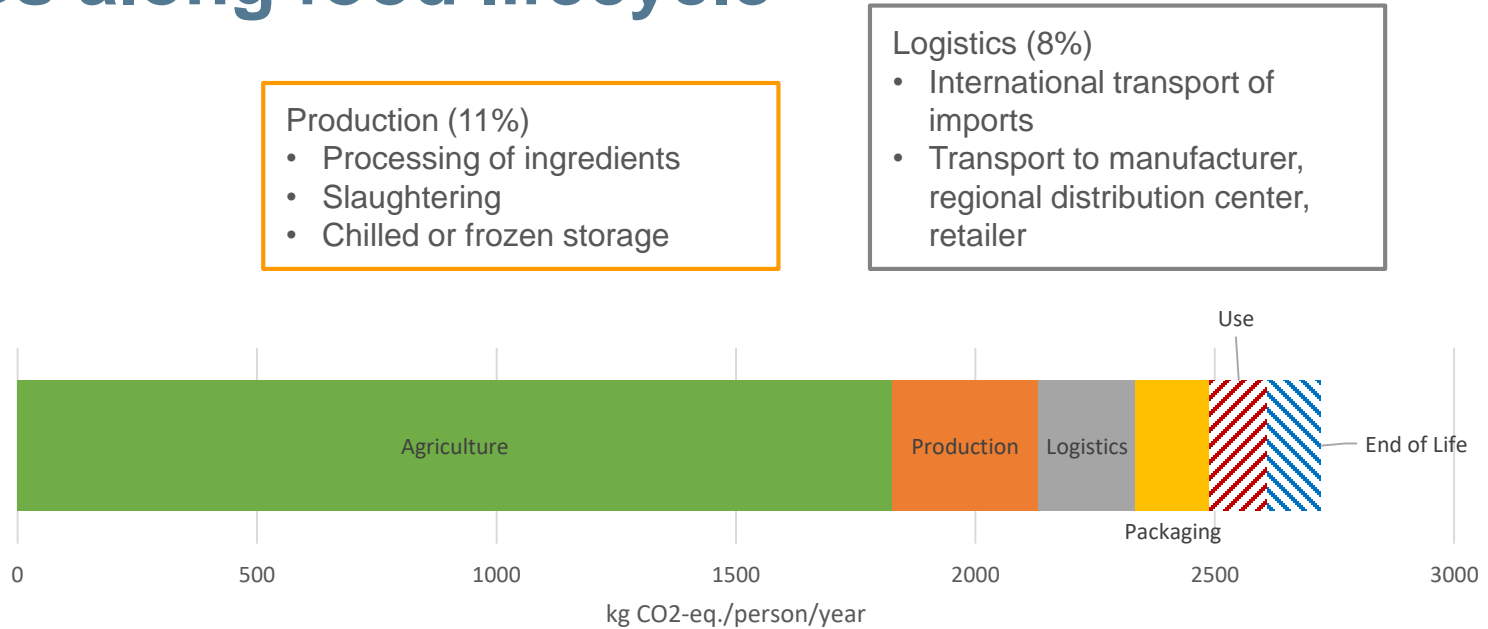
1. CARBON FOOTPRINT
2. AGRICULTURE
3. CONSUMER CHOICES
4. FOOD WASTE

1. CARBON FOOTPRINT

2. AGRICULTURE



GHGs along food lifecycle



Production (11%)

- Processing of ingredients
- Slaughtering
- Chilled or frozen storage

Logistics (8%)

- International transport of imports
- Transport to manufacturer, regional distribution center, retailer

Packaging (6%)

- Manufacture of packaging
- Final disposal of packaging

Use (4%)

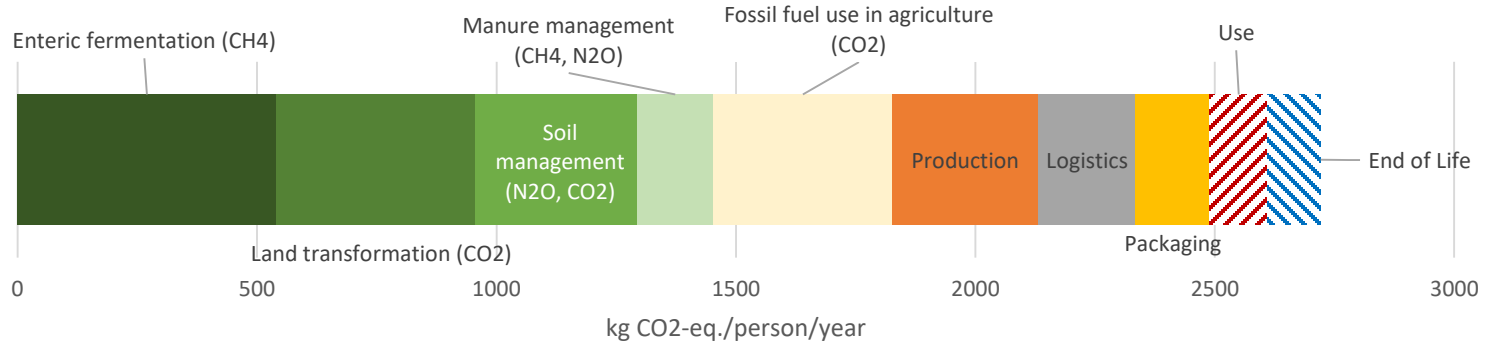
- Transport from retail to home
- Refrigerated storage at home
- Cooking

End of life (4%)

- Final disposal of food waste
- Wastewater treatment due to human excretion

GHGs along food lifecycle

Agriculture



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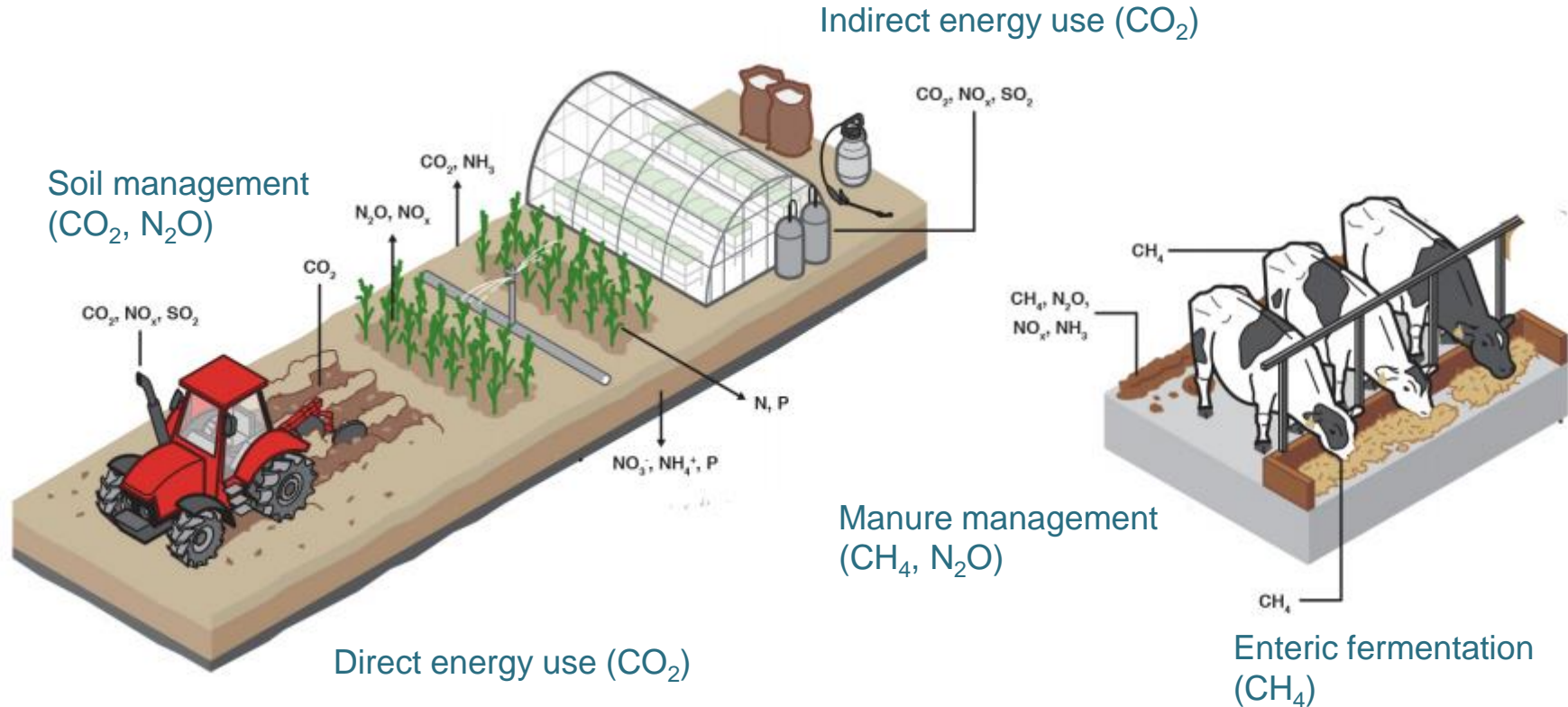
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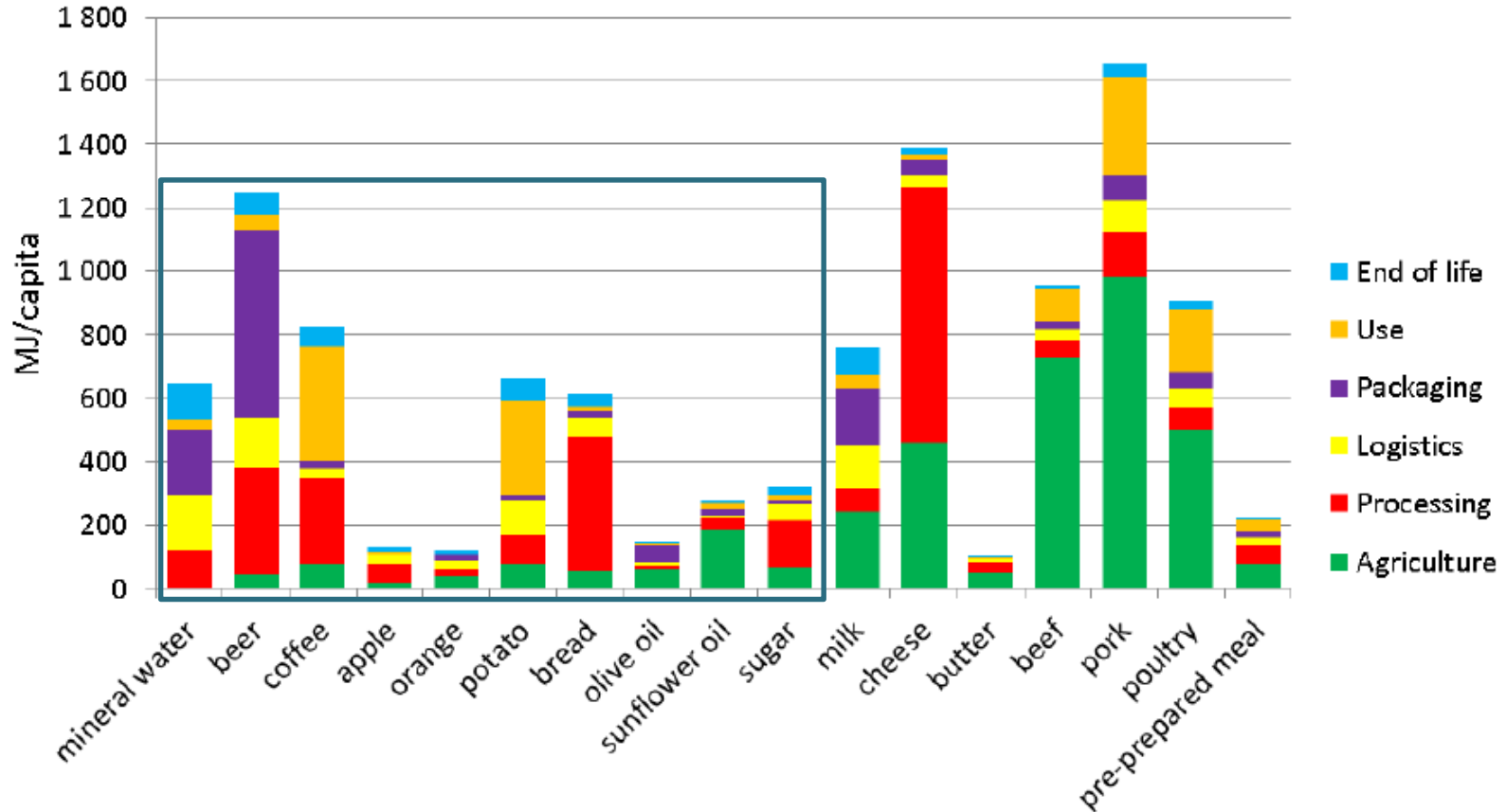
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GHG emissions in agriculture – Overview



