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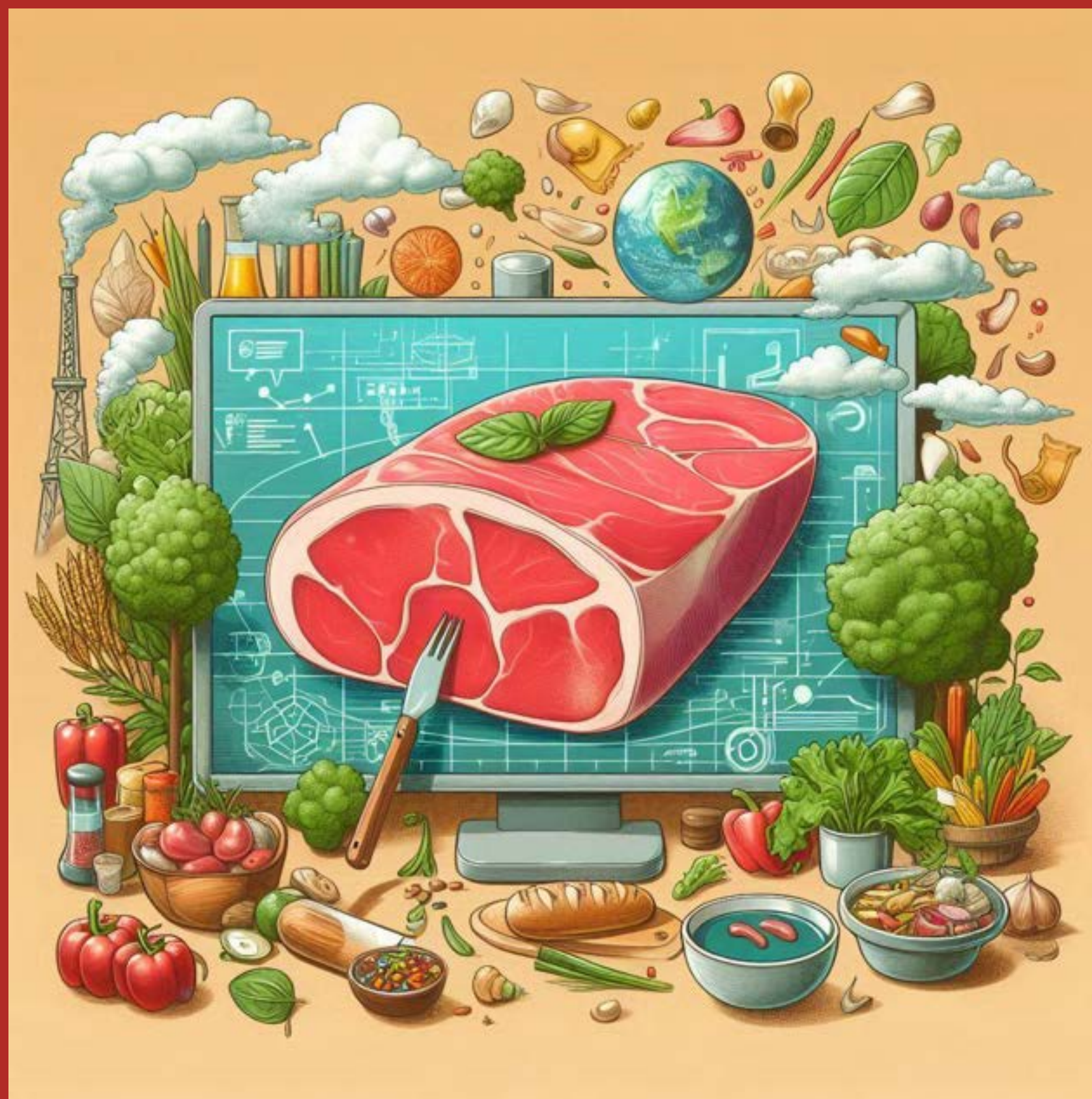
Università degli Studi di Sassari
Dipartimento di Agraria

