



# Medición de la sostenibilidad dietética

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## en qué punto estamos y hacia dónde vamos

--Ujué Fresán--



# Medición de la **sostenibilidad dietética**

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en qué punto estamos  
y hacia dónde vamos

--Ujué Fresán--

# **Dieta sostenibile**

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# Dieta sostenible

*"Dietas con bajo impacto ambiental, que contribuyen a la seguridad alimentaria y nutricional y a la vida sana de las generaciones presentes y futuras. Las dietas sostenibles concurren a la protección y respeto de la biodiversidad y los ecosistemas, son culturalmente aceptables, económicamente justas, accesibles, asequibles, nutricionalmente adecuadas, inocuas y saludables, y permiten la optimización de los recursos naturales y humanos."*

# Dieta sostenible



*"Diets with low environmental impact, that contribute to the food security, nutritional and healthy life of the present and future generations, respect the diversity of ecosystems, are accessible, nutritious, safe, and economically affordable, and they allow the sustainable use of natural resources and human resources."*

# Medición del impacto ambiental

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# Medición del **impacto ambiental**

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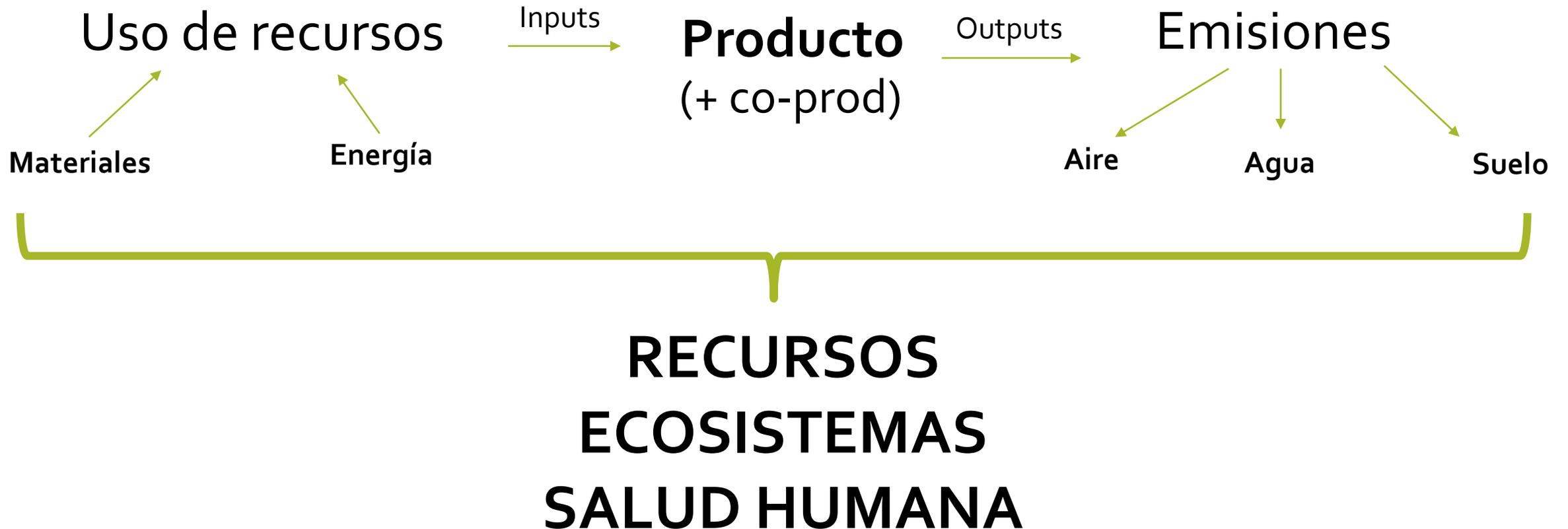
# Impacto ambiental

Cualquier cambio que un producto o un proceso puede causar en el medioambiente

- Disponibilidad de recursos
- Calidad del suelo, agua, aire, ecosistemas
- Biodiversidad
- Salud humana

# Impacto ambiental

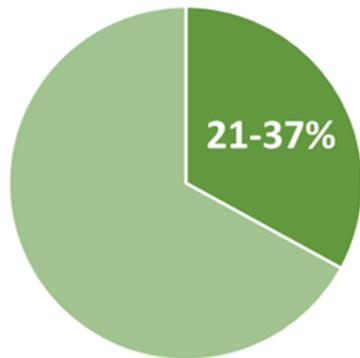
Todos los productos y procesos generan impacto ambiental



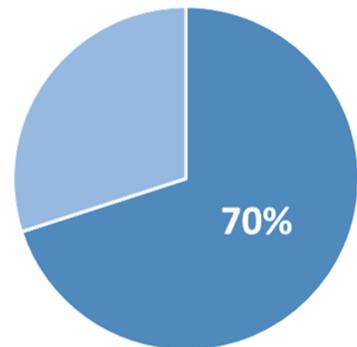
# Impacto ambiental: SISTEMA ALIMENTARIO

Uno de los principales sectores responsables del uso de recurso y de la degradación del medioambiente

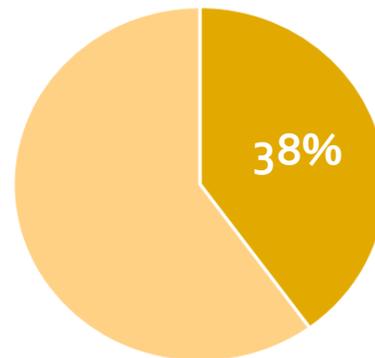
GEI



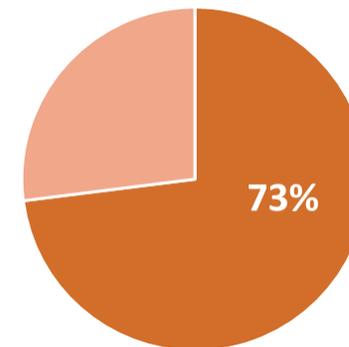
Consumo agua



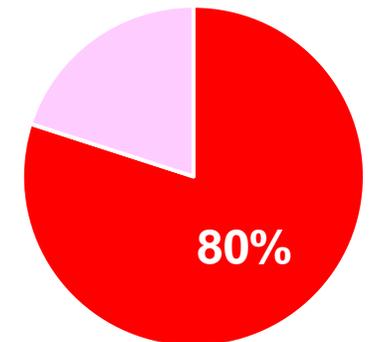
Uso suelo



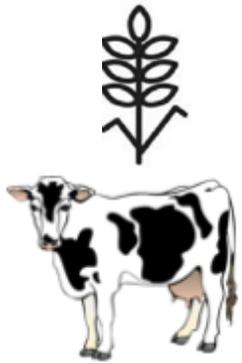
Deforestación



Biodiversidad

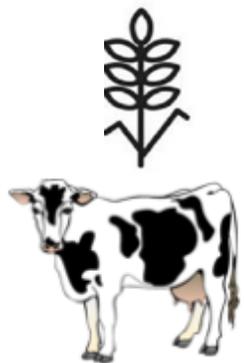


# Impacto ambiental



Producción

# Impacto ambiental



Producción

Procesamiento

Envases

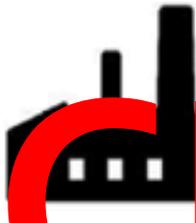
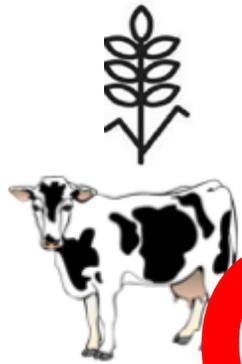
Comercio

Consumo

Residuos



# Impacto ambiental



# CICLO DE VIDA

Producción

Procesamiento

Envases

Comercio

Consumo

Residuos

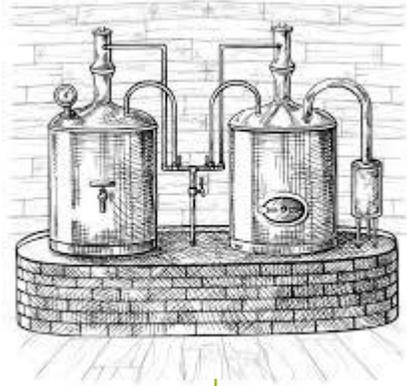




+ Transporte



Producción agrícola



+ Procesamiento



+ Envasado



+ Fin de vida



# Life Cycle Assessment (LCA)

Análisis de ciclo de vida (ACV)

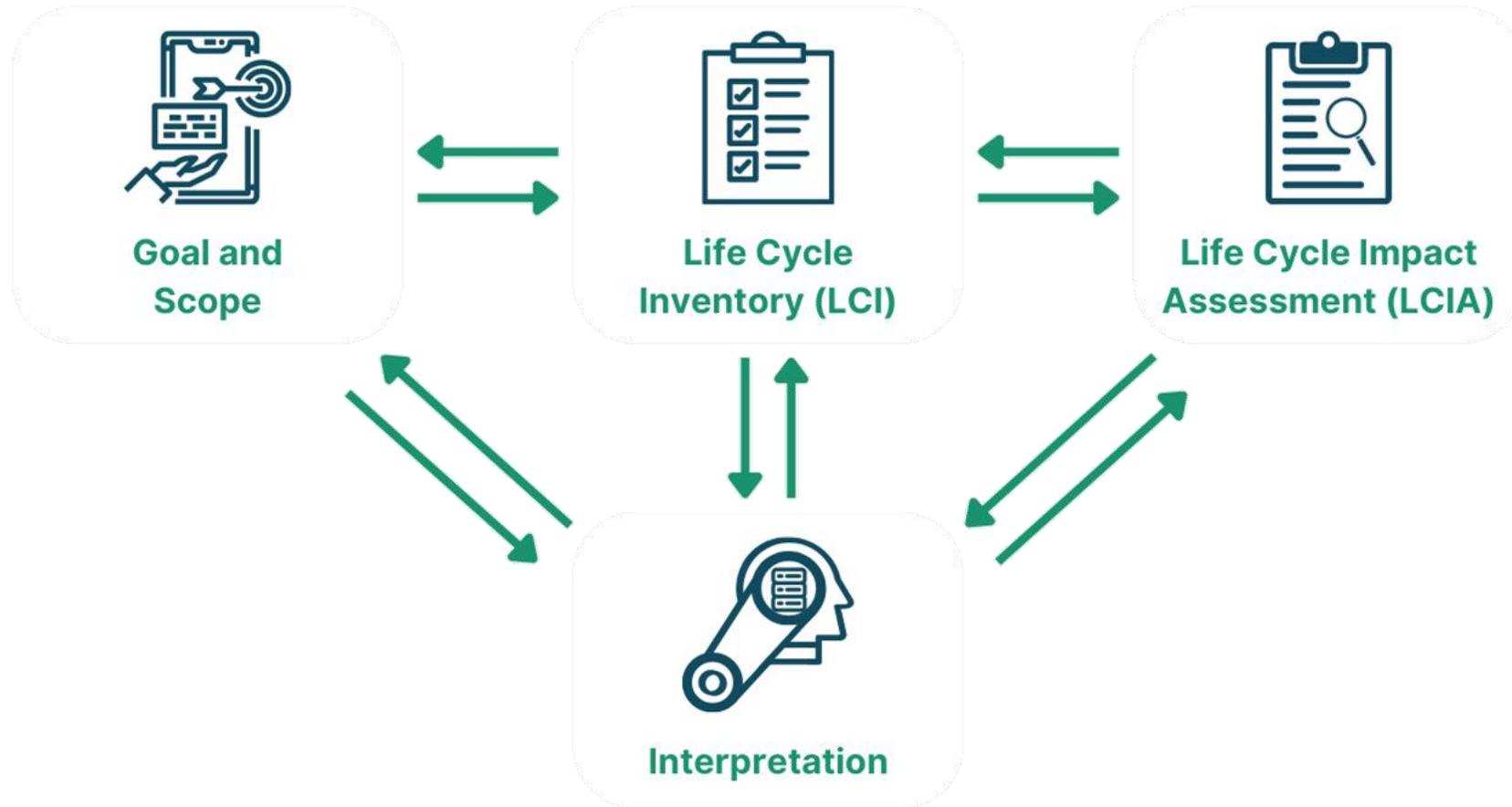
## Metodología estandarizada



[ISO 14040:2006: Environmental management — Life cycle assessment — Principles and framework](#)