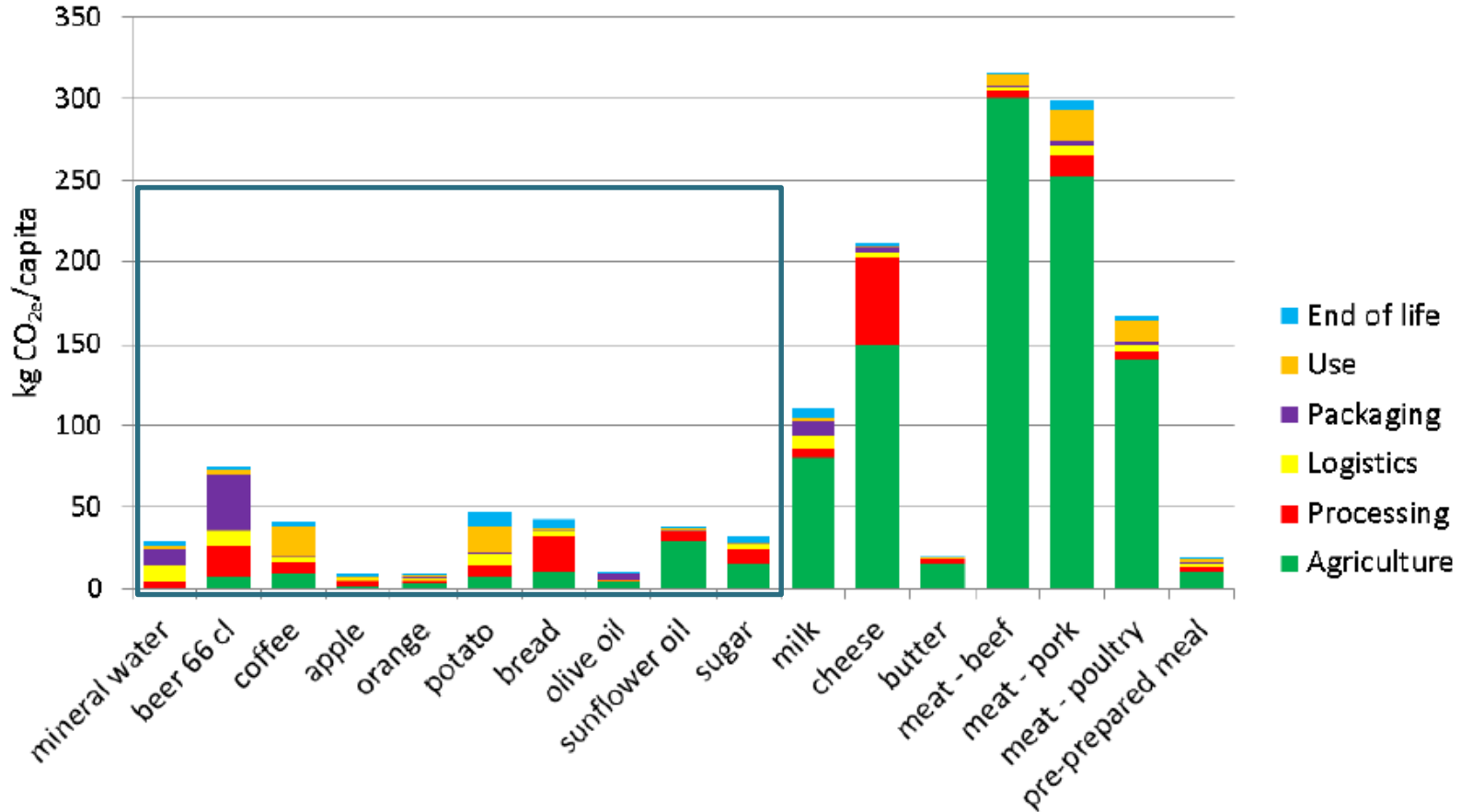
Energy use

Agriculture



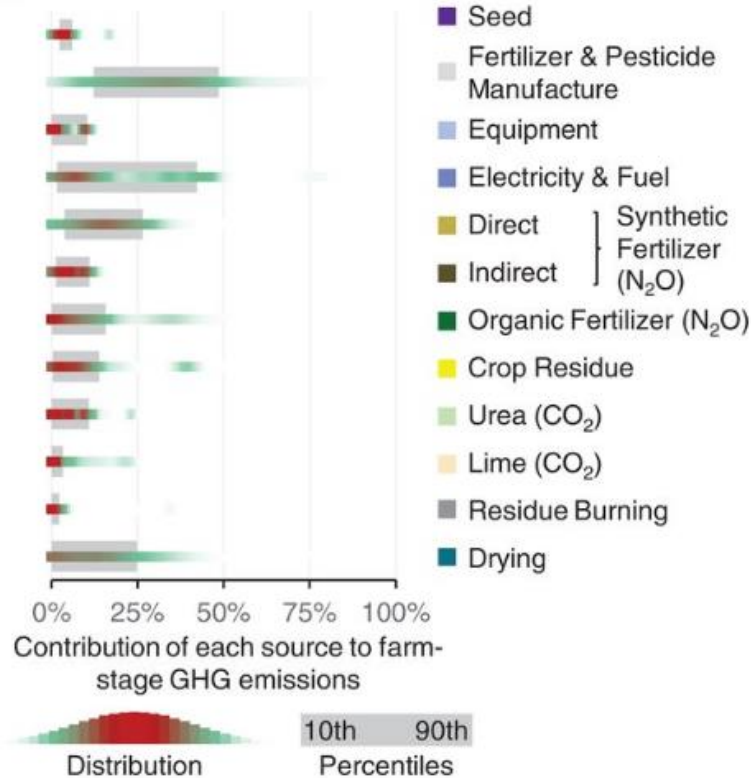
GHG emissions

Agriculture

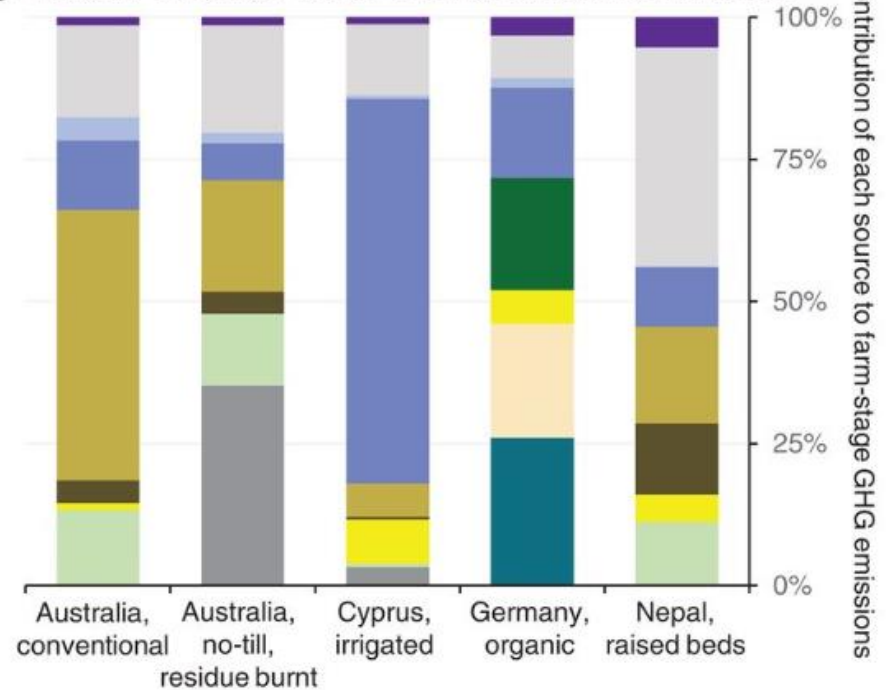


Farm-stage GHG emissions - Wheat

A Wheat farms



C Below median GHG emissions wheat farms



Pesticide use

- Fungicides (fungi)
- Herbicides (weeds)
- Insecticides (insects)

Herbicide vs tillage trade-off

Impact on off-target organisms

- Glyphosate ban in LU since 1 Jan 2021
- Glyphosate ban in DE starting 2024
- Neonicotinoid ban in EU since 2018

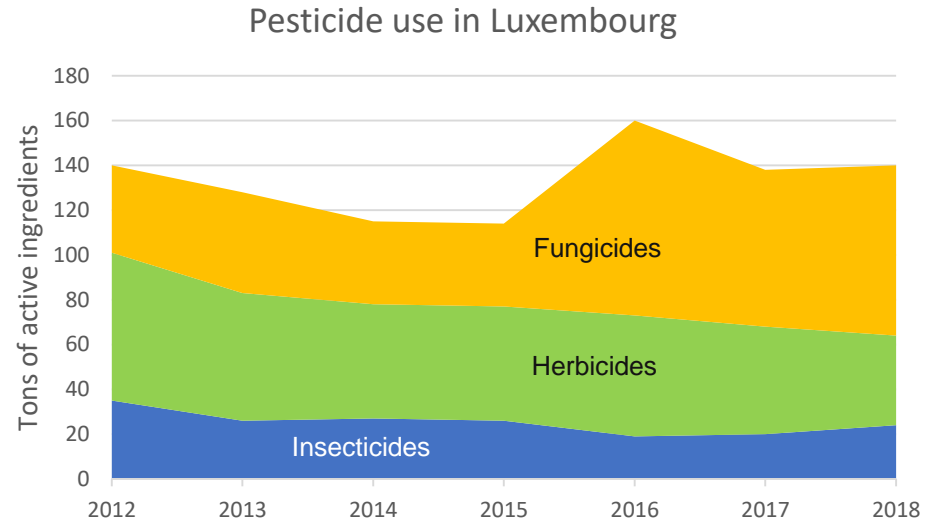
GMOs

- Herbicide-tolerant corn or soybeans

Pesticide resistance

Integrated Pest Management (IPM)

Precision agriculture



Field-applied



Télégramme/Claudi Prigent

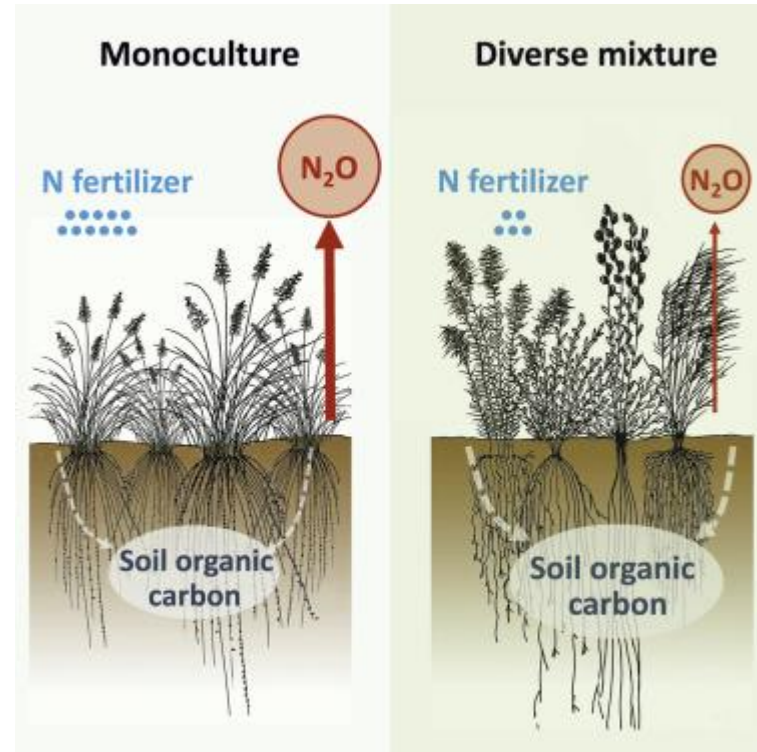
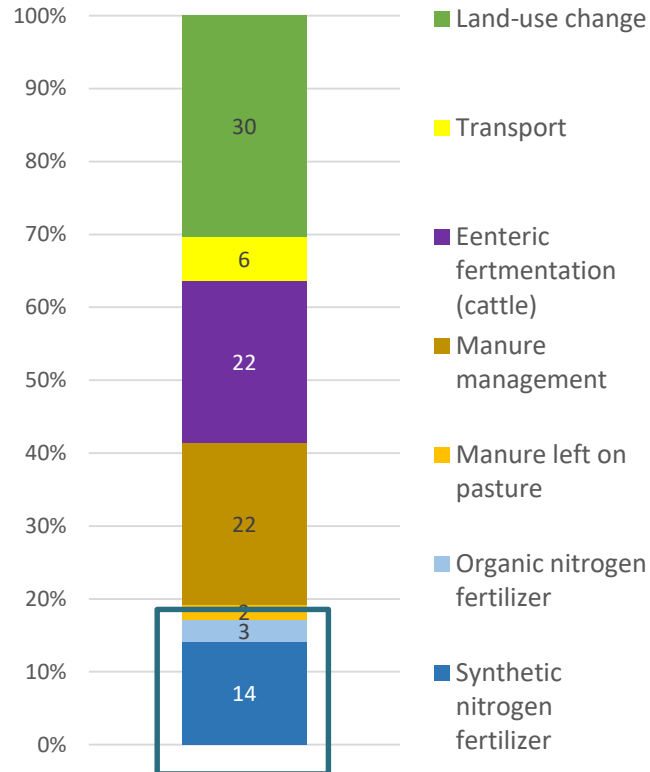
Seed treatment