La sostenibilità climatica della carne artificiale

Giuseppe Pulina

*Professore ordinario di Etica e sostenibilità degli
allevamenti,*

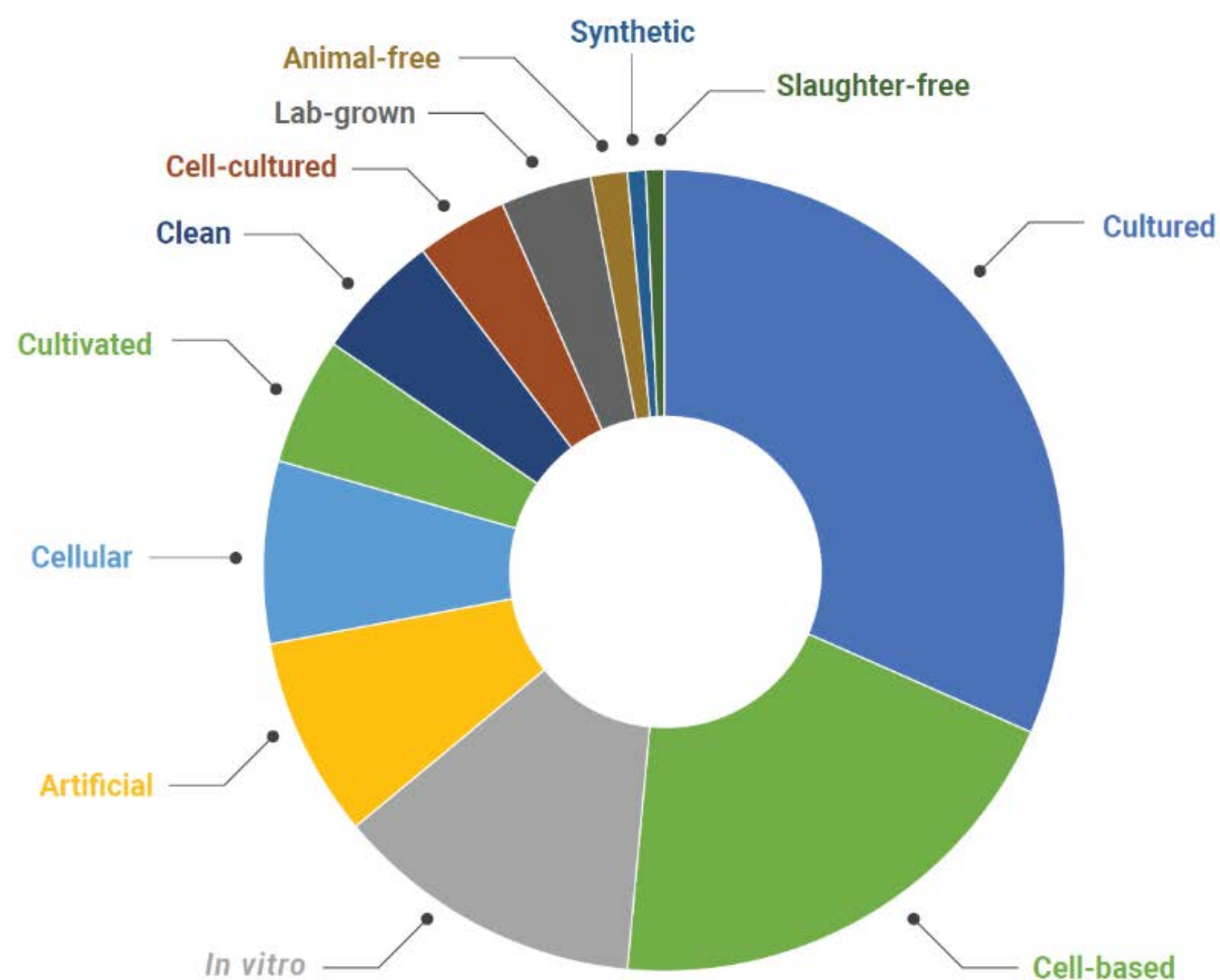
Presidente dell'Associazione no-profit Carni Sostenibili