[ISO 14044:2006: Environmental management — Life cycle assessment — Requirements and guidelines](#)

# Life Cycle Assessment (LCA)

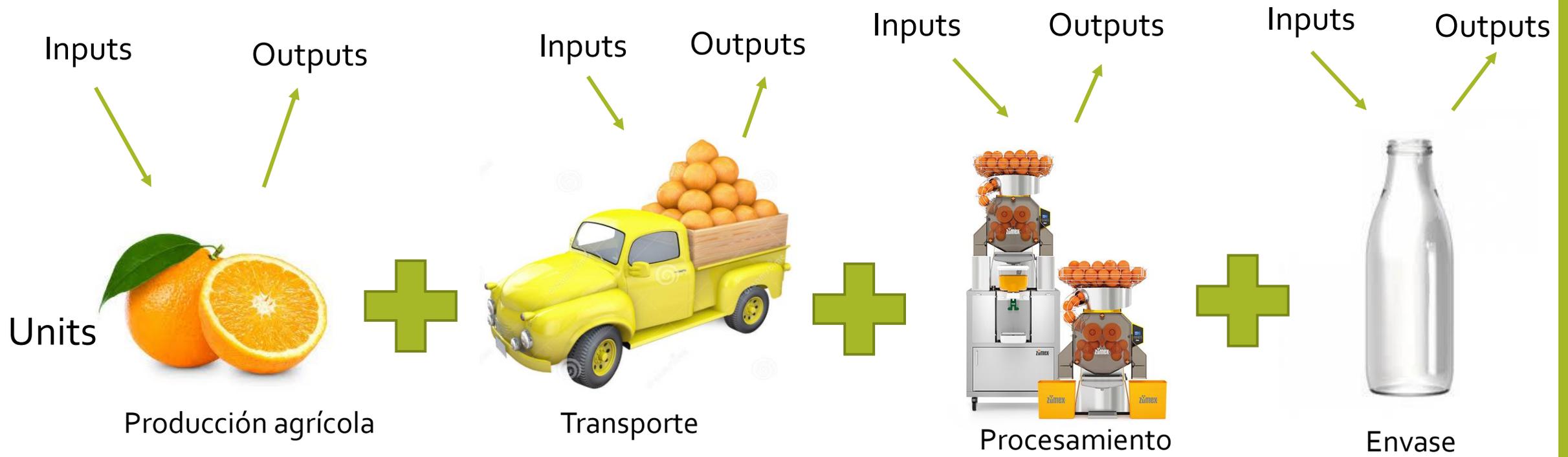


# 1. Goal and scope

- ✓ Describe el producto(s) (proceso o actividad) estudiado, y el propósito general del análisis.
- ✓ Establece el contexto.
- ✓ Establece la audiencia prevista.
- ✓ Define y justifica decisiones metodológicas y asunciones clave.
  
- ✓ **FUNCTIONAL UNIT**: Unidad de referencia en el estudio del LCA.
- ✓ **SYSTEM BOUNDARIES**: Fases del ciclo de vida del producto incluidas en el estudio de LCA.

## 2. Life cycle inventory (LCI)

- ✓ Identifica los **inputs y outputs** atribuibles al producto analizado **en los límites del sistema** establecidos.
- ✓ **Datos** de LCI deben ser de **alta calidad**.
- ✓ Consejo! Construir un **modelo** del LCI que una **todas las fases**.



System product



## 2. Life cycle inventory (LCI)

- ✓ Identifica los **inputs y outputs** atribuibles al producto analizado **en los límites del sistema** establecidos.
- ✓ **Datos** de LCI deben ser de **alta calidad**.
- ✓ Consejo! Construir un **modelo** del LCI que una **todas las fases**.
- ✓ Permite evaluar la **distribución** del uso de los recursos y las emisiones **a lo largo de las fases**.

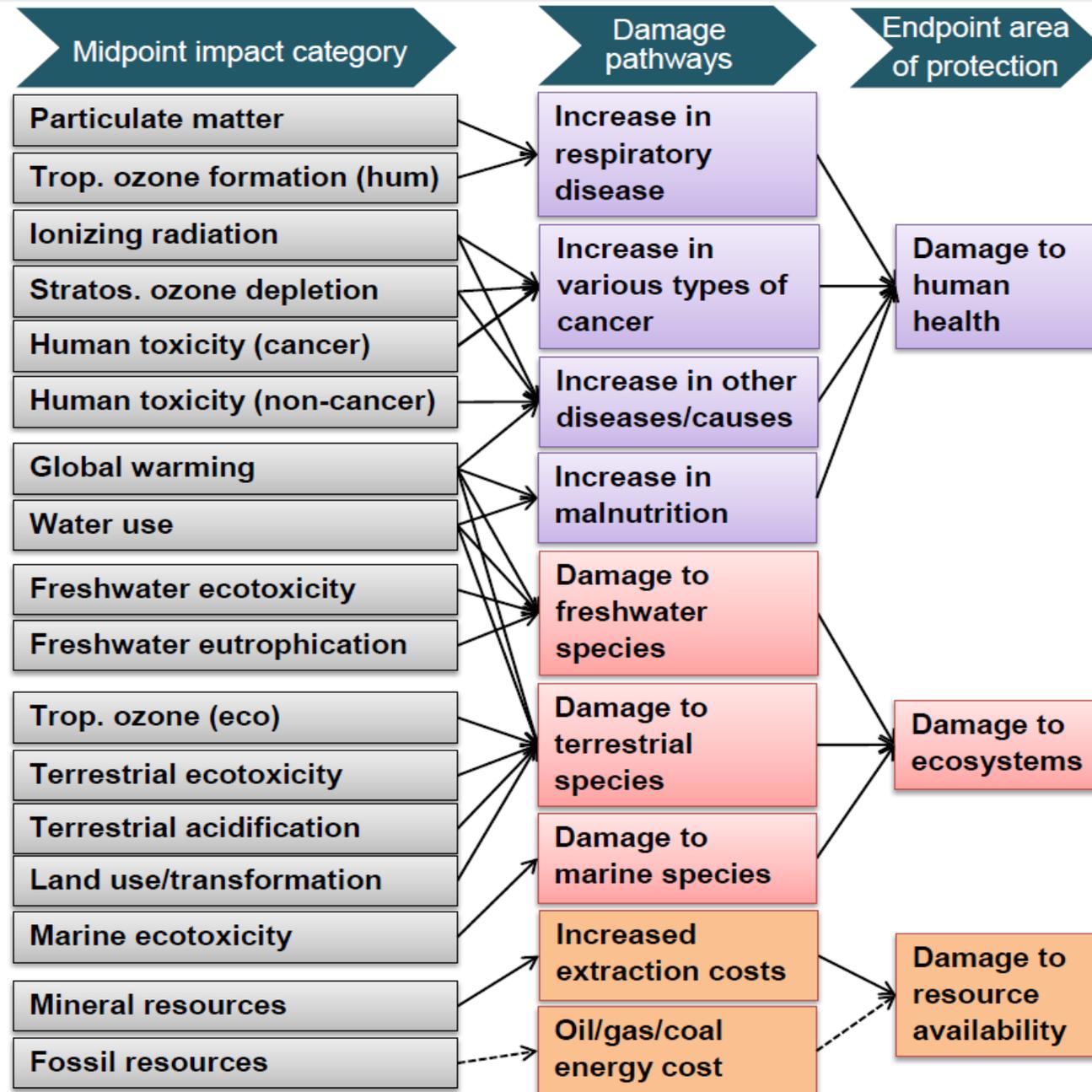
# 3. Life cycle impact assessment (LCIA)

- ✓ **Cuantificar el impacto** de las actividades representadas por el LCI
- ✓ **Amplia variedad de métodos** de LCIA disponibles
- ✓ **Diferentes categorías de impacto**
  - Específica (GWP) VS varios (WF, GWP, uso de tierra...)
- ✓ **Diferentes factores de caracterización**
  - Metano (CH<sub>4</sub>)
- ✓ **Elección de método:** fuente de **incertidumbre**
  - Análisis de sensibilidad.

### 3. Life cycle impact assessment (LCIA)

✓ **Resultados** se pueden expresar:

- Mid-point: resultados para indicadores ambientales específicos
- End-point: daños anticipados sobre los recursos, los ecosistemas, o la salud humana
  - varios indicadores mid-point agregados sobre una base común



# 3. Life cycle impact assessment (LCIA)

✓ **Resultados** se pueden expresar:

- Mid-point: resultados para indicadores ambientales específicos
- End-point: Daños anticipados sobre los recursos, los ecosistemas, o la salud humana