Science.lu/Science.lu

Fertilizers: Benefits from diversification

Carbon footprint of diets
in the EU, by source



Diverse cropping systems can reduce soil N_2O emissions by 30-40%

Soil management emissions – Tillage practices

Maize production – inputs and carbon footprint

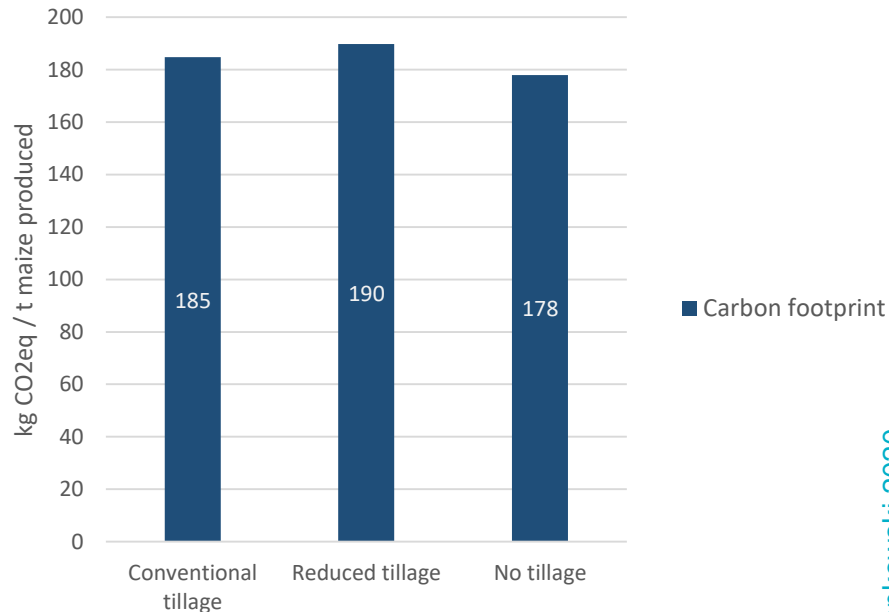
Conventional tillage (CT) Reduced tillage (RT) No tillage (NT)



Agriculture

Maize production – inputs

	Inputs per 1 t of grain maize production		
	Conventional tillage (CT)	Reduced tillage (RT)	No tillage (NT)
Herbicides (kg a.s.)	0.02	0.06	0.13
Diesel oil (kg)	6.88	6.22	4.93



Tillage vs. herbicide use trade-off

Soil management emissions – Tillage practices

Maize production – inputs and carbon footprint

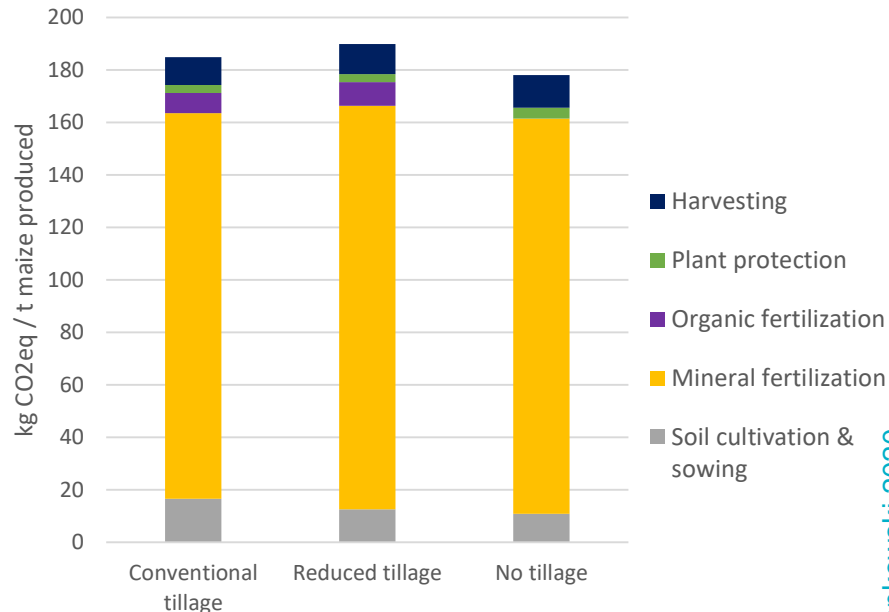
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Tillage vs. herbicide use trade-off



Source: Holka and Bienkowski 2020

Soil management emissions – Tillage practices

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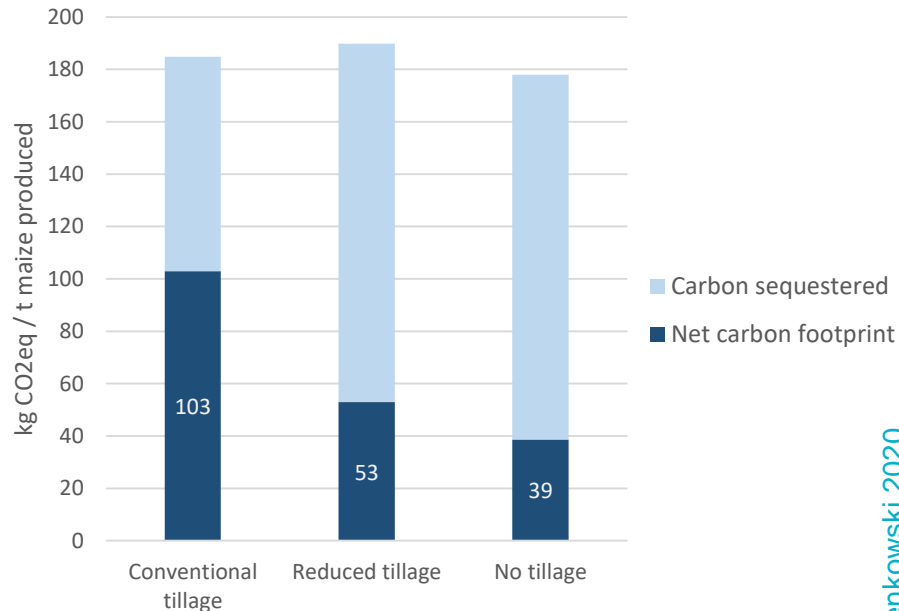


Agriculture

Maize production – inputs

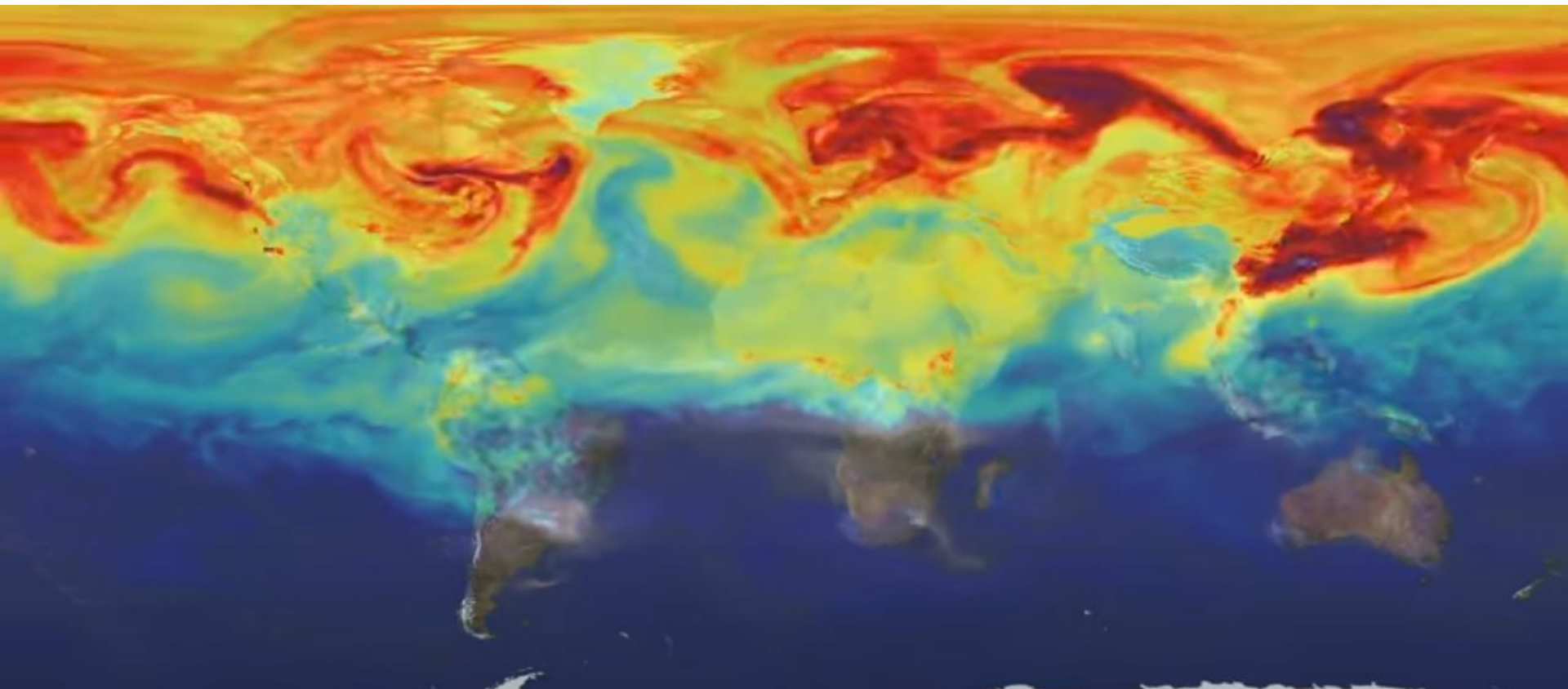
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Tillage vs. herbicide use trade-off



Switching from conventional to no tillage reduces the carbon footprint by more than 60%

CO2 map – March 17, 2006



Global Modeling and Assimilation Office

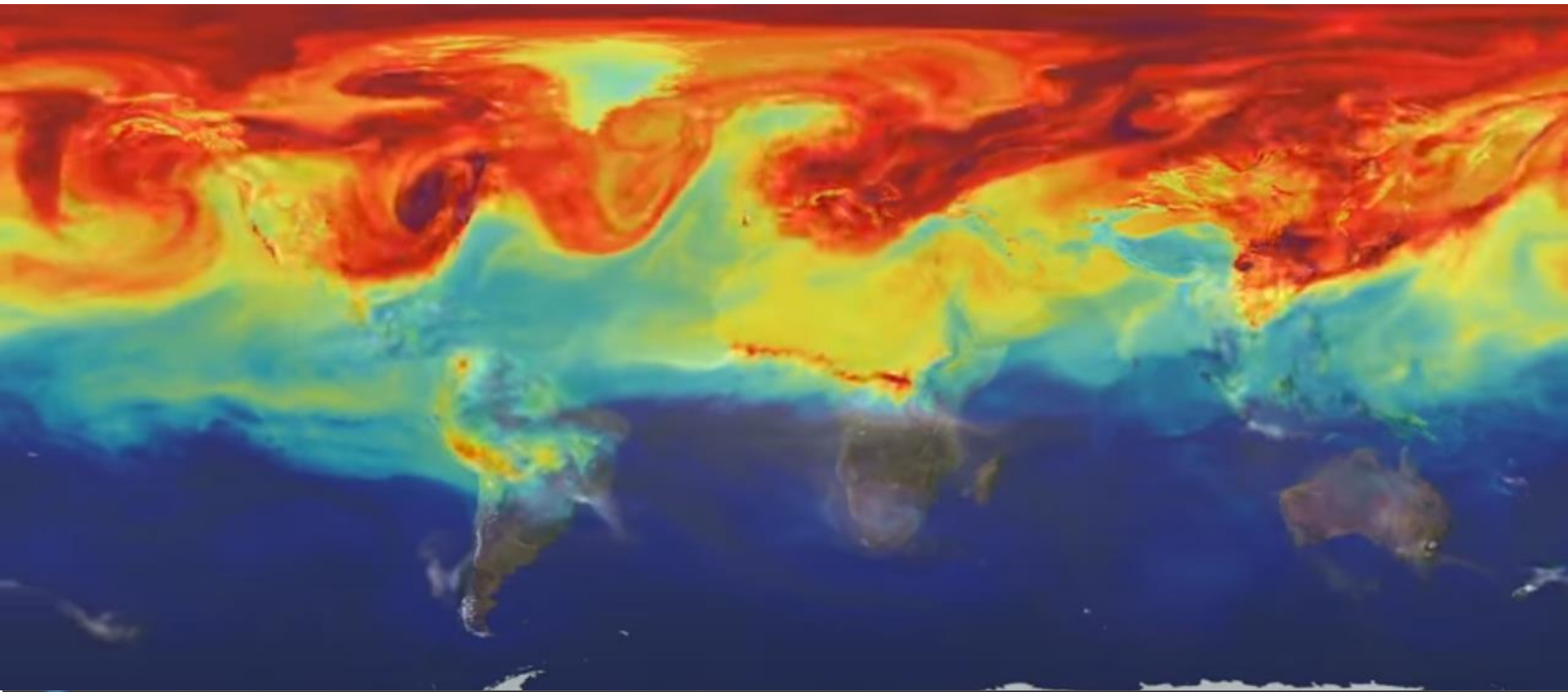
Carbon Monoxide Column Abundance [1.0×10^{18} molec cm^{-2}]