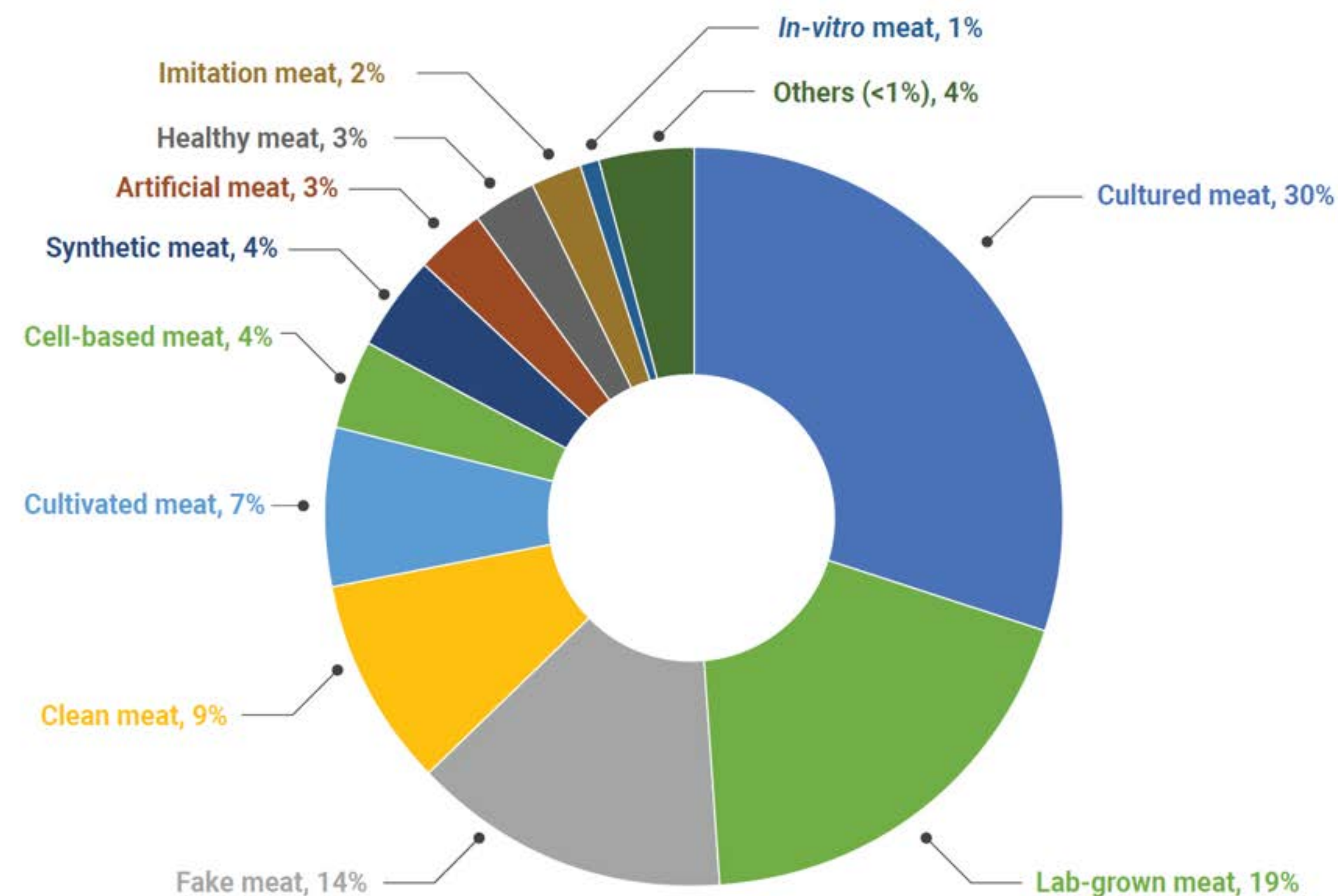
UN PO' DI TERMINOLOGIA

Frequenza dei diversi termini impiegati per definire la carne prodotta con bioreattori (FAO-WHO, 2023)

Ambito Accademico



Media



UN PO' DI TERMINOLOGIA

Come chiamare i sostituti della carni da colture cellulari?