## OPCIONAL:

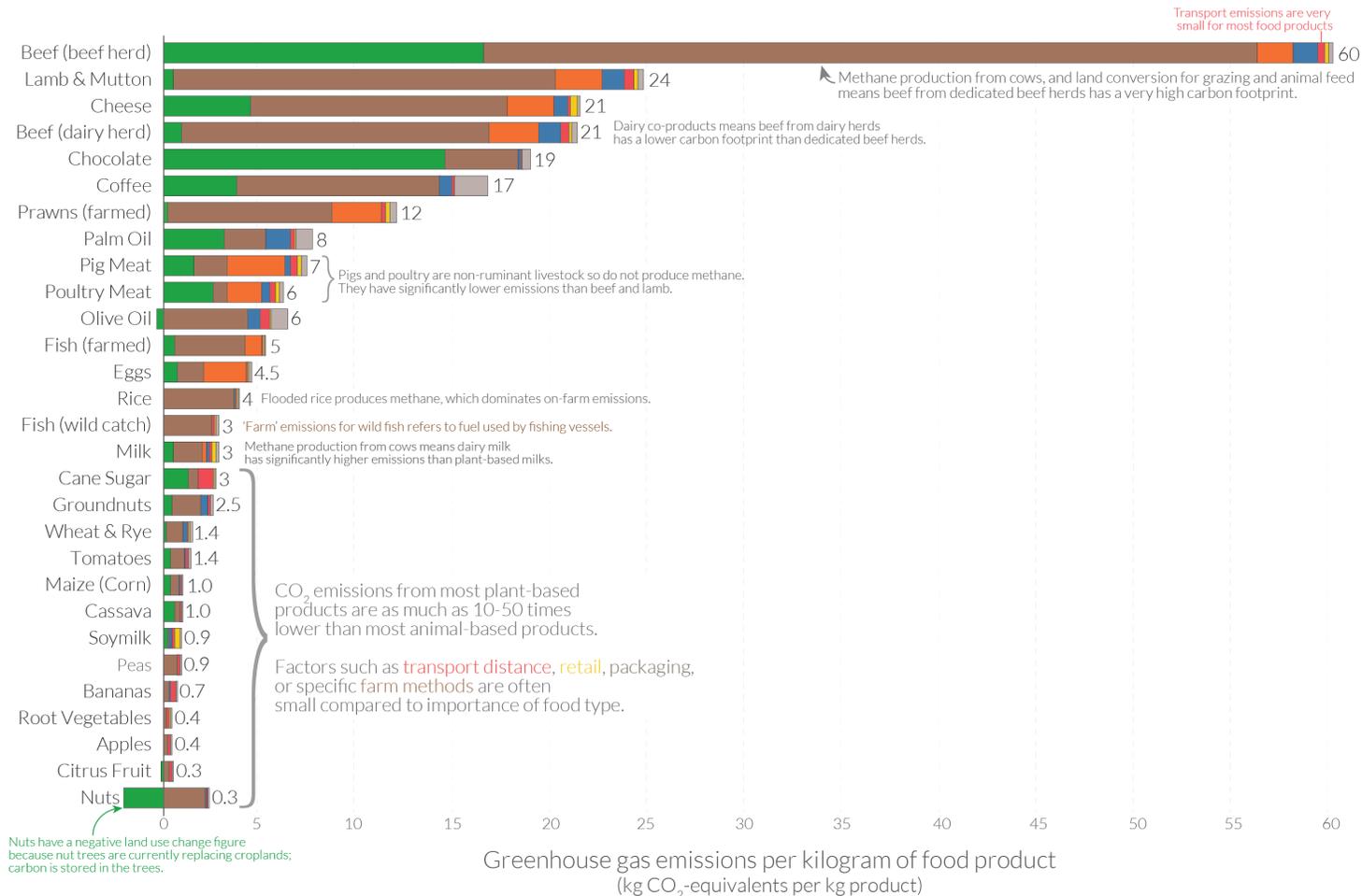
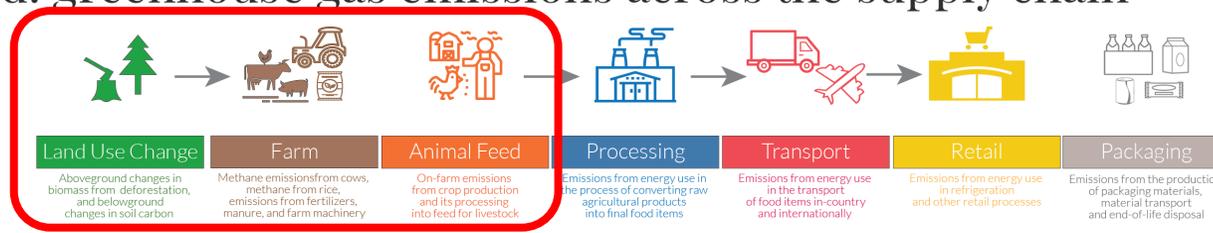
Normalization: comparar con una referencia.

Weighting: "fusionar" indicadores en una unidad común.

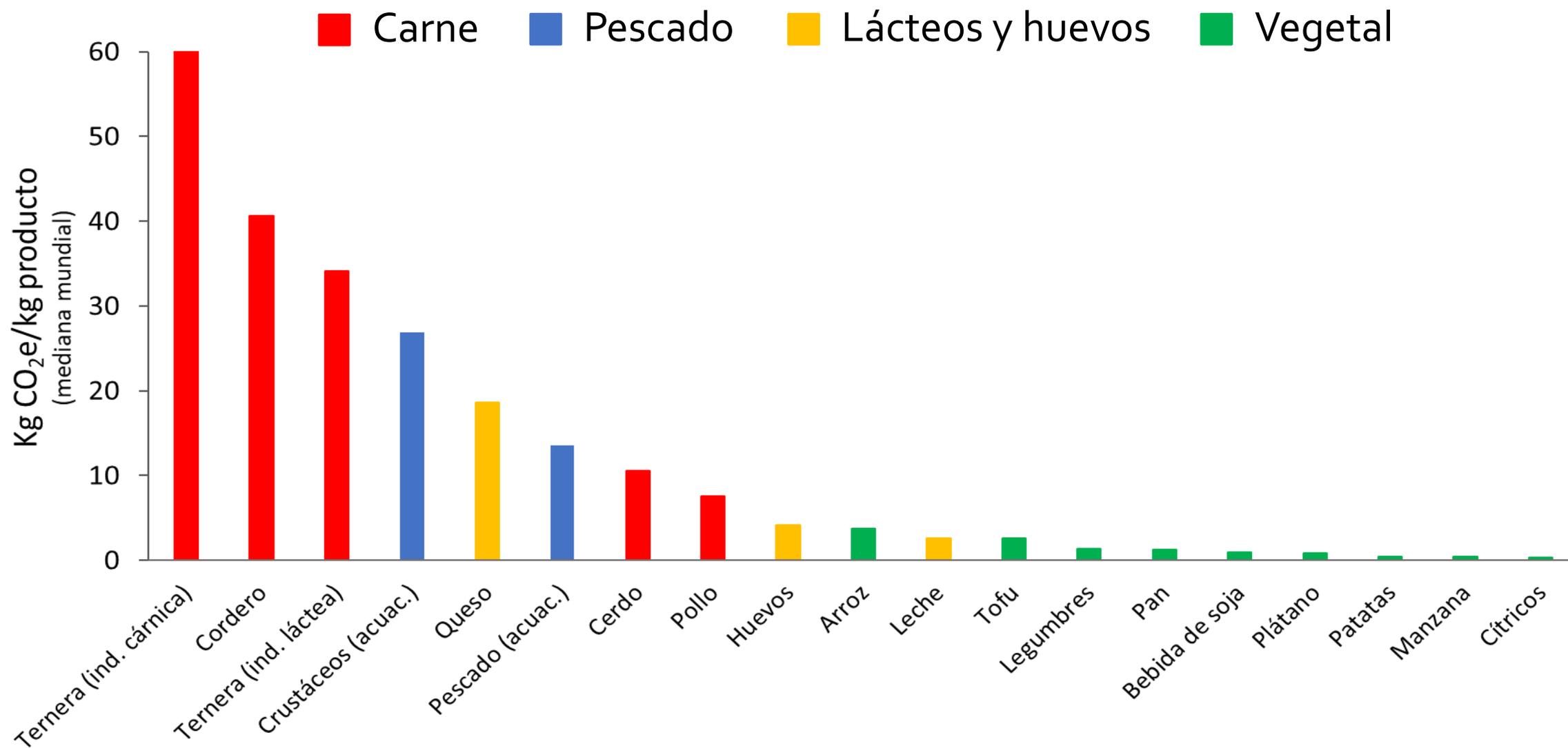
# 4. Interpretación

1. Análisis de resultados de LCI y LCIA: **identificación de hotspots**
2. **Verificación:**
  - Integridad: ¿falta información?
  - Sensibilidad: incertidumbre
  - Consistencia: coherencia entre objetivo, alcance, hipótesis, datos, etc. o al comparar
  - Otras...
3. **Conclusiones, recomendaciones e informes**