Carbon Dioxide Column Concentration [ppmv]



CO2 map – April 3, 2006



Global Modeling and Assimilation Office

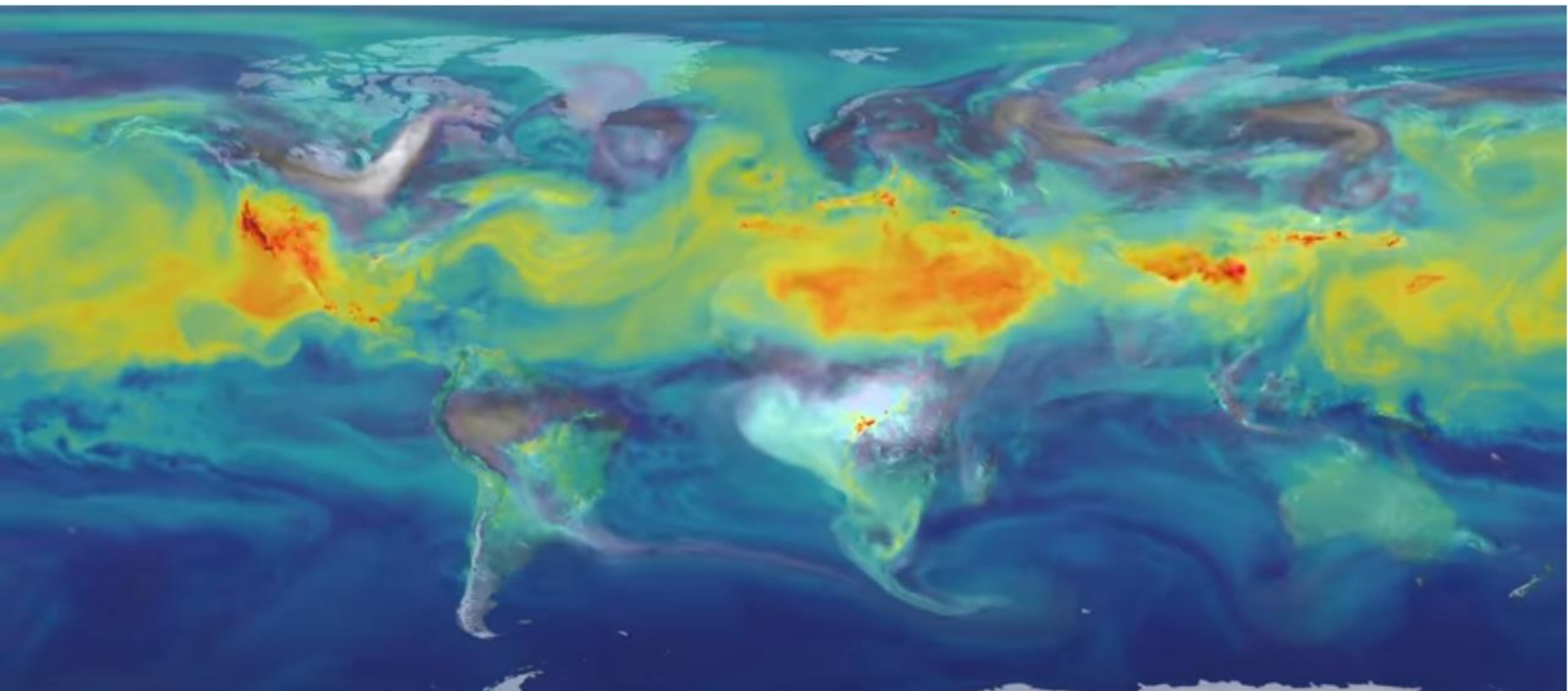
Carbon Monoxide Column Abundance [1.0×10^{18} molec cm^{-2}]



Carbon Dioxide Column Concentration [ppmv]



CO2 map – June 30, 2006



Global Modeling and Assimilation Office

Carbon Monoxide Column Abundance [1.0×10^{18} molec cm^{-2}]



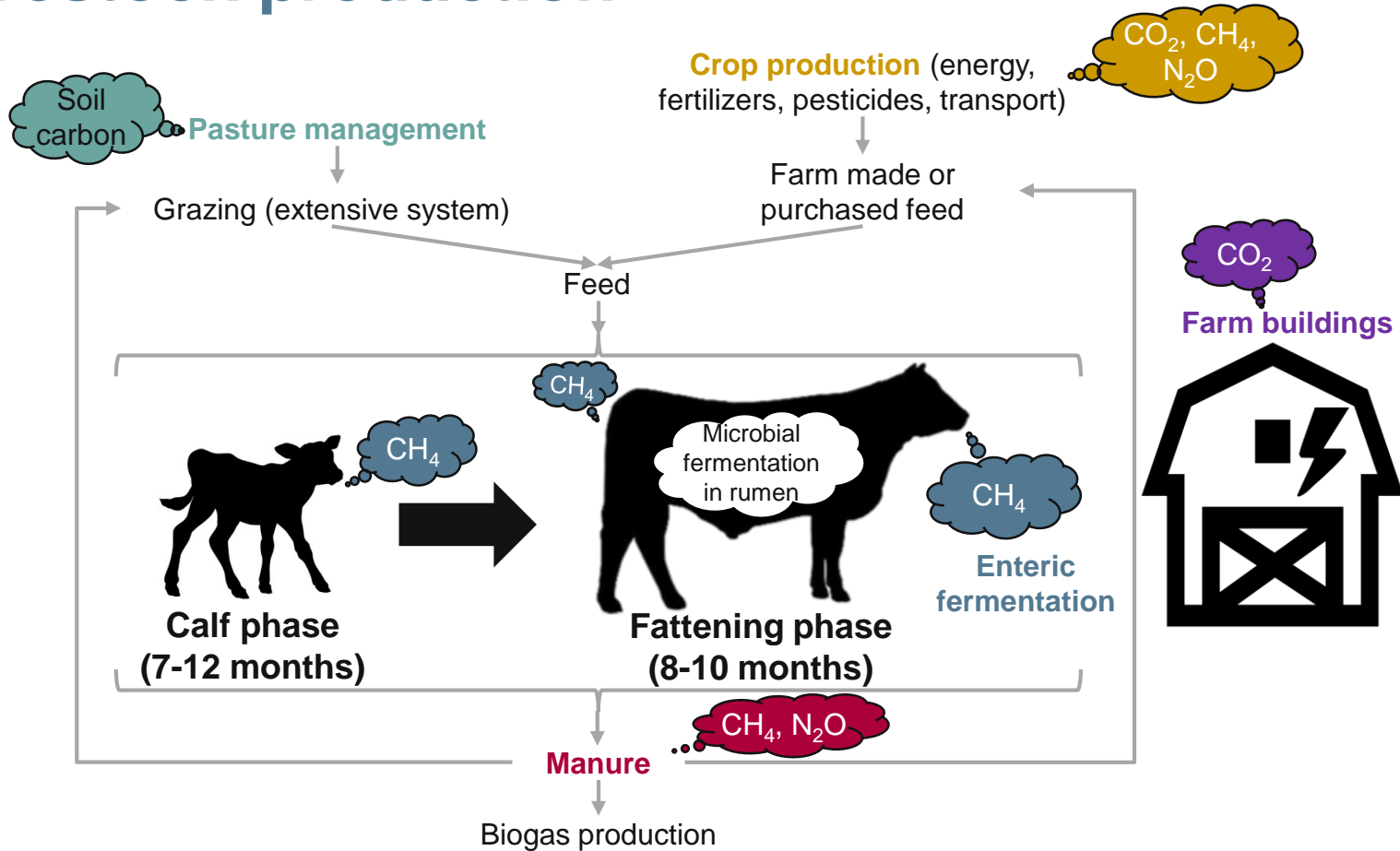
0.0 0.6 1.2 1.8 2.4 3.0 3.6 4.2 4.8 5.4 6.0

Carbon Dioxide Column Concentration [ppmv]