Carne in vitro

Carne sintetica

Carne da coltura cellulare

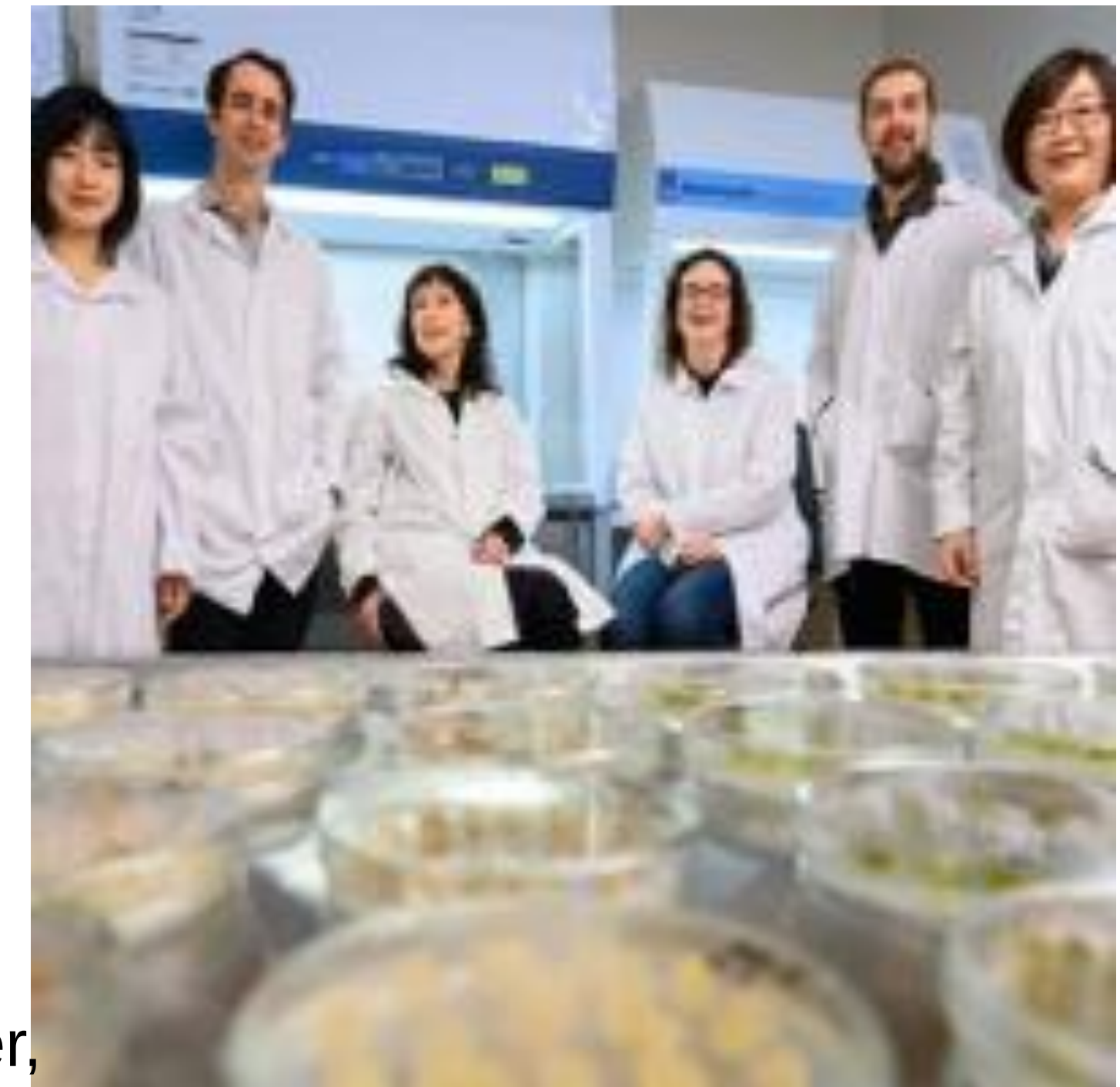