# Food: greenhouse gas emissions across the supply chain

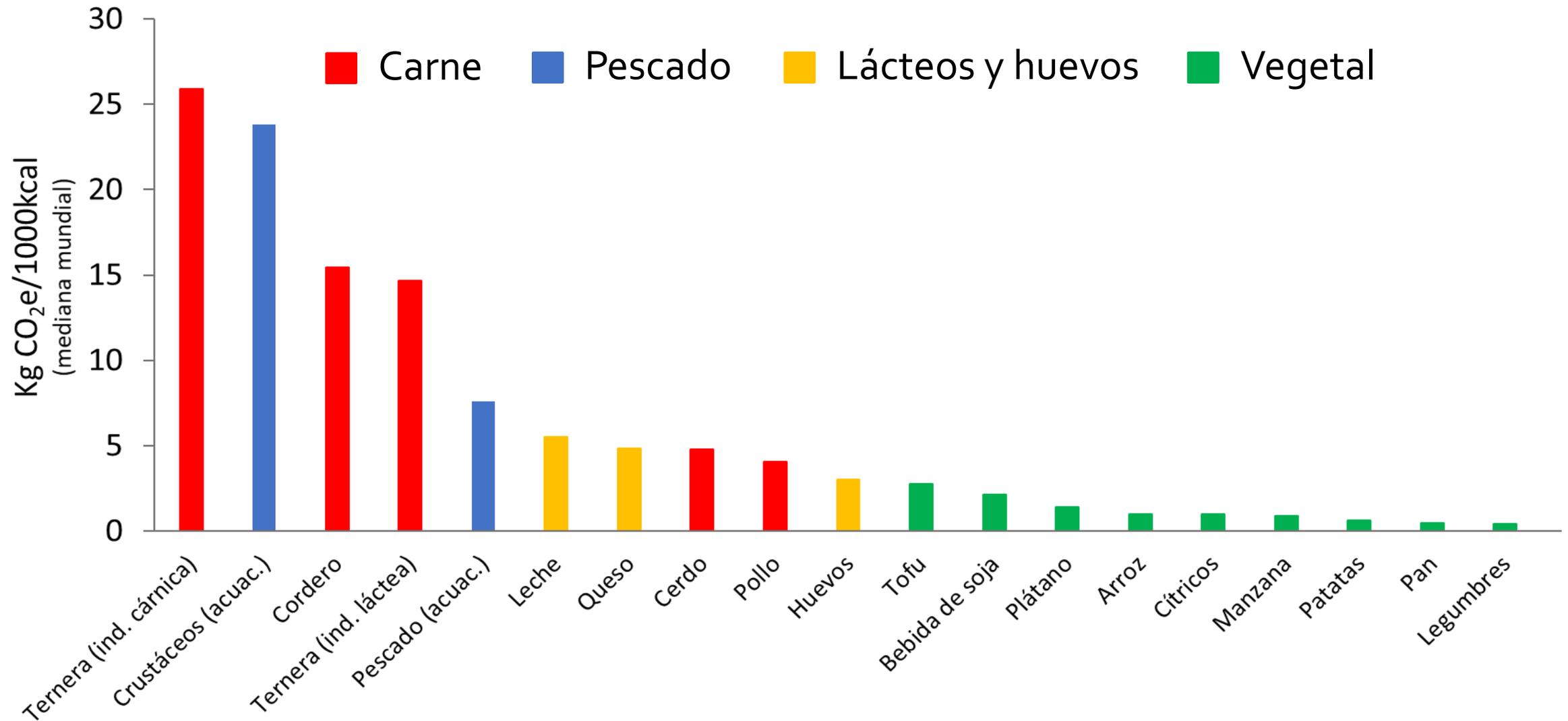


# GEI por kg de producto



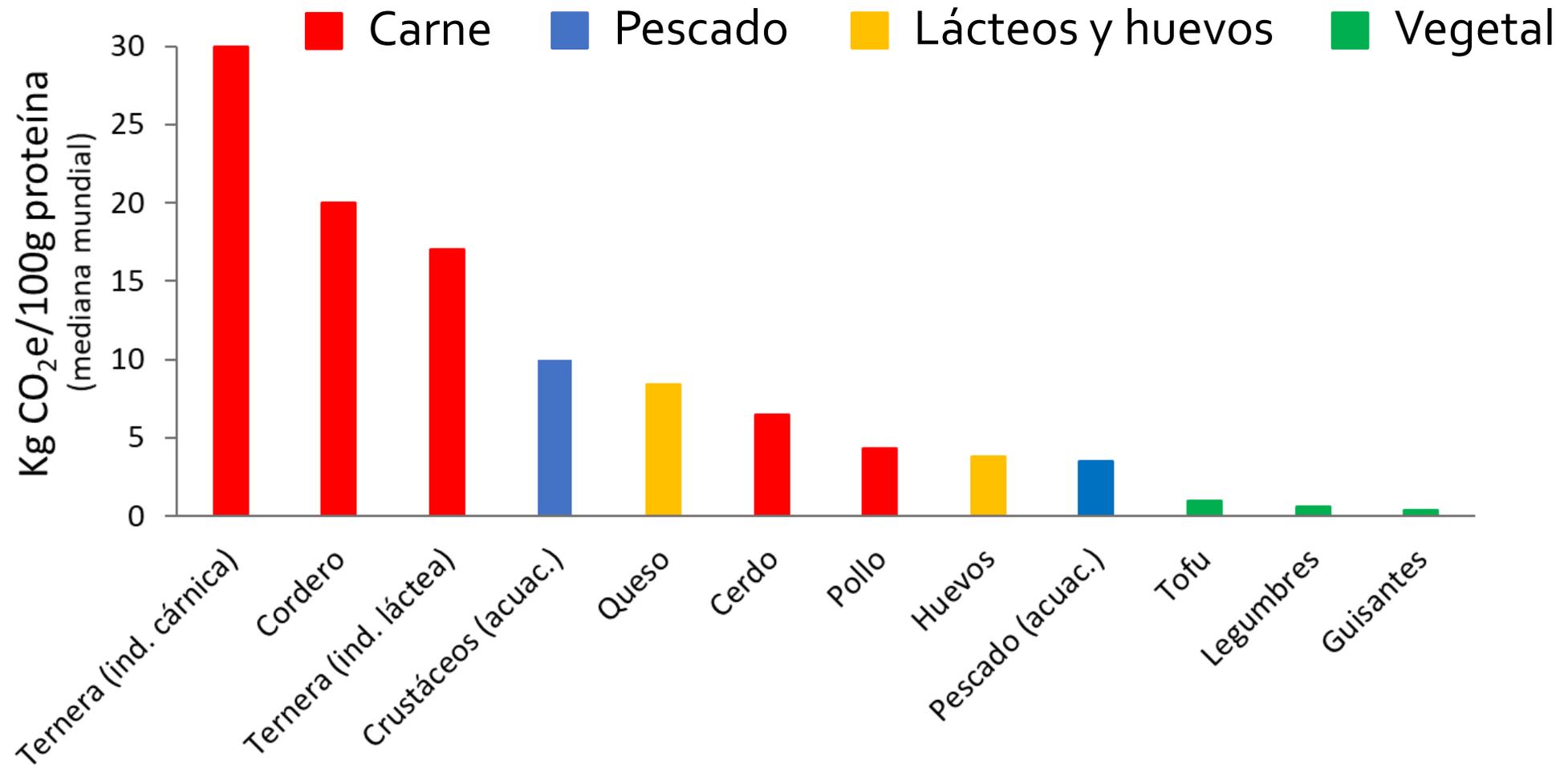
Fuente datos: Poore and Nemecek (2018) *Science*

# GEI por 1000kcal



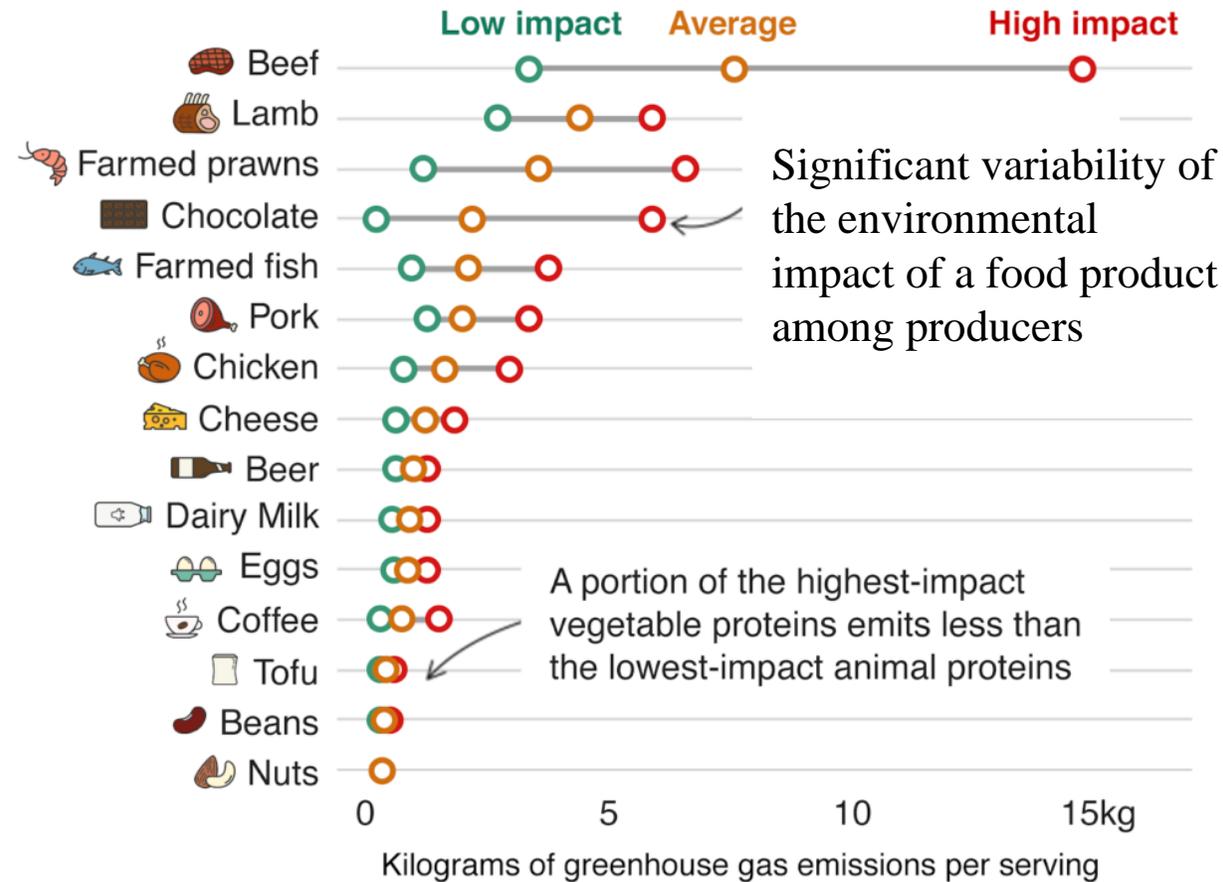
Fuente datos: Poore and Nemecek (2018) *Science*. Cálculos extra de elaboración propia (composición nutricional FAO)

# GEI por 100g proteína



# Beef has the biggest carbon footprint - but the same food can have a range of impacts

Kilograms of greenhouse gas emissions per serving



# **Integración de la salubridad en ACV**

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# nutritional-Life Cycle Assessment (nLCA)



# 1. Composición nutricional como FU

Food item	Type of food	kg CO <sub>2</sub> e/NRF 6.0	kg CO <sub>2</sub> e/NRF 9.3	kg CO <sub>2</sub> e/NRF 9.3 (all sugars)	kg CO <sub>2</sub> e/NRF 11.0	kg CO <sub>2</sub> e/NRF 15.3	kg CO <sub>2</sub> e/NRF 20.3
Ham shoulder medium fat boiled	Red meat	1.52	2.71	2.80	0.79	0.79	0.68
Beef rump steak prepared	Red meat	4.15	2.76	2.76	1.29	1.20	1.02
Potatoes w/o skins boiled average	Starchy vegetables	0.07	0.06	0.06	0.06	0.05	0.05
Eggs (chicken) boiled average	Eggs	0.59	0.44	0.44	0.22	0.15	0.14
Chicken with skin prepared	Poultry	2.41	2.76	2.76	1.22	1.15	0.74
Milk whole	Dairy	0.82	0.83	1.37	0.35	0.38	0.34
Milk skimmed	Dairy	0.87	0.62	0.94	0.35	0.33	0.30
Cheese Gouda 48+ average	Dairy	0.70	1.70	1.70	0.41	0.52	0.47
Shrimps Dutch peeled boiled	Fish	2.91	2.19	2.20	0.19	0.20	0.19
Herring salted	Fish	0.56	1.34	1.34	0.06	0.05	0.05
Kale curly boiled	Vegetables	0.08	0.07	0.07	0.07	0.06	0.05
Mushrooms boiled	Vegetables	2.59	1.51	1.53	1.36	0.78	0.65
Pineapple	Fruit	0.15	0.13	0.20	0.13	0.18	0.15
Banana	Fruit	0.32	0.15	0.46	0.14	0.36	0.15
Beans French boiled	Legumes	0.30	0.18	0.19	0.17	0.12	0.10
Peas frozen boiled	Legumes	0.16	0.13	0.13	0.12	0.09	0.08
Bread wholemeal average	Cereals	0.16	0.14	0.15	0.09	0.10	0.07
Bread white water based	Cereals	0.34	0.44	0.54	0.22	0.27	0.20
Cashew nuts unsalted	Nuts	0.40	0.23	0.25	0.15	0.12	0.08

## 2. Efecto en salud como indicador de impacto

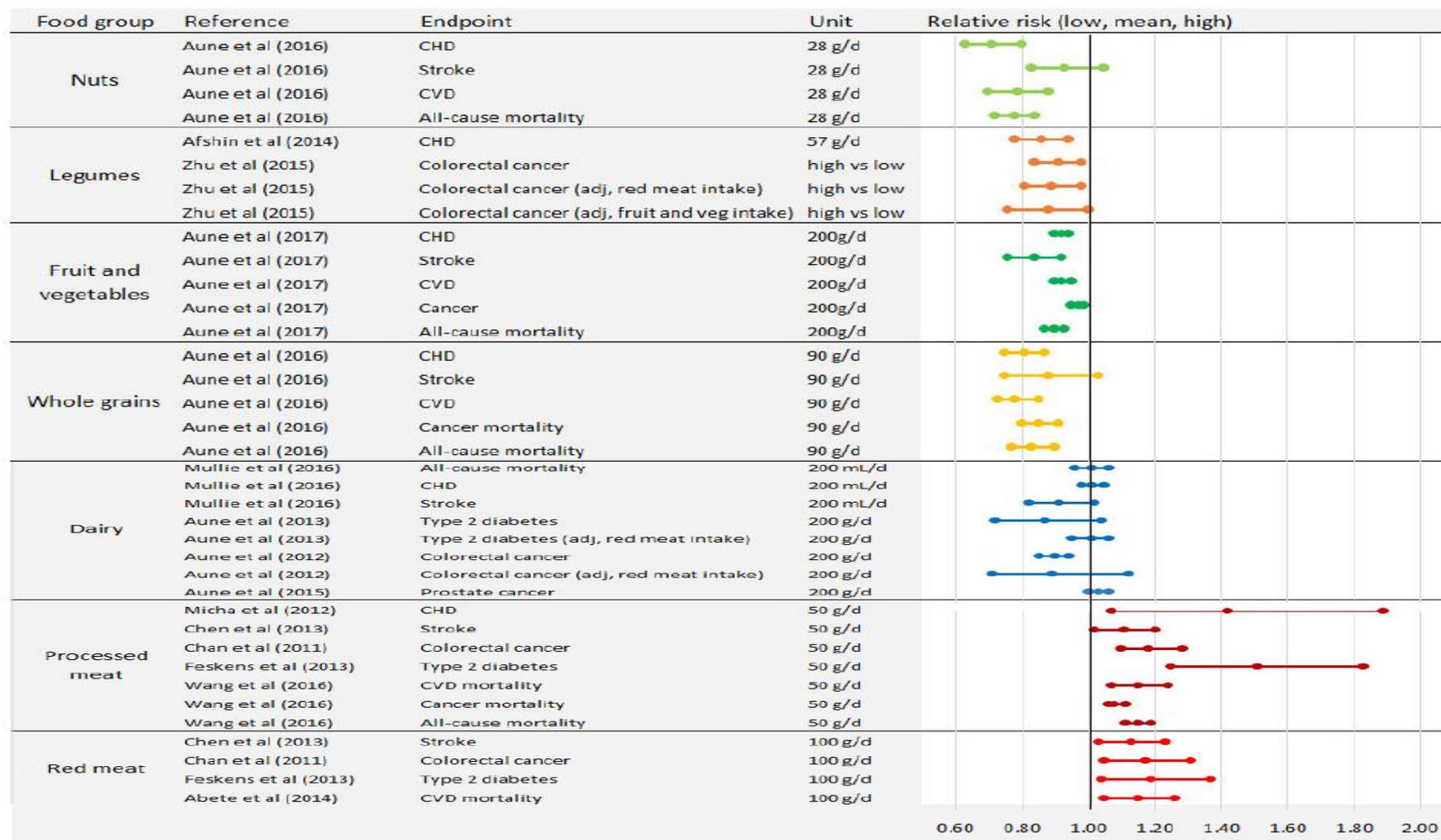
### 3. Life cycle impact assessment (LCIA)