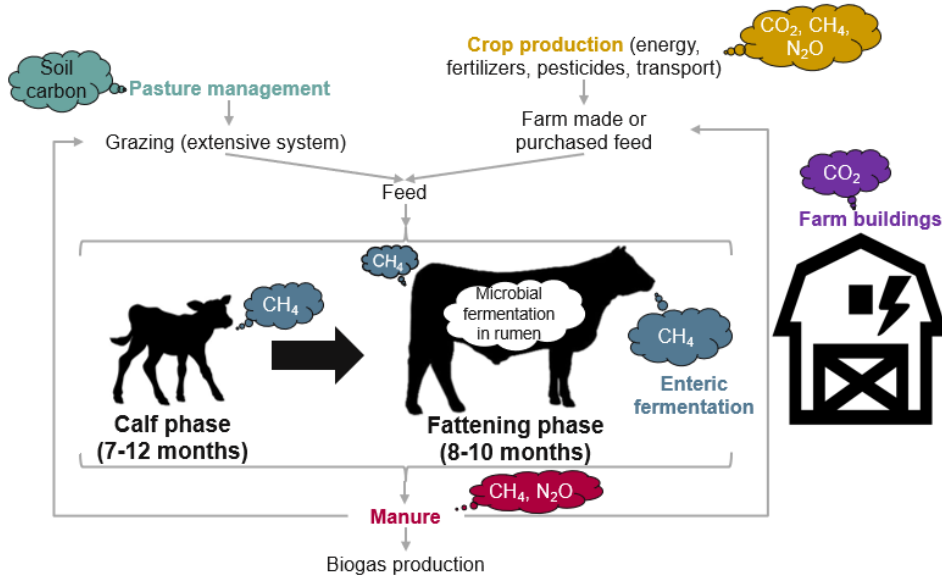
377 379 381 383 385 387 389 391 393 395

Livestock production

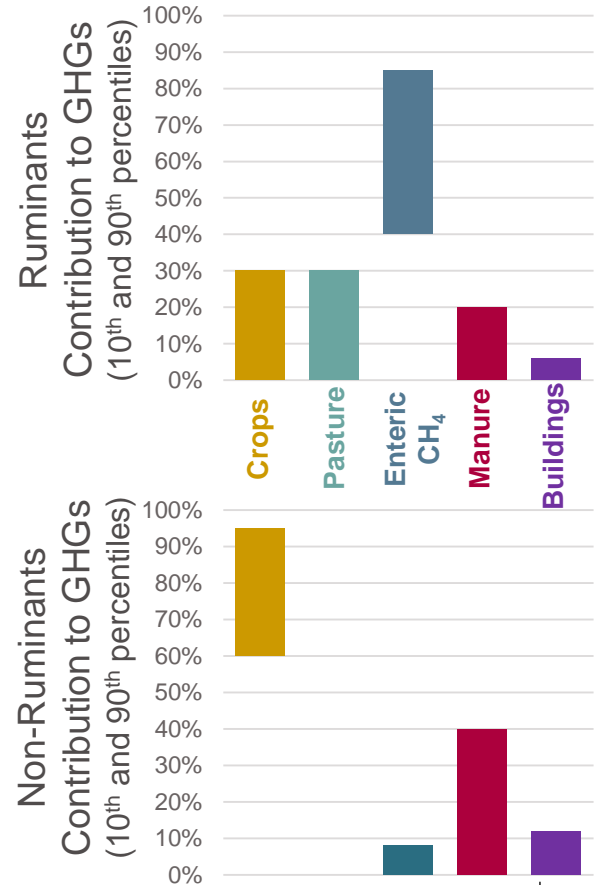


Livestock production

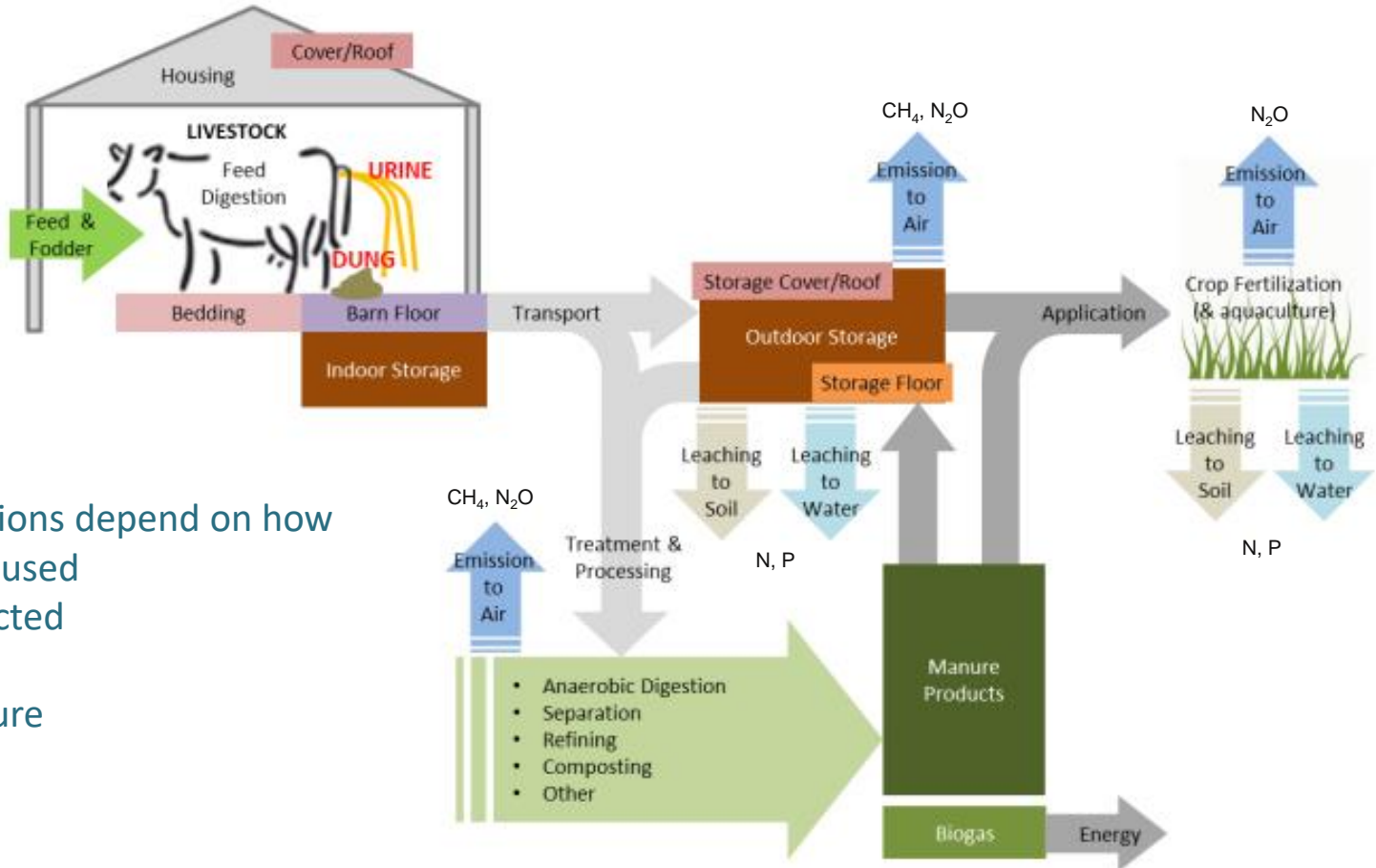
Agriculture



Non-ruminants: no grazing → no GHGs from pasture; lower enteric emissions



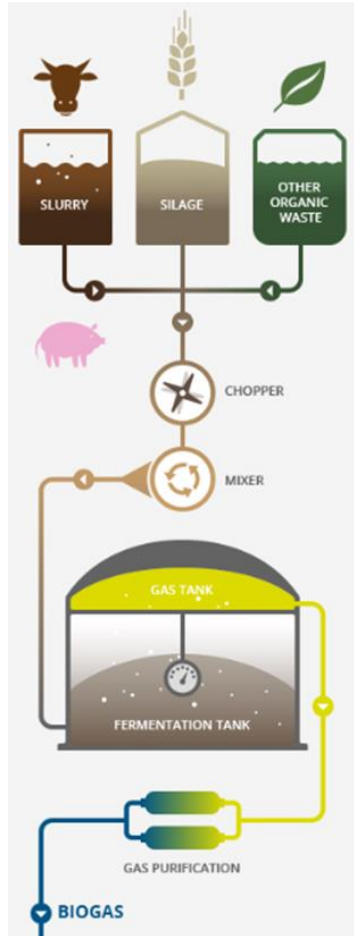
Manure management emissions



CH₄ and N₂O emissions depend on how

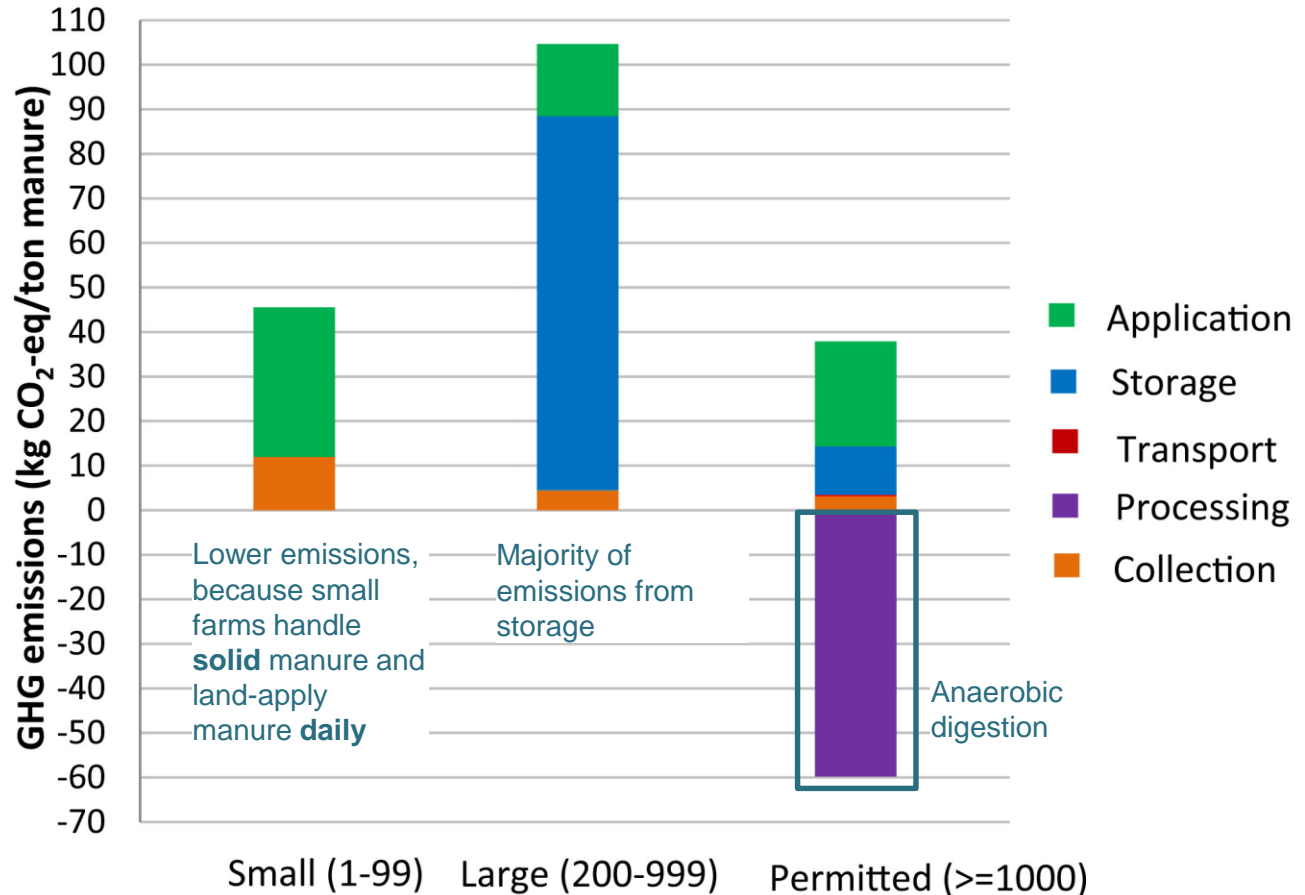
- livestock are housed
- manure is collected
- stored
- applied to pasture

Methane digester / Biogas plant



Manure management emissions

Dairy manure management GHG emissions for small, large, and extra-large dairy farms (number of cows in parentheses).



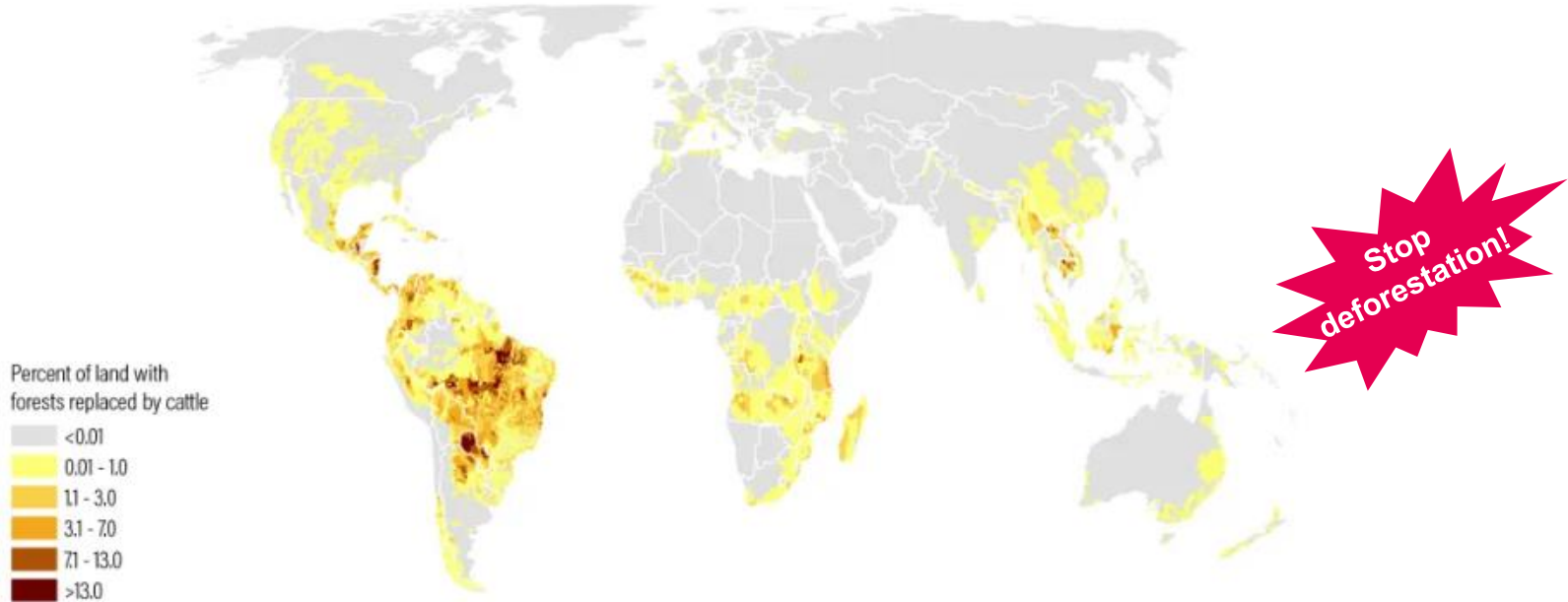
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Livestock production

Cattle pasture:
45 millions hectares

Global forest loss due to cattle grazing 2001-2015



Source: [World Resource Institute](http://WorldResourceInstitute)

Livestock production

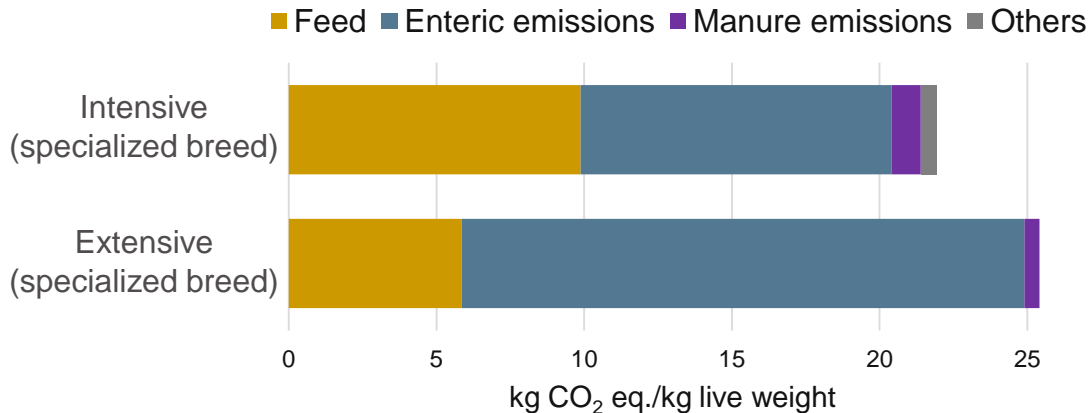
- How can we decrease the GHG emissions from livestock production?