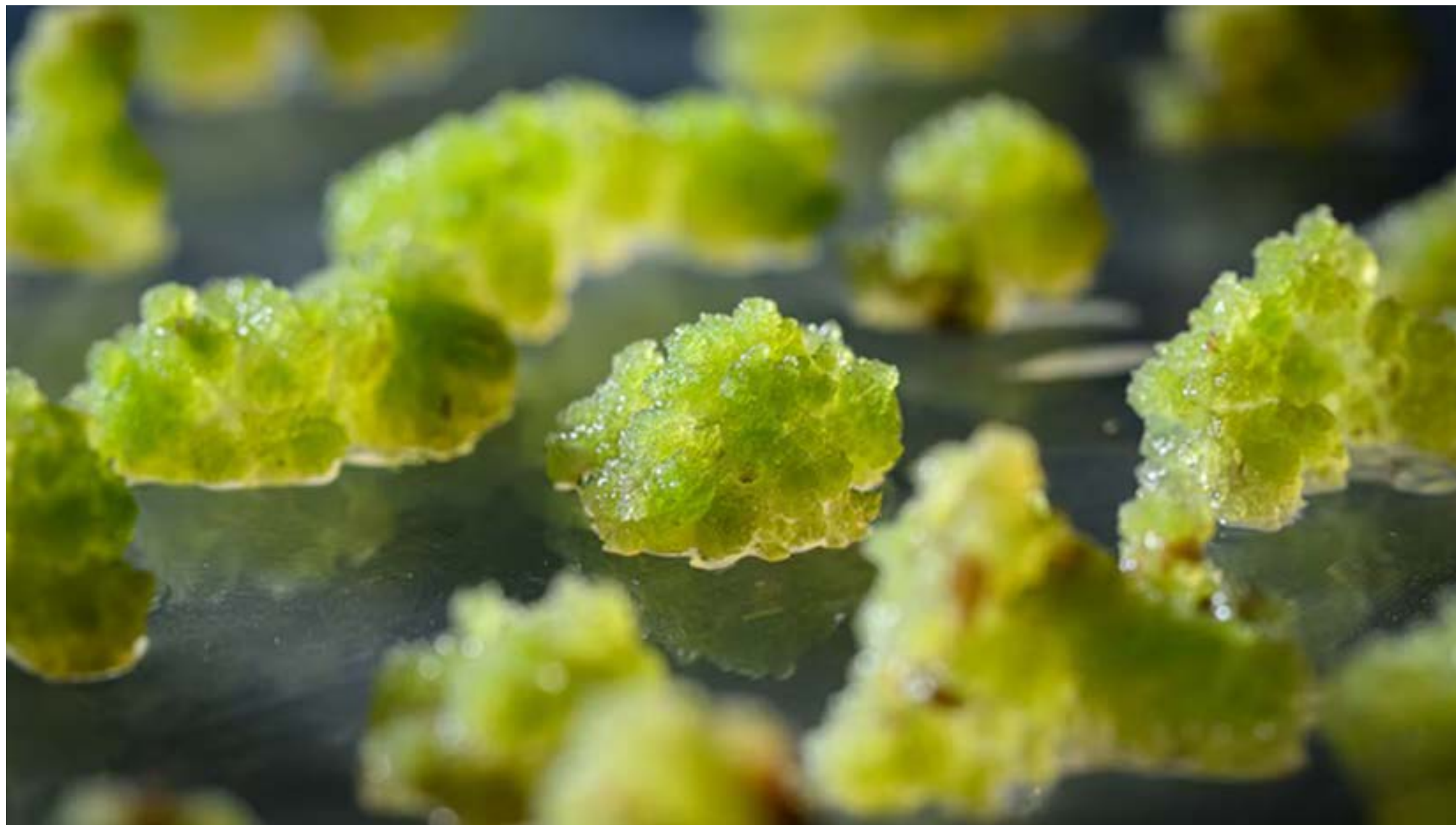
Carne artificiale