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# 2. Efecto en salud como indicador de impacto

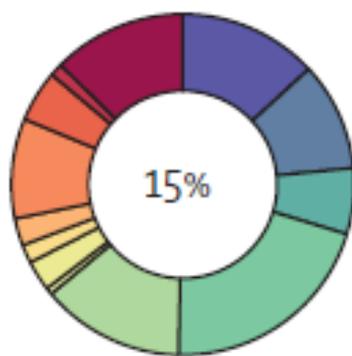
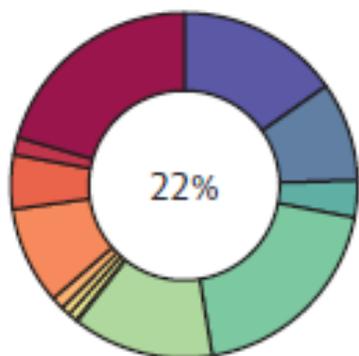


## 2. Efecto en salud como indicador de impacto

### Mortalidad

Global

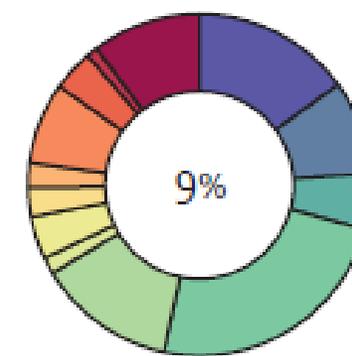
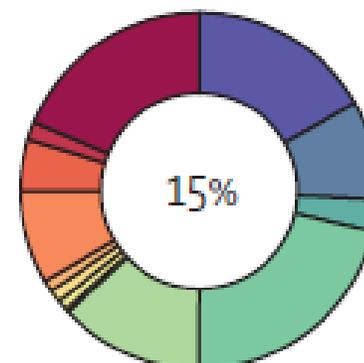
Western Europe



### DALY

Global

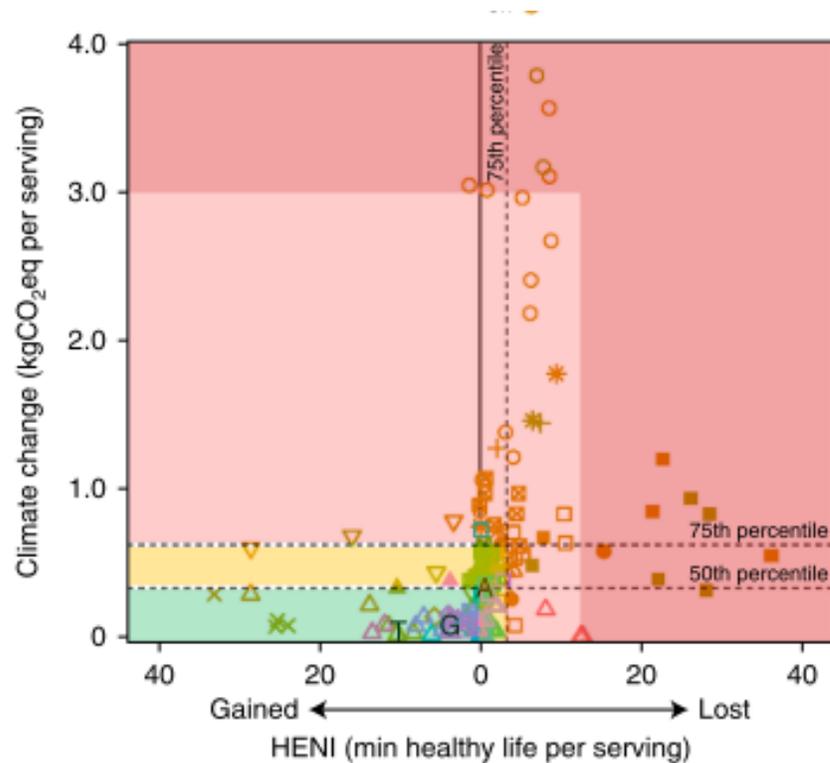
Western Europe



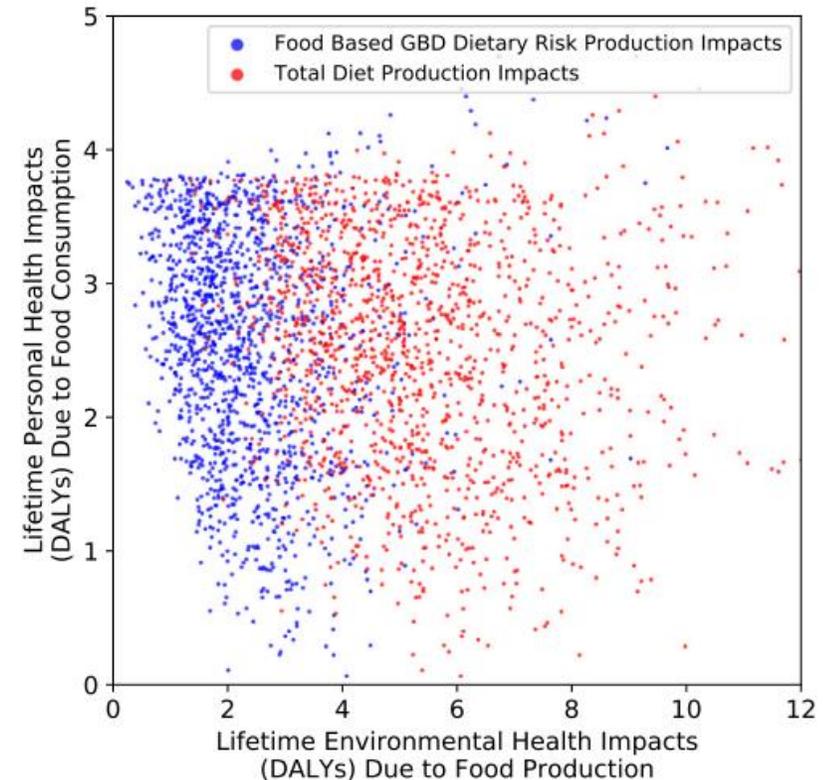
■ Low fruit    ■ Low whole grains    ■ High processed meat    ■ Low omega-3    ■ High sodium  
■ Low vegetables    ■ Low nuts and seeds    ■ High sugar-sweetened beverages    ■ Low PUFA  
■ Low legumes    ■ High red meat    ■ Low calcium    ■ High trans fats

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## 2. Efecto en salud como indicador de impacto



Fuente: Stylianou et al. (2021) *Nature Food*



Fuente: Walker et al. (2019) *Science of Total Environment*

## 2. Efecto en salud como indicador de impacto

The International Journal of Life Cycle Assessment  
<https://doi.org/10.1007/s11367-024-02298-7>

COMMENTARY AND DISCUSSION ARTICLE

### Accounting for nutrition-related **health impacts** in food life cycle assessment: insights from an expert workshop

Laura Scherer<sup>1</sup>  · Nicole Tichenor Blackstone<sup>2</sup> · Zach Conrad<sup>3,4</sup> · Victor L. Fulgoni, III<sup>5</sup> · John C. Mathers<sup>6</sup> · Jolieke C. van der Pols<sup>7</sup> · Walter Willett<sup>8</sup> · Peter Fantke<sup>9</sup> · Stephan Pfister<sup>10</sup> · Katerina S. Stylianou<sup>11</sup> · Bo P. Weidema<sup>12</sup> · Llorenç Milà i Canals<sup>13</sup> · Olivier Jolliet<sup>9</sup>

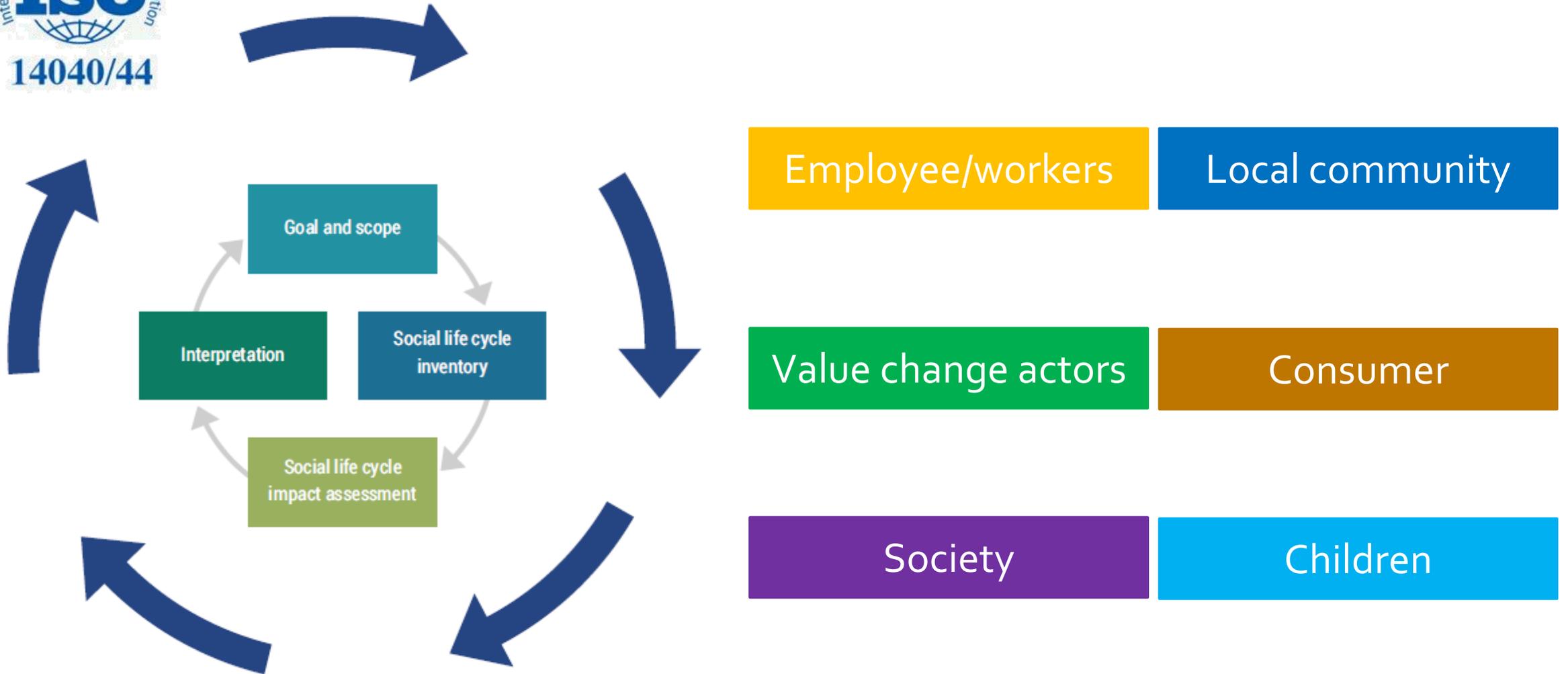
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# Medición del impacto social