The benefits of agricultural practices (e.g. organic, feed type, confinement) vary a lot, but one practice is significantly better worldwide:

→ Improved pasture management: **-10% to -50% of GHGs**, mainly thanks to lower soil carbon losses (lower deforestation)

But this also means switching from **extensive to intensive** systems

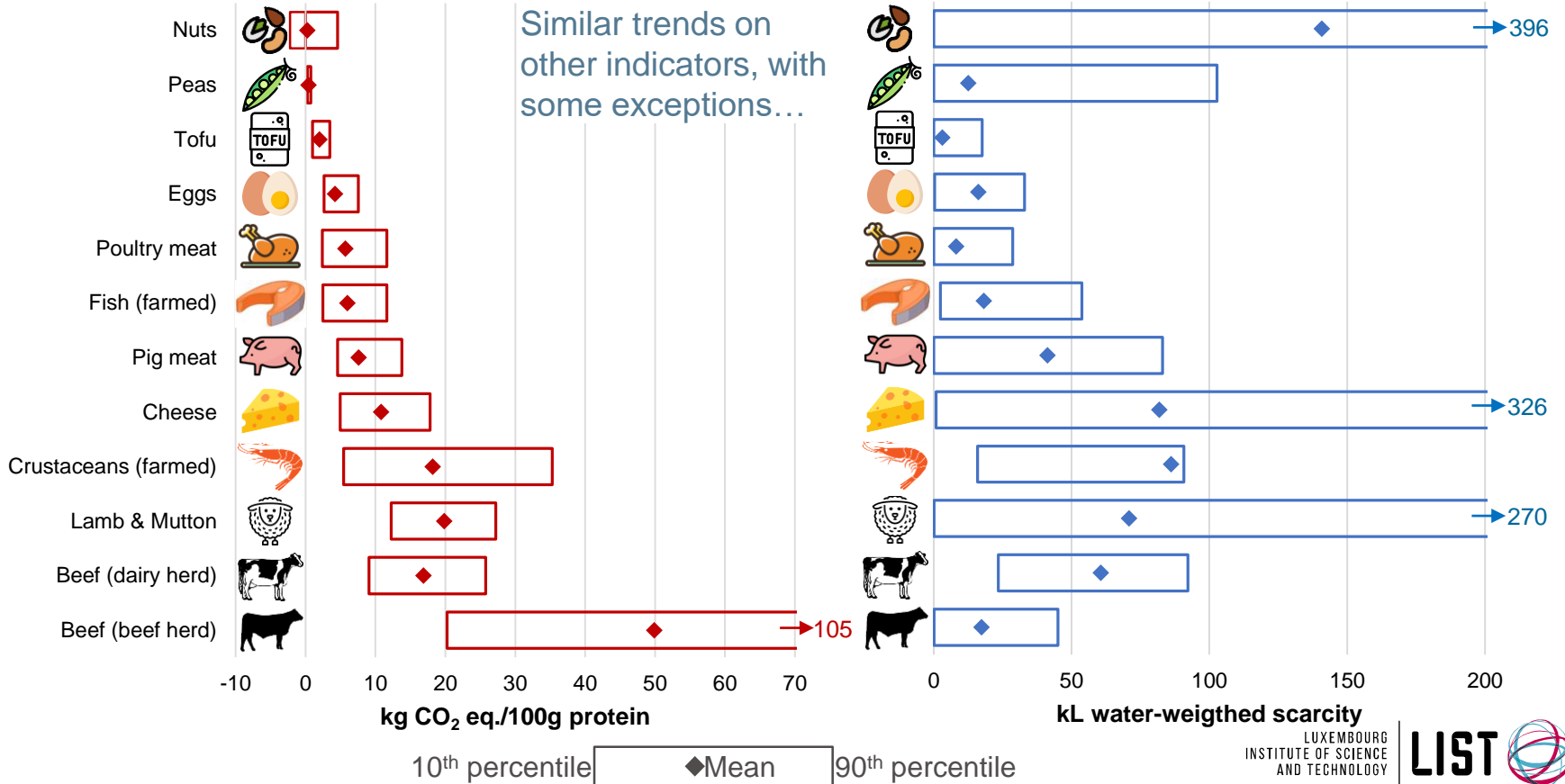
Example: Beef production in Italy



But different trends can be found on other indicators, e.g. for water use, due to irrigation for feed production

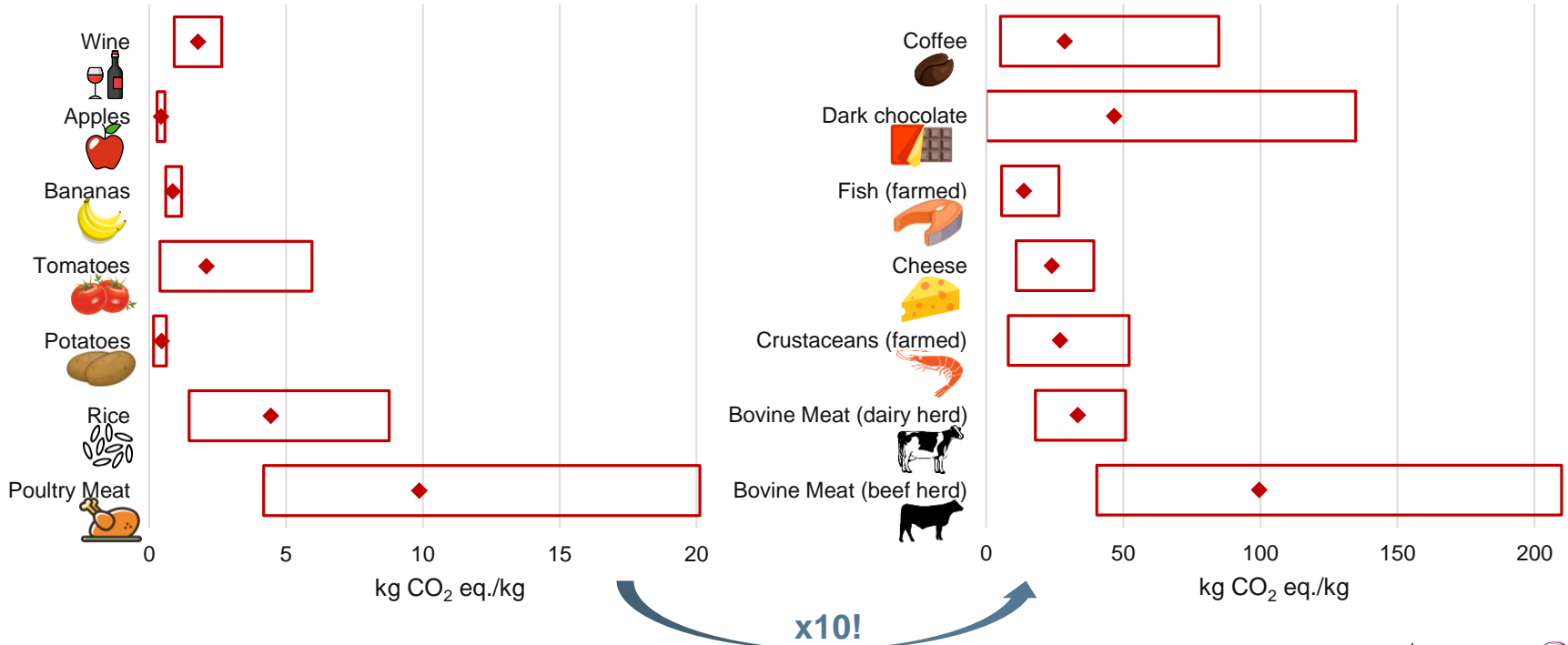
Comparison of food ingredients production

Agriculture



Comparison of food ingredients production

Agriculture



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2. AGRICULTURE

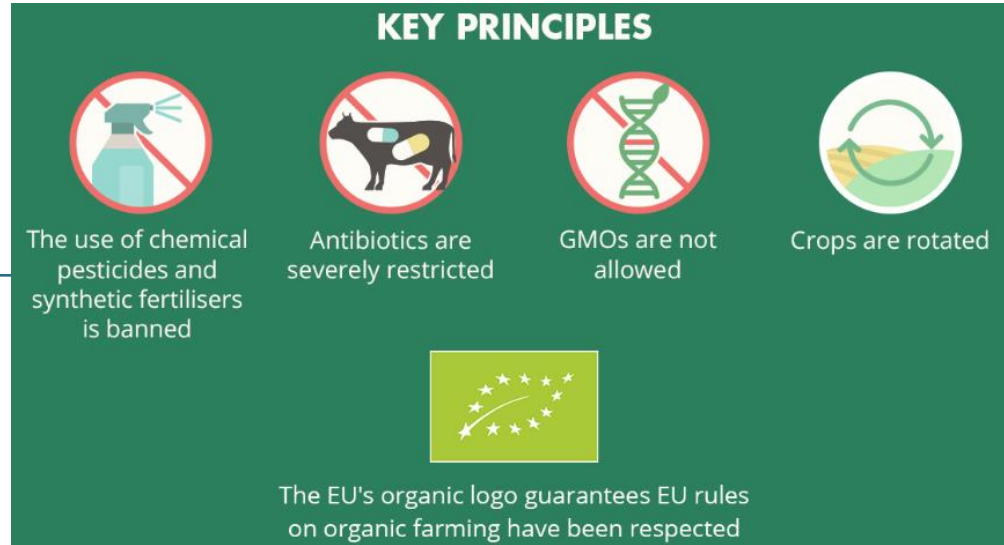
3. CONSUMER CHOICES



LIVE POLL !



Organic food



Non-synthetic pesticides and fertilizers allowed



National labels respect EU regulation with additional criteria:



Biodynamic



National products



Biodynamic and fair prices

Share of organic farms: 4.4%



vs. 7.5%

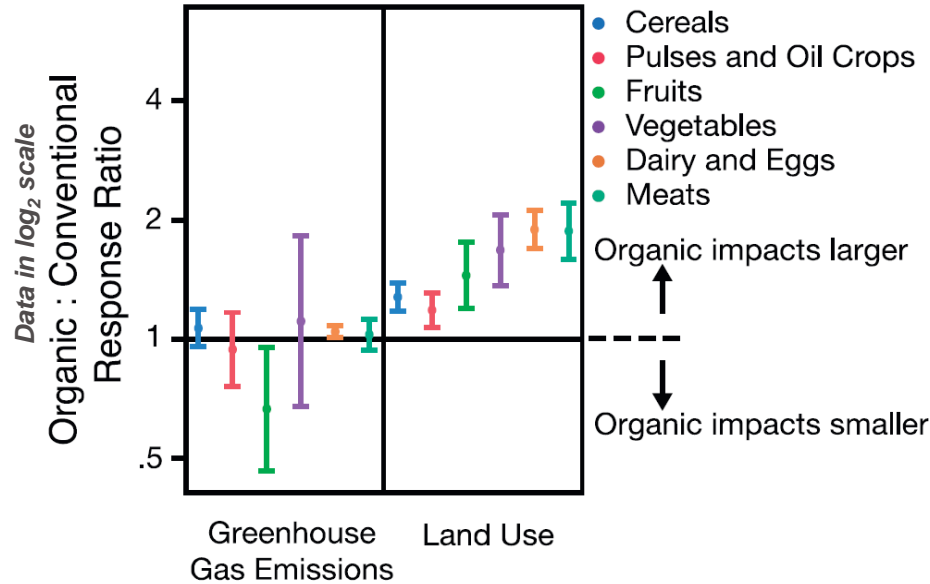


But increasing demand
→ 80% of organic food is imported

Organic food

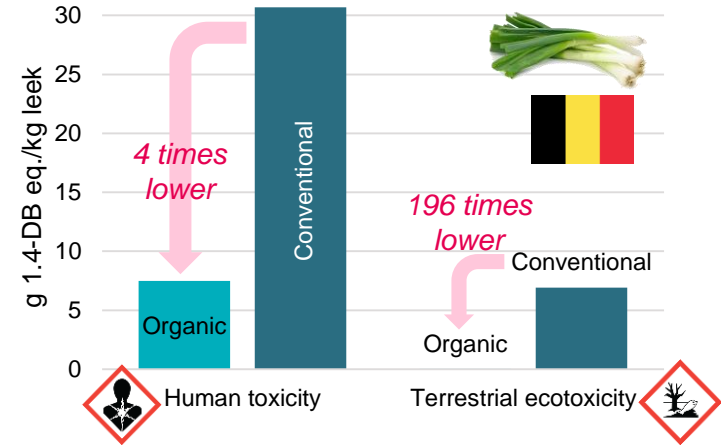
Impacts of organic farming?