Carne artificiale

La carne naturale (come tutti i cibi) è costituita da cellule e la loro coltivazione avviene con processi naturali all'interno degli animali che alleviamo, alimentiamo e curiamo per questo scopo. L'espianco di queste cellule e la loro messa in coltura extracorporea è un processo totalmente artificiale.

E se al posto della carne ottenessimo mirtilli? Sarebbero mirtilli «coltivati» o «artificiali»?



Food by Design program's team members Yuki Wadamori, Dr. Ben Schon, Dr. Jan Grant, Julie Latimer, Matthew Plowman-Holmes and Dr. Esther Kim (*Image credit: Plant and Food Research*).

**food
ingredients** 1st



Food and Agriculture Organization
of the United Nations

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English

Food safety and quality

Background

Food control systems

Scientific advice

Emergencies

News

Resources

Article in Nature: Food culture and cell-culture



23/04/2025

In a world with mounting pressures on natural resources, rising global protein demands, and an urgent need to reduce greenhouse gas emissions, the way we produce food is under the microscope—literally. Is it possible to have meat without slaughtering, or milk proteins produced without a single cow in sight? Some rapidly evolving technologies, such as cell-based food production and precision fermentation, hold potential to transform the boundaries of what's possible in agrifood systems. However, as many other new technologies do, cell-based food production has some key areas that can benefit from further (and possibly substantial) improvement, so that they can eventually be able to offer options to help produce sufficient amount of food with necessary nutrients, to be not just safe but more ethical and sustainable.

FAO article in Nature:
Food culture and cell-culture

An article by FAO authors and collaborators has been published in Nature on the need for socio-economical and cross-cultural research on cell-based food production. The article entitled "Food culture and cell-culture: technical, ethical and social frontiers", co-authored by Sghaier Chriki, William Hallman, Jean-Francois Hocquette, Marie-Pierre Ellies-Oury and Masami Takeuchi of FAO's Agrifood Systems and Food Safety Division, provides insights on the follow-up on the food safety considerations of this newly established food production system.

npj | science of food

Comment

Published in partnership with Beijing Technology and Business University & International Union of Food Science and Technology

<https://doi.org/10.1038/s41538-025-00417-8>

Food culture and cell-culture: technical, ethical and social frontiers

Sghaier Chriki, William Hallman, Jean-François Hocquette, Marie-Pierre Ellies-Oury & Masami Takeuchi

Check for updates

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Gap nella conoscenza

Fig. 1 | Research gaps that need to be filled to better meet the expectations of cell-based food production. The research gaps in cell-based food production are

Gli impatti climalteranti della carne artificiale e il confronto con la carne naturale.



Diverse difficoltà:

1. Si comparano prodotti diversi
2. Il metodo LCA utilizzato non è adeguato
3. Le fonti scientifiche sono fortemente asimmetriche
4. Le metriche impiegate non sono corrette