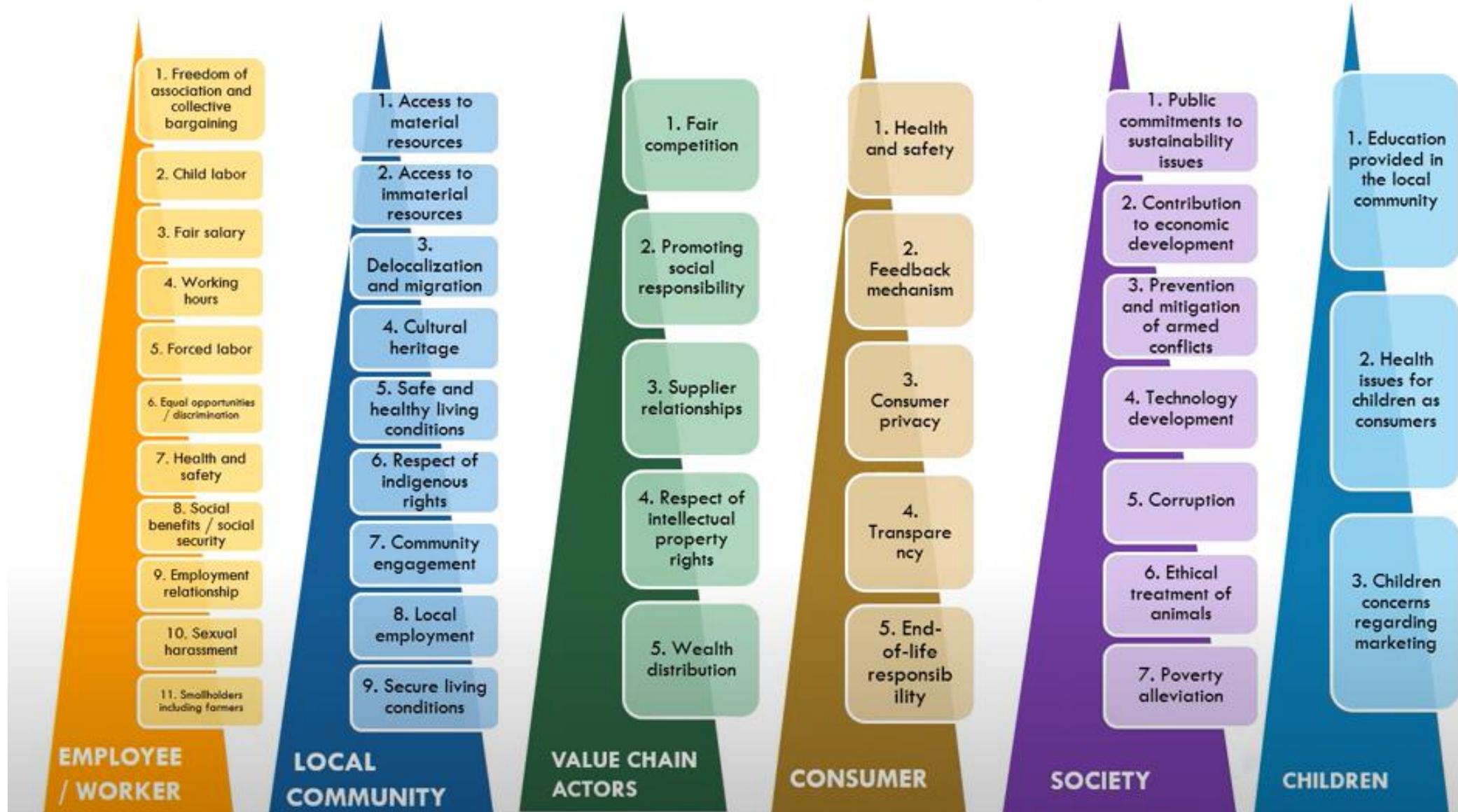
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# Social-LCA (SLCA)



# Social-LCA (SCLA)

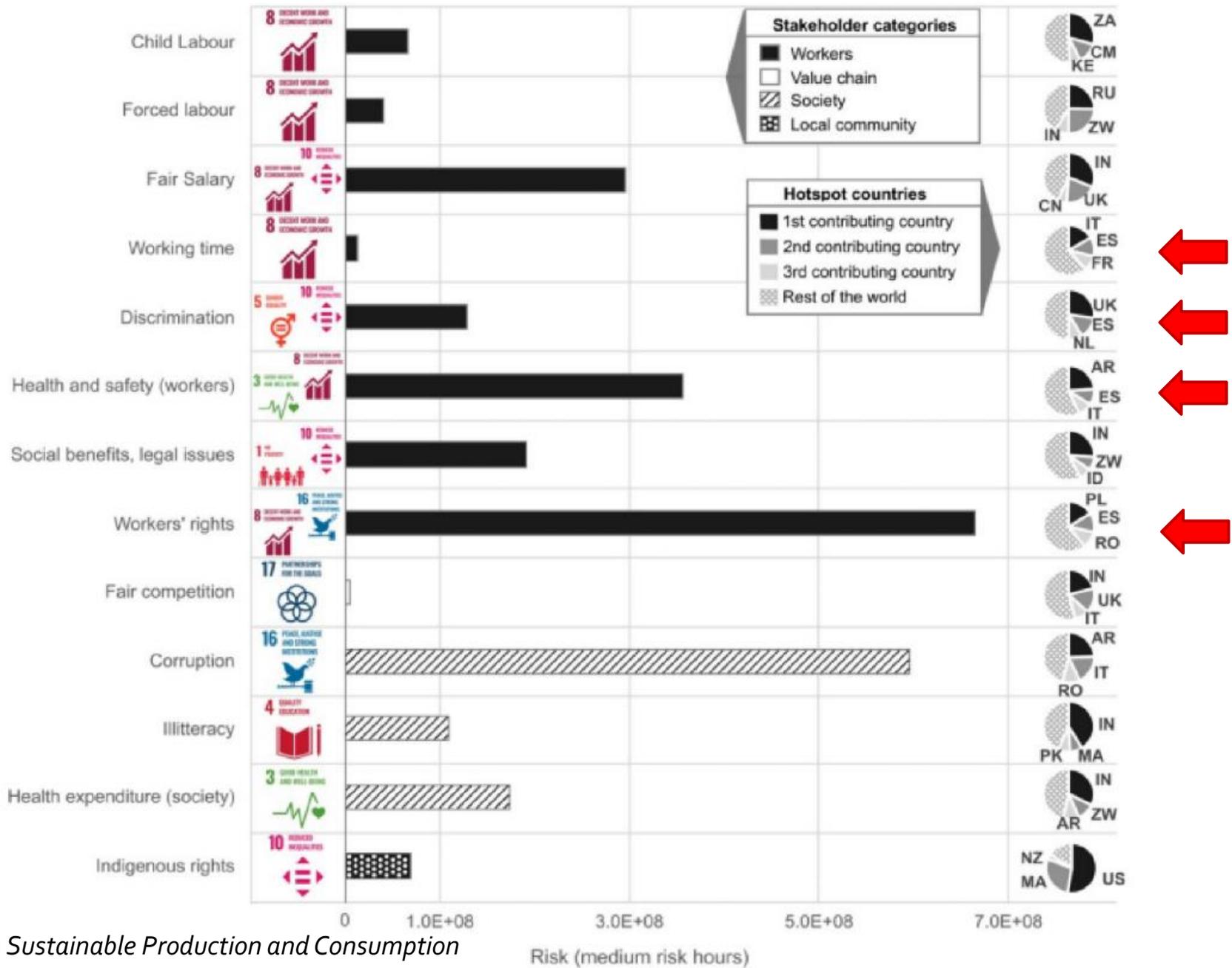


Product	CL	FL	FS	WT	DI	HSw	SB	WR	FC	C	CED	IL	HSs	IR
Almonds	0.05	0.03	0.40	0.02	0.10	0.28	0.21	1.10	0.00	0.60	-0.04	0.06	0.07	0.65
Apples	0.46	0.09	0.44	0.02	0.16	1.81	0.44	1.56	0.01	2.75	-0.07	0.08	0.49	0.22
Avocado	1.70	0.05	0.29	0.02	0.17	0.93	0.54	1.56	0.01	1.41	-0.08	0.25	0.49	0.12
Banana	1.05	0.11	1.90	0.02	0.10	0.74	0.97	1.44	0.01	1.63	-0.05	0.84	1.16	0.17
Beans	0.97	0.47	5.61	0.10	0.61	13.55	3.44	3.90	0.07	28.93	-0.29	0.30	4.09	0.96
Beer	0.01	0.02	0.51	0.02	0.32	0.24	0.07	0.70	0.00	0.25	-0.04	0.02	0.02	0.03
Biscuits	0.01	0.02	0.21	0.02	0.16	0.38	0.09	0.59	0.01	0.34	-0.03	0.02	0.03	0.03
Bread	0.00	0.02	0.17	0.01	0.14	0.29	0.07	0.58	0.01	0.26	-0.04	0.02	0.02	0.02
Broccoli	0.82	0.04	0.30	0.02	0.11	0.41	0.43	1.35	0.01	1.67	-0.09	0.34	0.44	0.17
Butter	0.01	0.02	0.14	0.02	0.09	0.26	0.06	0.58	0.00	0.16	-0.04	0.02	0.02	0.04
Carrot	0.12	0.02	0.14	0.02	0.77	1.05	0.23	0.91	0.01	0.69	-0.02	0.04	0.12	0.09
Cashew	1.27	0.58	11.39	0.04	5.16	0.82	7.80	12.91	0.09	12.74	-0.30	5.90	7.97	0.44
CattleBeefMeat	0.00	0.01	0.11	0.01	0.08	0.27	0.06	0.40	0.00	0.28	-0.03	0.01	0.03	0.04
Cheese	0.00	0.02	0.10	0.02	0.09	0.26	0.06	0.50	0.00	0.24	-0.03	0.02	0.02	0.03
Chickpeas	0.24	0.31	5.02	0.07	0.58	8.26	3.12	3.97	0.05	18.17	-0.23	1.14	3.32	0.60
Chocolate	0.04	0.02	0.15	0.02	0.10	0.32	0.09	0.50	0.01	0.29	-0.03	0.05	0.06	0.04
Cod	0.25	0.12	0.83	0.02	0.20	0.44	0.28	1.58	0.01	1.38	-0.05	0.15	0.25	0.16
Coffee	0.01	0.01	0.07	0.01	0.06	0.21	0.05	0.39	0.00	0.30	-0.03	0.02	0.02	0.04
DairyBeefMeat	0.01	0.01	0.15	0.01	0.11	0.31	0.08	0.48	0.01	0.38	-0.05	0.02	0.04	0.05
Eggs	0.01	0.01	0.19	0.02	0.12	0.32	0.11	1.01	0.00	0.45	-0.04	0.04	0.03	0.68
Lentils	0.03	0.04	0.29	0.03	0.09	0.23	0.23	1.39	0.01	0.85	-0.07	0.07	0.05	1.41
MeatBasedDishes	0.00	0.01	0.18	0.01	0.12	0.20	0.06	0.33	0.01	0.10	-0.03	0.01	0.01	0.02
MilkCream	0.00	0.01	0.13	0.01	0.11	0.23	0.06	0.43	0.01	0.16	-0.03	0.01	0.01	0.02
Mineral Water	0.02	0.01	0.12	0.01	0.11	0.28	0.05	0.70	0.00	0.44	-0.03	0.03	0.03	0.02
OliveOil	0.02	0.03	0.14	0.02	0.11	0.44	0.09	0.96	0.01	0.51	-0.05	0.07	0.05	0.04
Oranges	1.06	0.79	0.51	0.03	0.20	2.63	1.65	2.05	0.01	4.31	-0.09	0.31	2.22	0.13
PalmOil	0.19	0.44	1.95	0.04	0.37	0.92	3.58	1.55	0.01	3.51	-0.09	0.23	1.01	0.21
Pasta	0.01	0.01	0.09	0.02	0.06	0.34	0.07	0.46	0.00	0.69	-0.03	0.03	0.03	0.03
PigMeat	0.00	0.02	0.12	0.01	0.08	0.28	0.07	0.53	0.00	0.20	-0.03	0.02	0.02	0.03
Potatoes	0.01	0.03	0.18	0.02	0.13	0.27	0.11	0.92	0.01	0.42	-0.03	0.03	0.03	0.03
PoultryMeat	0.01	0.02	0.17	0.01	0.12	0.29	0.06	0.70	0.01	0.32	-0.04	0.02	0.02	0.03
Quinoa	4.04	0.17	2.81	0.03	0.16	1.21	0.63	1.97	0.04	3.12	-0.09	0.11	0.11	0.08
Rapeoil	0.01	0.03	0.16	0.02	0.12	0.30	0.07	0.81	0.00	0.36	-0.05	0.03	0.03	0.03
Rice	0.33	0.85	8.60	0.05	0.99	2.04	5.26	5.25	0.02	5.80	-0.24	4.97	5.76	0.17
Salmon	0.34	0.15	0.93	0.02	0.20	0.46	0.31	2.06	0.01	1.83	-0.06	0.17	0.27	0.18
Shrimps	0.34	0.62	5.01	0.03	0.62	1.24	3.15	4.39	0.02	5.86	-0.13	3.34	3.74	1.75
SoybeanOil	0.01	0.04	0.13	0.02	0.11	0.34	0.07	0.85	0.00	0.47	-0.05	0.03	0.03	0.04
Strawberry	0.01	0.02	0.14	0.03	0.12	0.32	0.16	0.79	0.00	0.65	-0.03	0.24	0.22	0.33
Sugar	0.06	0.03	0.30	0.01	0.23	0.40	0.19	0.87	0.01	0.59	-0.05	0.12	0.16	0.03
SunFlowerOil	0.02	0.05	0.23	0.02	0.16	0.54	0.08	1.43	0.01	1.00	-0.07	0.05	0.05	0.04
Tea	0.05	0.03	0.38	0.01	0.14	0.24	0.20	0.53	0.01	0.38	-0.06	0.05	0.06	0.05
Tomatoes	0.03	0.02	0.07	0.02	0.08	0.49	0.18	0.85	0.01	1.13	-0.03	0.27	0.31	0.49
Tuna	0.01	0.02	0.22	0.02	0.15	0.22	0.08	0.99	0.01	0.38	-0.03	0.03	0.03	0.04
Wine	0.07	0.02	0.11	0.02	0.17	0.54	0.10	0.77	0.01	0.98	-0.06	0.03	0.13	0.10