- No clear increase or reduction of GHG emissions
- Main trade-off: higher land use (-10% to -60% on yield)



But other environmental benefits

- On human- and eco-toxicity



- On ecosystem services, e.g. providing habitat for pollinators, for native pest/disease control agents, better soil quality

Local food

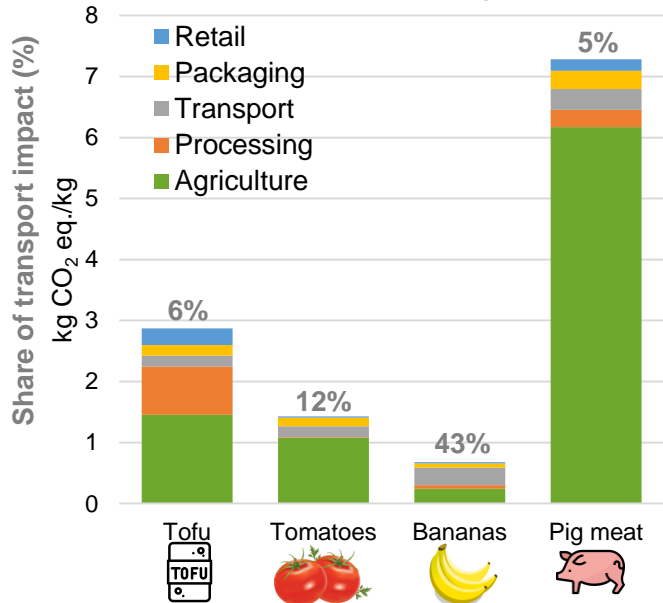
Luxembourg **highly dependant on imports** for food

→ Example: the local production of vegetables represents 5% of the consumption

→ Lower dependence only for meat products: 62% from local production

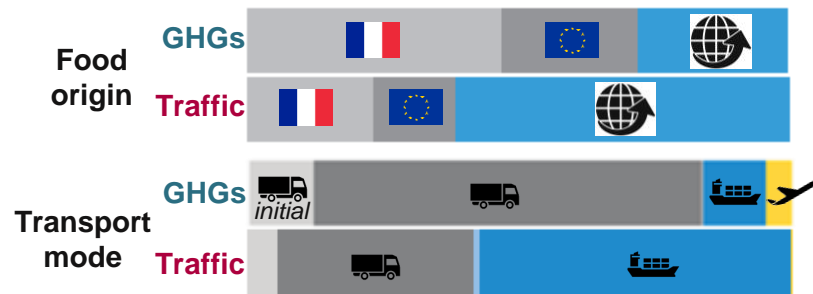
GHG emissions of **transport: ~8%** of EU food consumption

➤ Different shares depending on products:



➤ What are the main transport impacts?

Example: Total food supply in France



GHGs = 14 x GHGs for the same distance

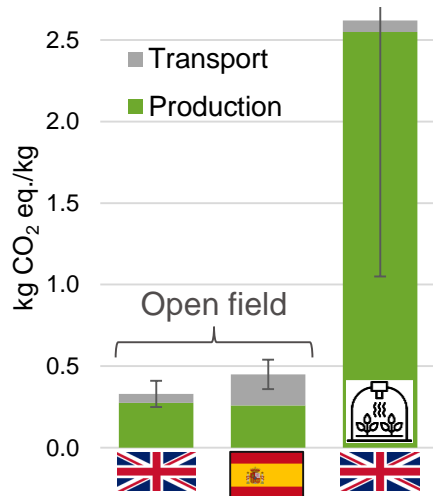
Animal feed ~20% GHGs (international imports)

Local food

Impacts of local food consumption?

- Buying national products?

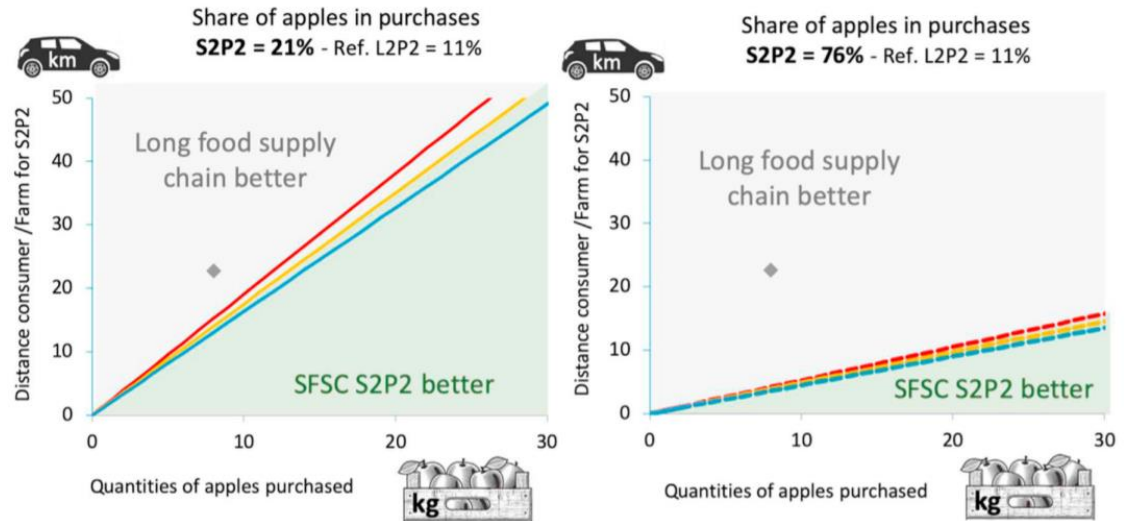
Example: Consumption of lettuce in United Kingdom



→ Depends on agricultural practices and climatic conditions

- Buying on-farm sale?

Example: Consumption of apples in Montpellier (France)



→ Depends on consumer trip (distance and trip purpose)

Seasonal food

Regionally seasonal vs. Globally seasonal



June-July



February-May



Off-season consumption



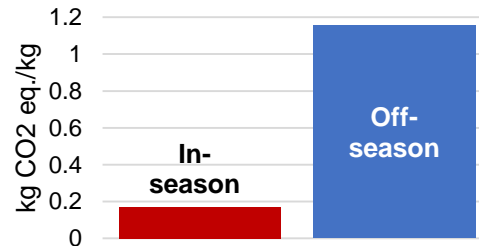
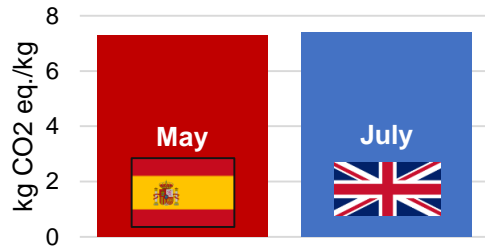
Import of globally seasonal products

- Higher transport and losses
- But variable impacts depending on the agricultural practices



Use of heated greenhouses

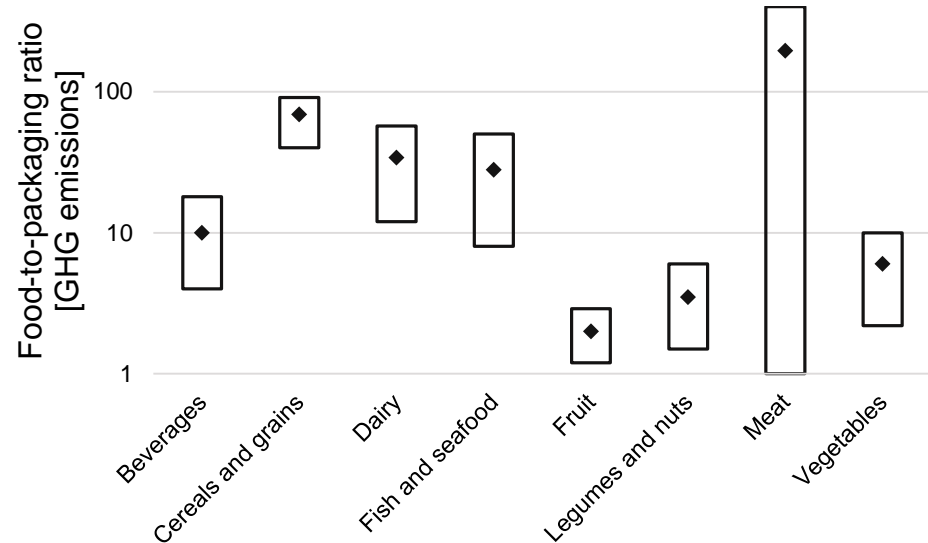
- Higher energy usage
- Can only be beneficial in countries with low-impact heating (e.g. Sweden, Iceland)



Packaging

GHG emissions of **packaging**: ~6% of EU food consumption
Main function of packaging: **preserve and protect food**

Consumer choices



Packaging

How can we reduce packaging impacts?

- Packaging-free supermarkets?

Example: “Original Unverpackt” in Germany

Around **-30% of GHGs** for 4 out of 6 products



Fruit bears due to cleaning
Tofu due to glass packaging

Similar trends for other indicators, with worse results for water use (cleaning)

→ **Increase reuse numbers and minimize cleaning impacts**



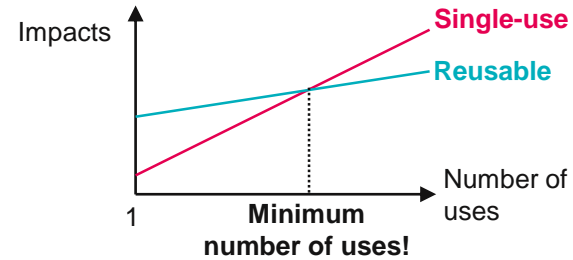
What about me?



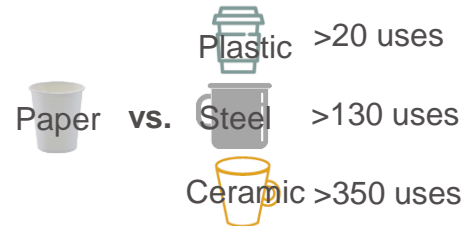
Research still needed...

Source: nomoretrash.org

- Reusable vs. single-use packaging
Mostly environmental benefits but...

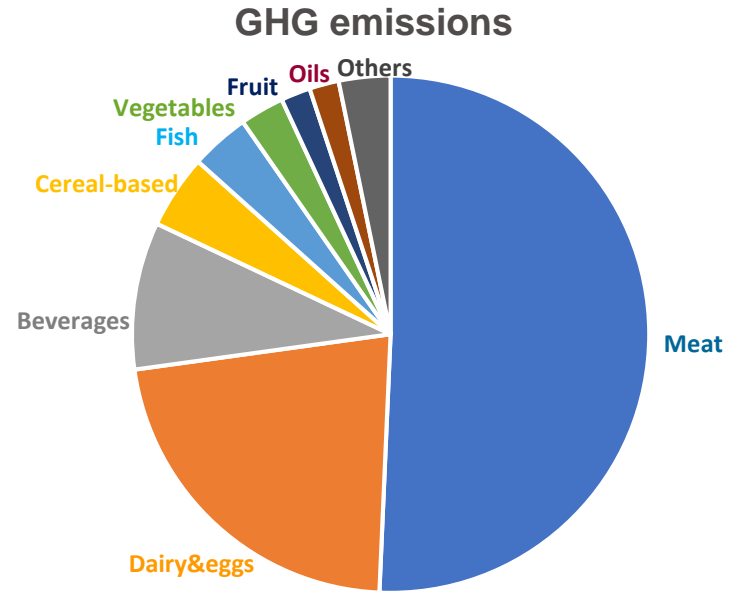
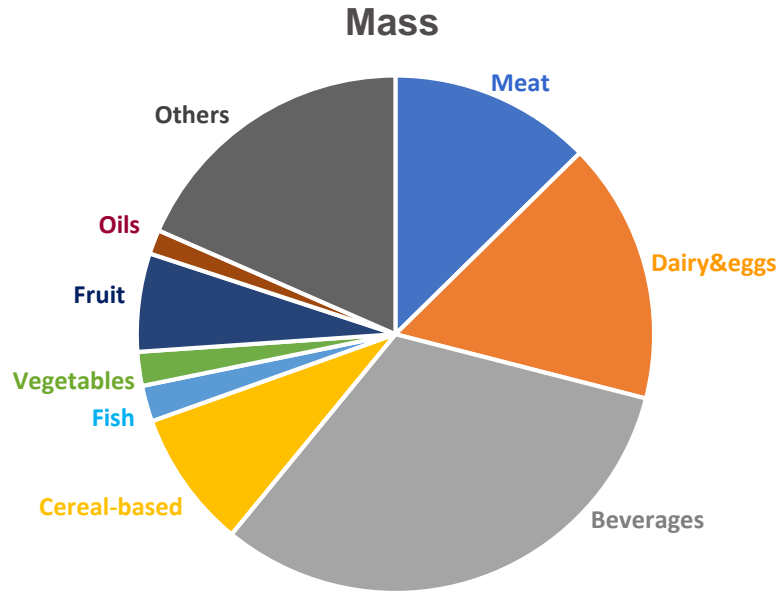


Example: Beverage cups in Europe



Adapt our diet?