1. Si comparano prodotti diversi

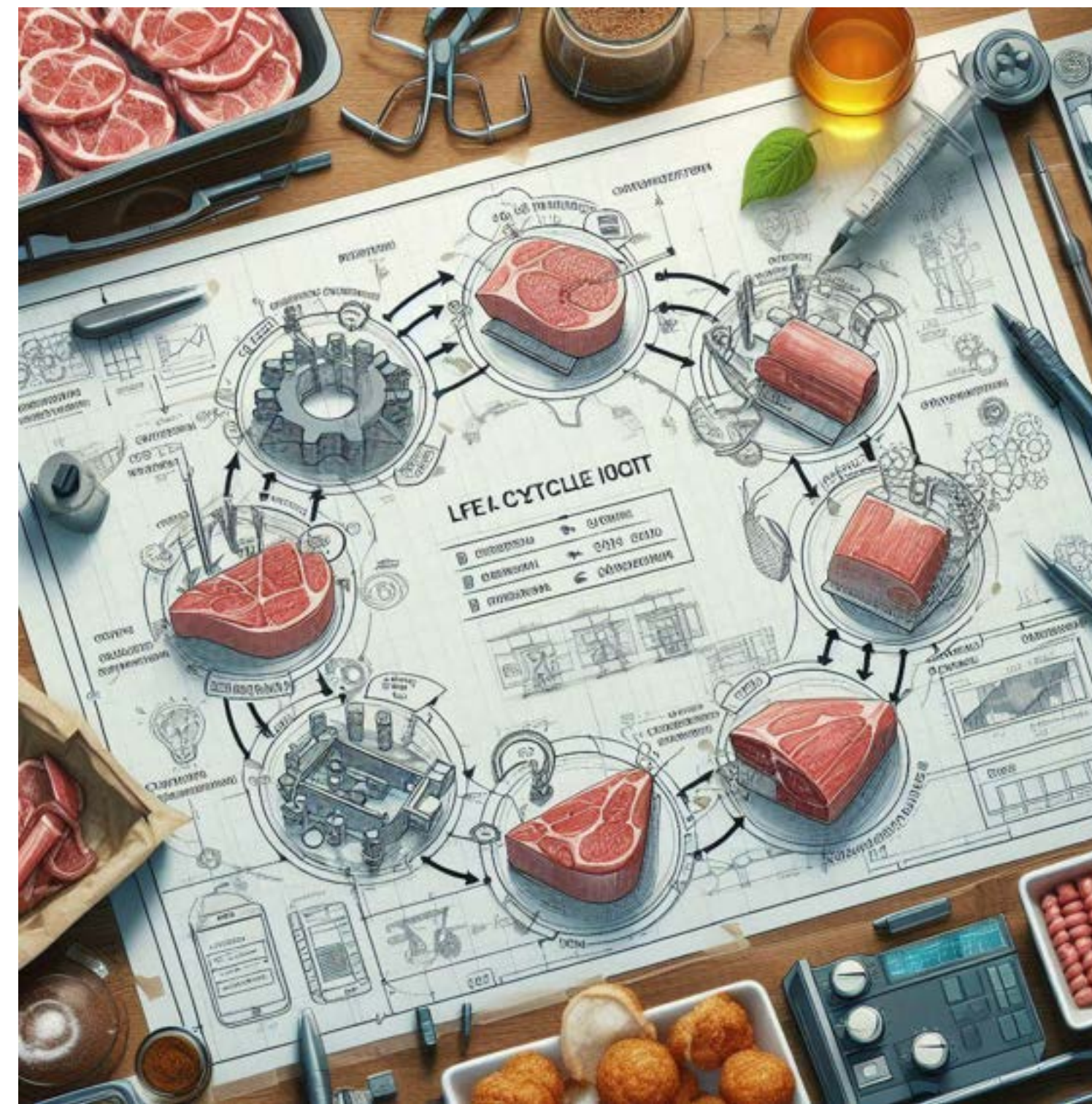
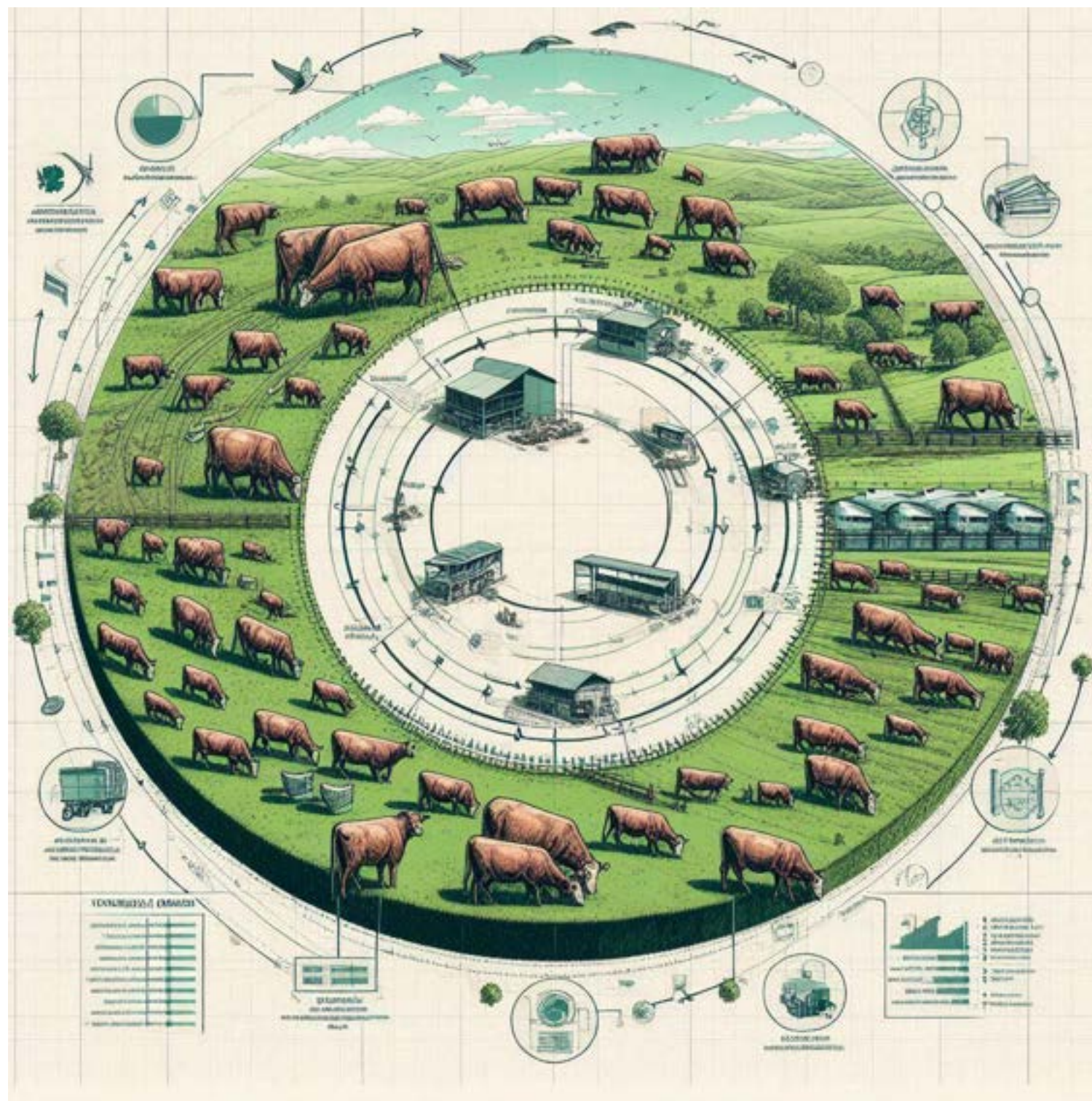