CL: Child Labour  
FL: Forced Labour  
FS: Fair Salary  
WT: Working Time  
DI: Discrimination  
HSw: Health and Safety (workers)  
SB: Social Benefits, Legal Issues  
WR: Workers' Rights  
FC: Fair Competition  
C: Corruption  
CED: Contribution to Economic Development  
IL: Illiteracy  
HS: Health and Safety (society)  
IN: Respect of Indigenous Rights.

# Social-LCA (SLCA)

Product	Impact subcategory	Product risk share within the basket	Contributing countries	Country share
Unitary risk				
Quinoa	Child labour	29 %	Bolivia	53 %
			Peru	47 %
Cashew	Fair salary	22 %	India	95 %
	Discrimination	37 %	Vietnam	74 %
	Social benefits, legal issues	22 %	India	82 %
	Illiteracy	30 %	India	97 %
	Society health and safety	24 %	India	90 %
Beans	Workers health and safety	30 %	Argentina	98 %
	Corruption	27 %	Argentina	97 %
Rice	Illiteracy	25 %	India	70 %



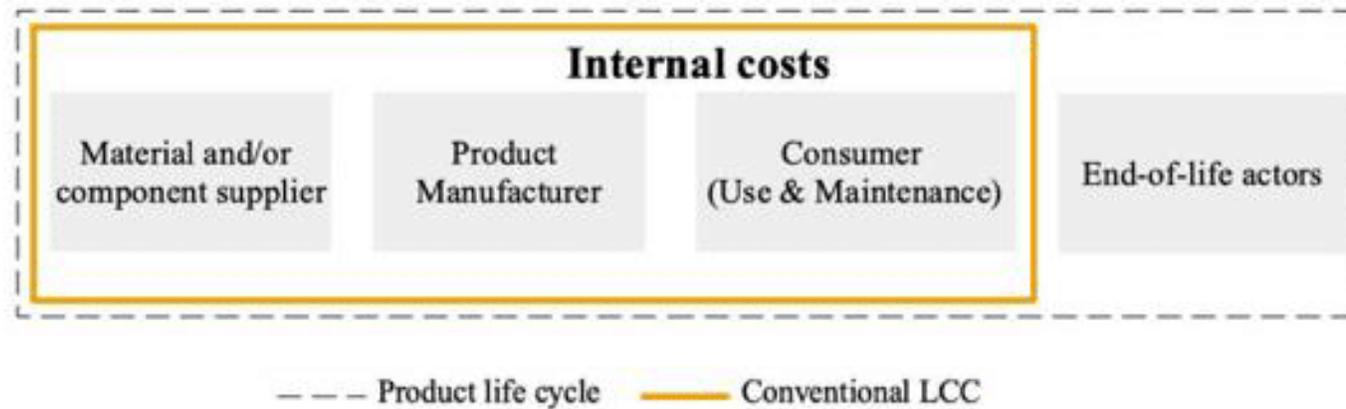
Fuente: Mancini et al. (2023) *Sustainable Production and Consumption*

Risk (medium risk hours)

# Medición del coste

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# Life Cycle Costing (LCC)



# Life Cycle Costing (LCC)



Science of The Total Environment

Volume 850, 1 December 2022, 158012

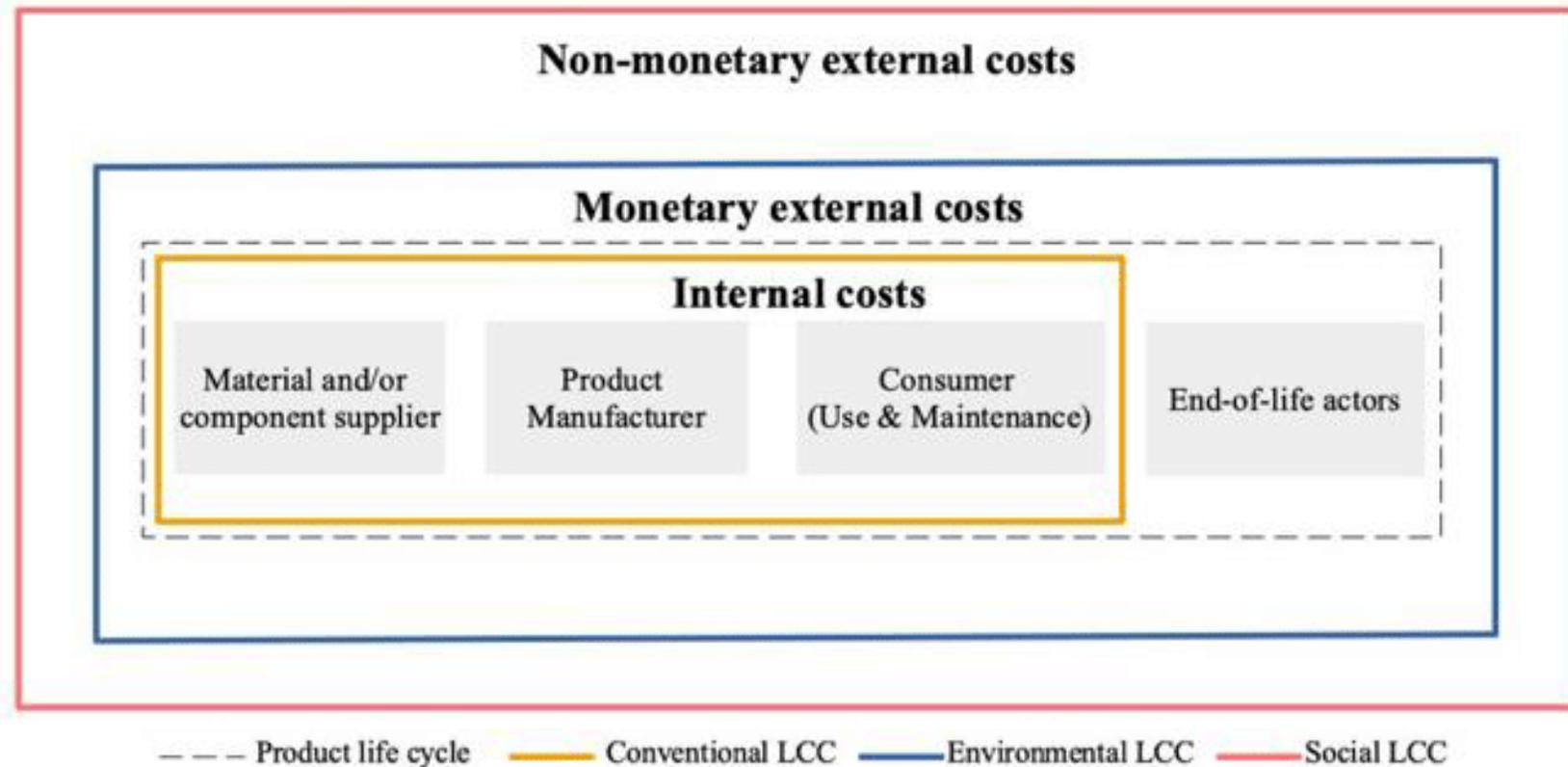


Review

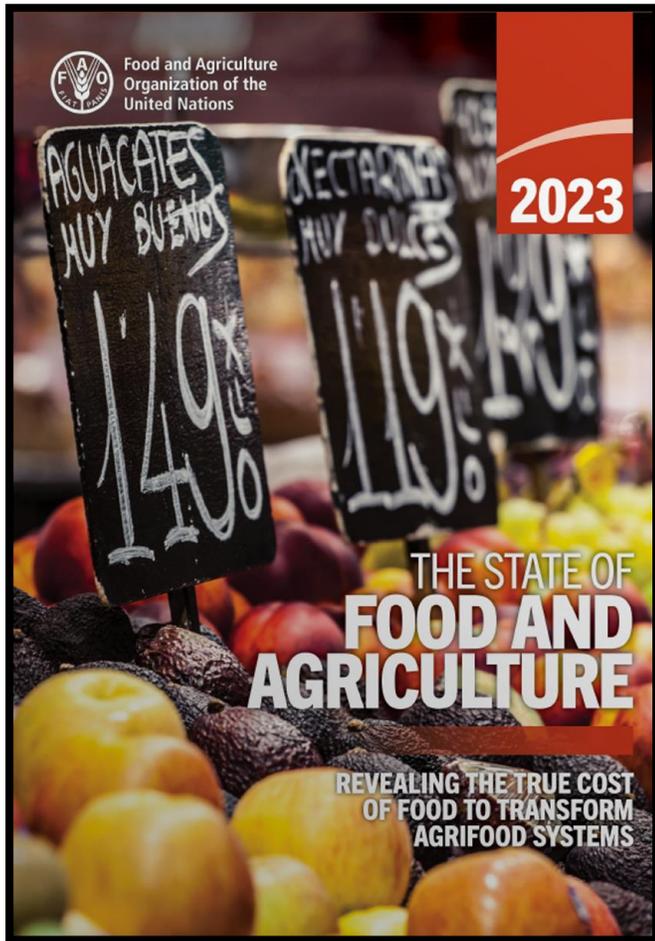
## Life cycle cost analysis of agri-food products: A systematic review