Consumer choices



Impacts mainly driven by **meat consumption**:  246 g meat/day (EU average: 237 g/day)

Dietary recommendation: max 100 g meat/day (or less)

Adapt our diet?

Reduction of GHG emissions with

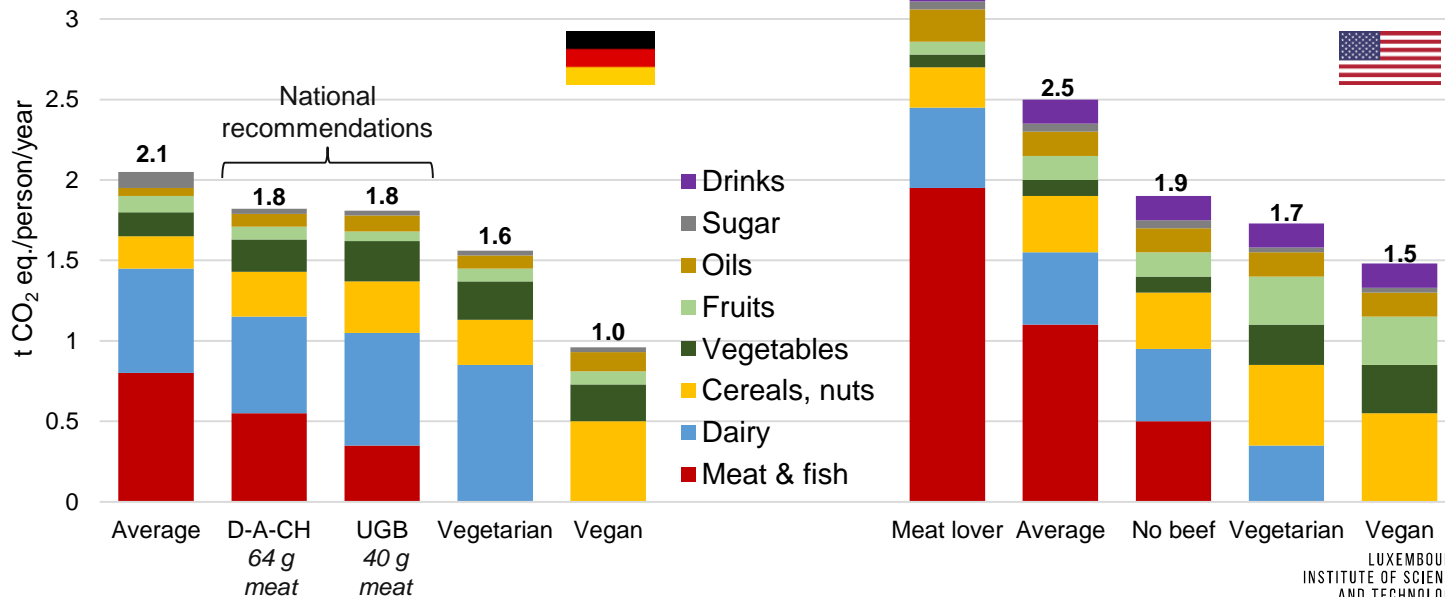
- ✓ Dietary recommendations → -10% to -20%
- ✓ Vegetarian and vegan diets → -30% to -50%



Additional benefits on human health and on other environmental indicators



Potential trade-offs on water scarcity (nuts)
Potential lack of vitamin B12



Consumer choices

1. CARBON FOOTPRINT

2. AGRICULTURE

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4. FOOD WASTE



FOOD WASTE, WHAT DOES IT MEAN?

Available

- **Edible food lost** during primary production
- **Edible leftover** from overproduction, retail and consumption stages.
- Non edible food due to the management of food

Non available:

- Food that cannot be eaten by humans, due to their natural inedibility (e.g. bones, shells)



Sources: EU Commission 2016
Teigiserova D., Hamelin L., et al. 2020.

LIVE POLL !



Food waste worldwide

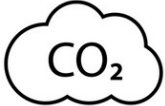
Overview



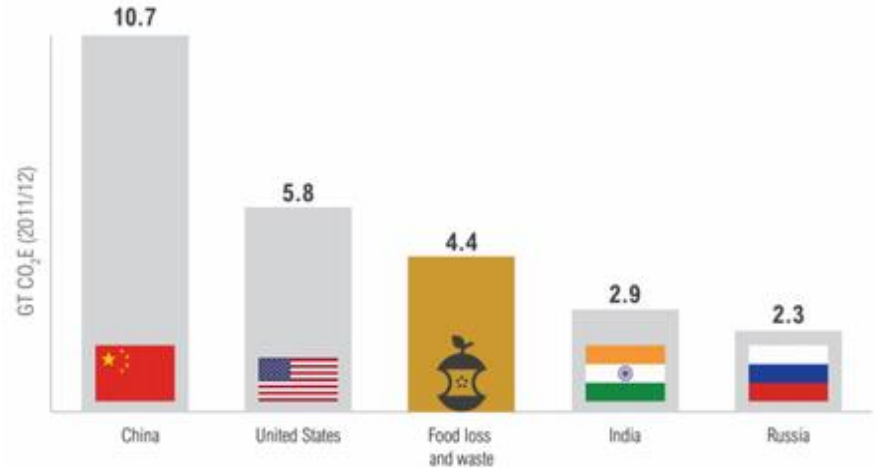
1/3 of the food produced in the world for human consumption is lost or wasted



1.3 billion tons per year worldwide



8% GHG emissions worldwide are caused by food waste

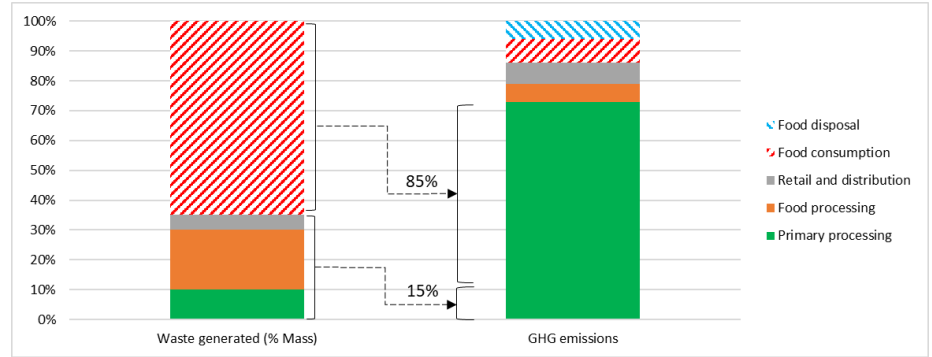


If food waste were its own country it would be the third largest Greenhouse Gas emitter

Food waste along food supply chain

Quantity and associated carbon footprint

- Waste exist at each stage of the food supply chain
- The further along the chain the food loss occurs, the more carbon intensive is the wastage.



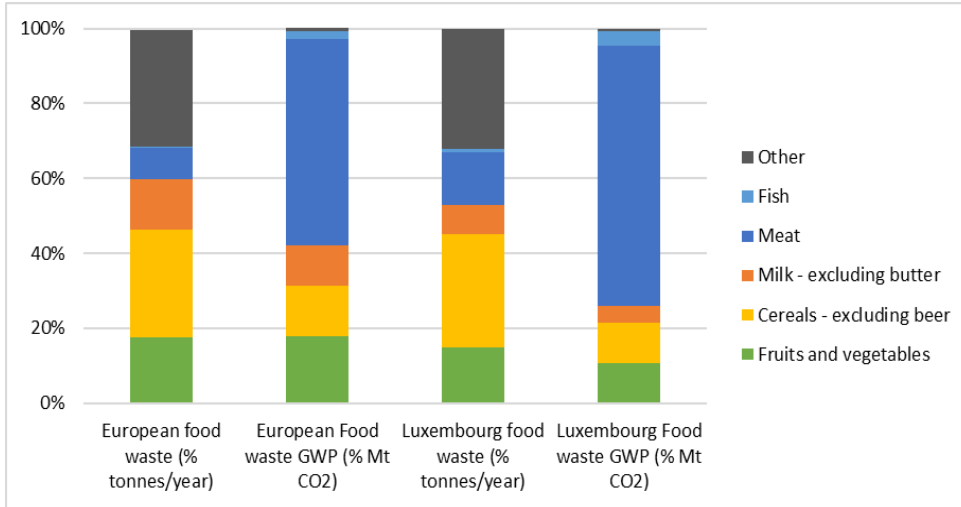
Carbon footprint from food waste over the food supply chain represents 15% of the total impact of the entire food supply chain.

European yearly average:

88 Mt food waste
⇔ 173 kg/capita
⇔ 186 Mt CO₂ eq
≈ 2 kg CO₂ eq/ kg waste

Food waste in Luxembourg

Typology and Carbon footprint



Luxembourg “Generation, treatment, and prevention of food waste” 2019 study

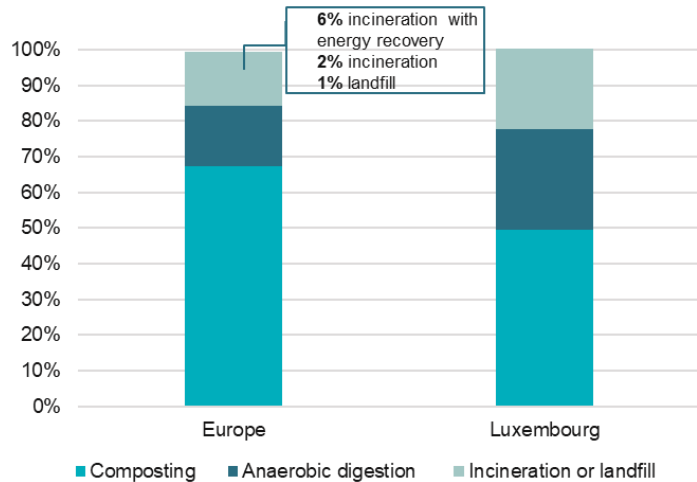


- **70 800 tonnes per year**
↔ **330 kg CO2 eq/capita/year**
- **118 kg/pers/year food waste**
 - Households **75%**
 - Restaurants & canteens **17%**
 - Retailers **7%**
- **40% estimated avoidable**

Source: [Scherhauser et al. 2018](#)
[European Parliament. 2017](#)
[Emwelt.lu](#)

Disposal of food waste

4 main routes



Anaerobic digestion ⇔ 64 kg CO₂ eq / ton food waste

Production of biogas (methane) and compost

Biogas substitutes Electricity, Natural gas

Compost avoids production of mineral fertiliser (Urea)



Composting ⇔ 97 kg CO₂ eq / ton food waste

Avoid production of mineral fertiliser (Urea)



Incineration ⇔ 814 kg CO₂ eq / ton food waste

Electricity substitution in case incinerator allows heat recovery



Landfill ⇔ 1232 kg CO₂ eq / ton food waste

Luxembourg strategy and objectives

“Plan National de Gestion des Déchets”

- **40% of food waste should be avoided:**
 - 27% at households
 - 80% at food services
 - 90% at retailers
- **Strengthen contribution of bio-waste valorisation into renewable energy production**
- **Roadmap “Null Offall Lëtzebuerg” strategy**

“Actions to prevent food waste at consumption are the most efficient to reduce the carbon footprint of the overall average Basket of Product”

European Commission Joint Research Centre 2017 Gruber et al. 2016)



United Nations Sustainable Development Goal 12

“By 2030, halve per capita global food waste at the retail and consumer levels, and reduce food losses along production and supply chain”

1. CARBON FOOTPRINT

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5. TAKE-AWAY MESSAGES

SCIENCE TO
be green



Are you ready for a change?

Take-away messages

Expected reduction on your food carbon footprint

High
>30%

Low
<10%

Negligible
- uncertain

Low - uncertain
Significant trade-offs

High
No trade-offs

Other environmental benefits

Local food

Seasonal food

Organic food

Reusable packaging

Stop food waste

Dietary recommendations

Vegetarian/vegan diet