[Margo Degieter](#)<sup>a</sup>  , [Xavier Gellynck](#)<sup>a</sup> , [Shashank Goyal](#)<sup>b</sup> ,  
[Denise Ott](#)<sup>b</sup> , [Hans De Steur](#)<sup>a</sup> 

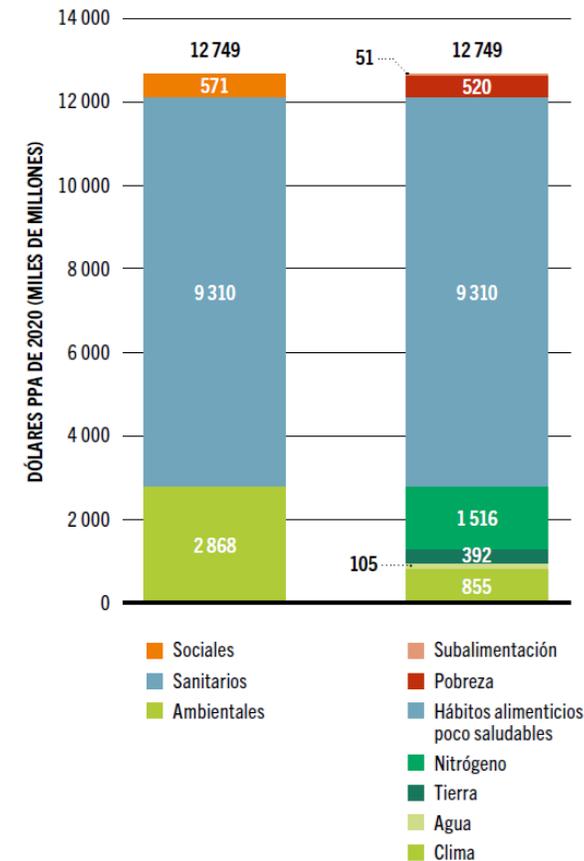
# Life Cycle Costing (LCC)



# Life Cycle Costing--True cost of food



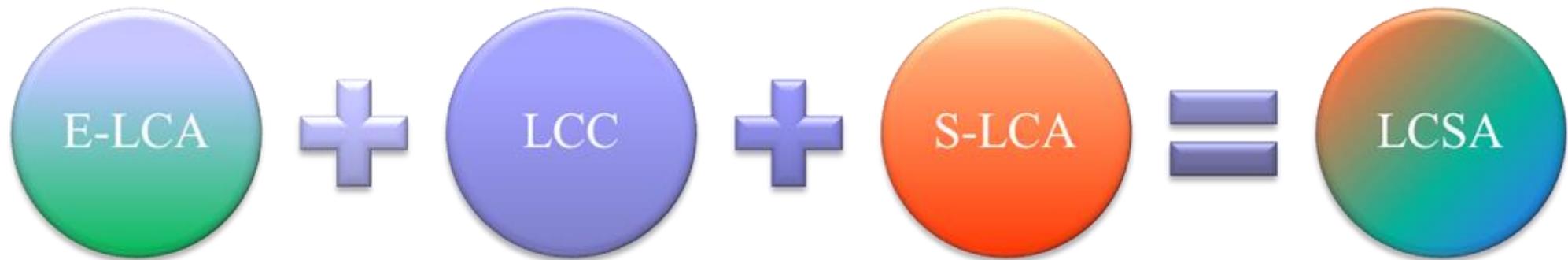
## COSTOS OCULTOS CUANTIFICADOS DE LOS SISTEMAS AGROALIMENTARIOS



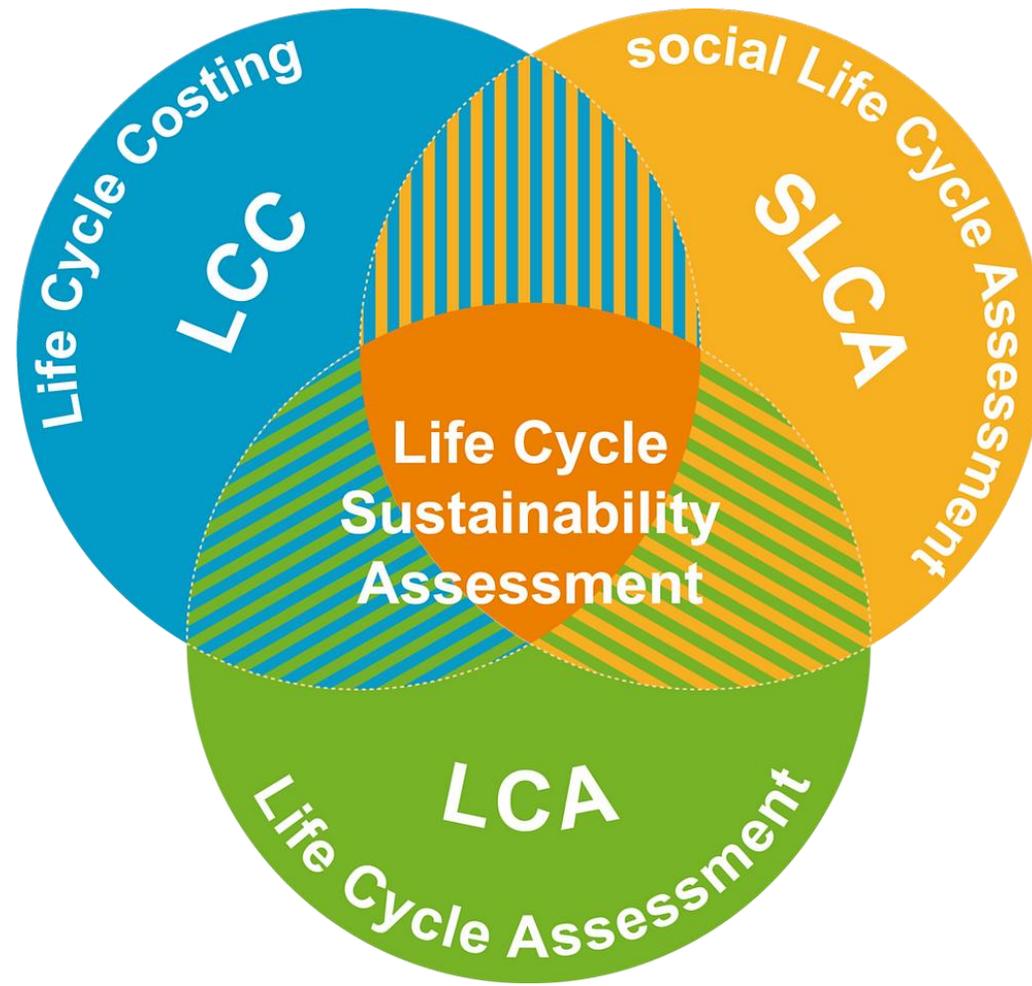
# Medición de la **SOSTENIBILIDAD**

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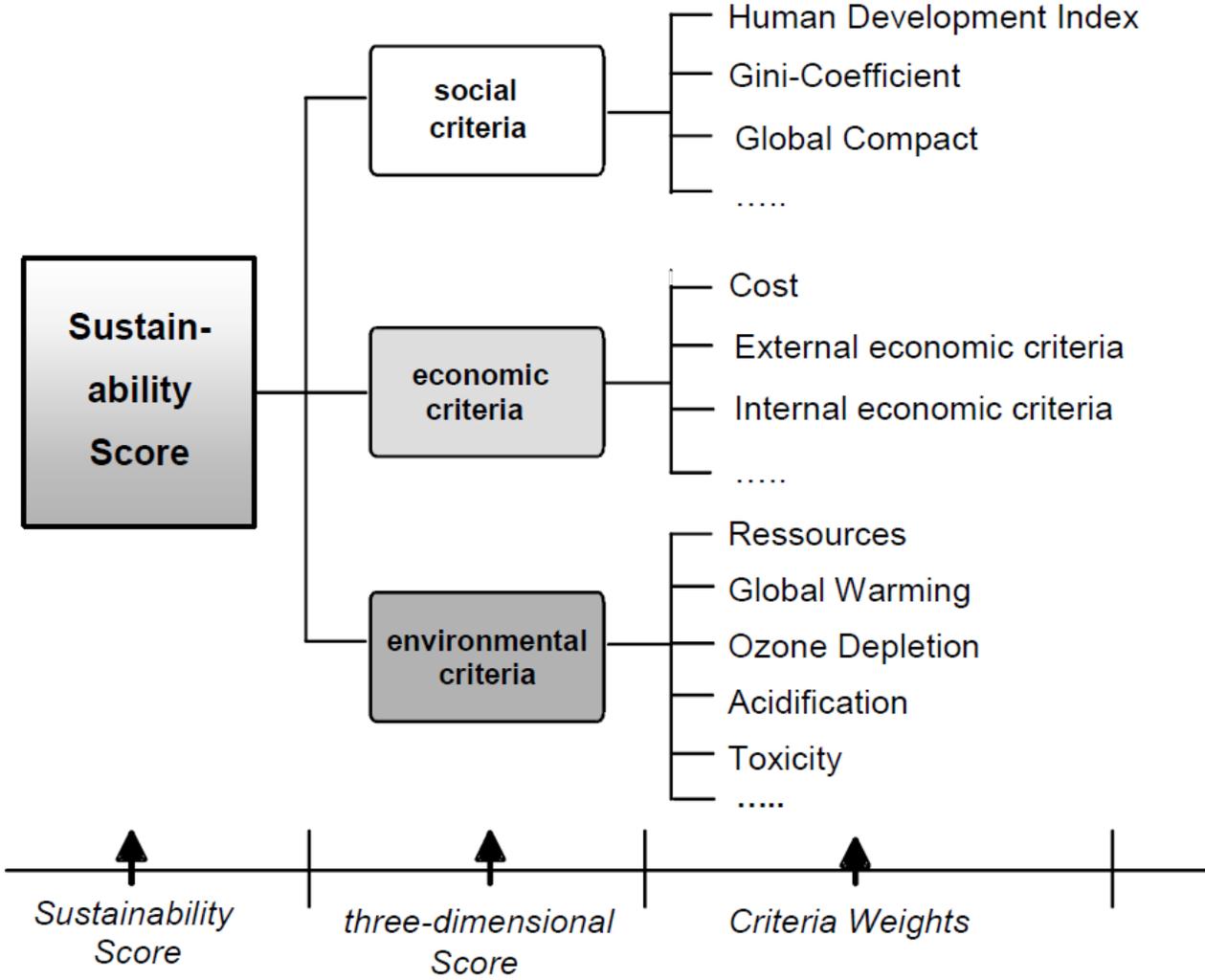
# Life Cycle Sustainability Assessment (LCSA)



# Life Cycle Sustainability Assessment (LCSA)



# Life Cycle Sustainability Assessment (LCSA)



Fuente: Finkbeiner *et al.* (2010) *Sustainability*

**Resumiendo...**

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# OBJETIVOS DE DESARROLLO SOSTENIBLE



An aerial photograph of a dense green forest. A large, light-brown footprint is superimposed on the right side of the image, extending from the top right towards the center. The text '¡Gracias!' is written in a large, bold, red font across the middle of the image, partially overlapping the footprint and the forest canopy.

**¡Gracias!**