**Prevalentemente
fresca**



**Esclusivamente
iperprocessata (+ 5
ingredienti)**

2. Il metodo LCA utilizzato non è adeguato per questa comparazione



- a) Il modello di riferimento è diverso
- b) Il problema dell'allocazione degli impatti

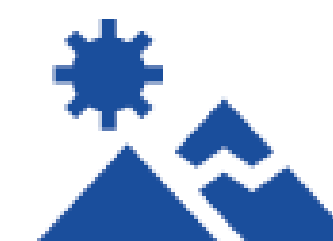
a) Lo standard utilizzato per valutare gli impatti ambientali (anche in agricoltura) si basa sul metodo LCA [ISO 14040/14044]



Review

Life Cycle Assessment on Agricultural Production: A Mini Review on Methodology, Application, and Challenges

Jianling Fan ^{1,*}, Cuiying Liu ², Jianan Xie ³, Lu Han ¹, Chuanhong Zhang ¹, Dengwei Guo ¹, Junzhao Niu ¹, Hao Jin ¹ and Brian G. McConkey ⁴



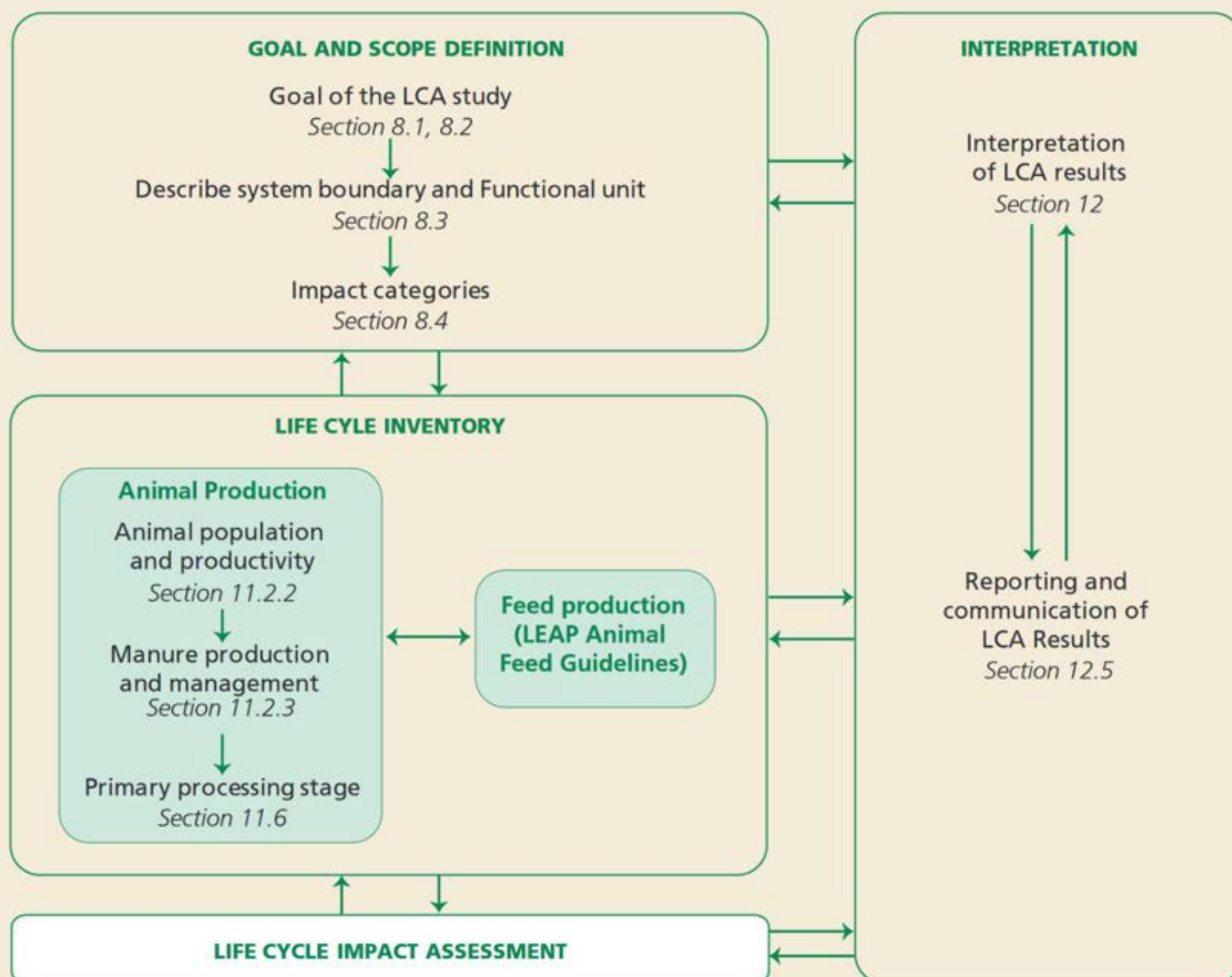
Raw
material

Produce

Consumption

Waste

Linear
economy



Dall'economia lineare a quella circolare



Linear economy

VS



Circular economy



Circular economy

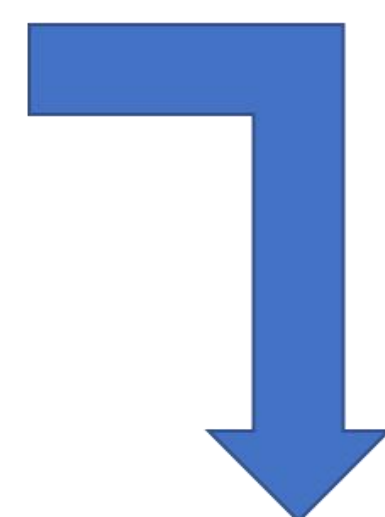


$$\Delta G = \Delta H + T \Delta S$$

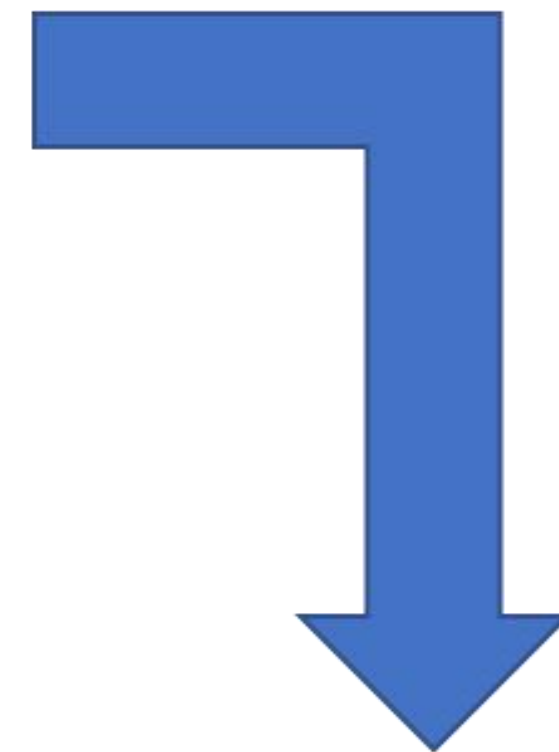
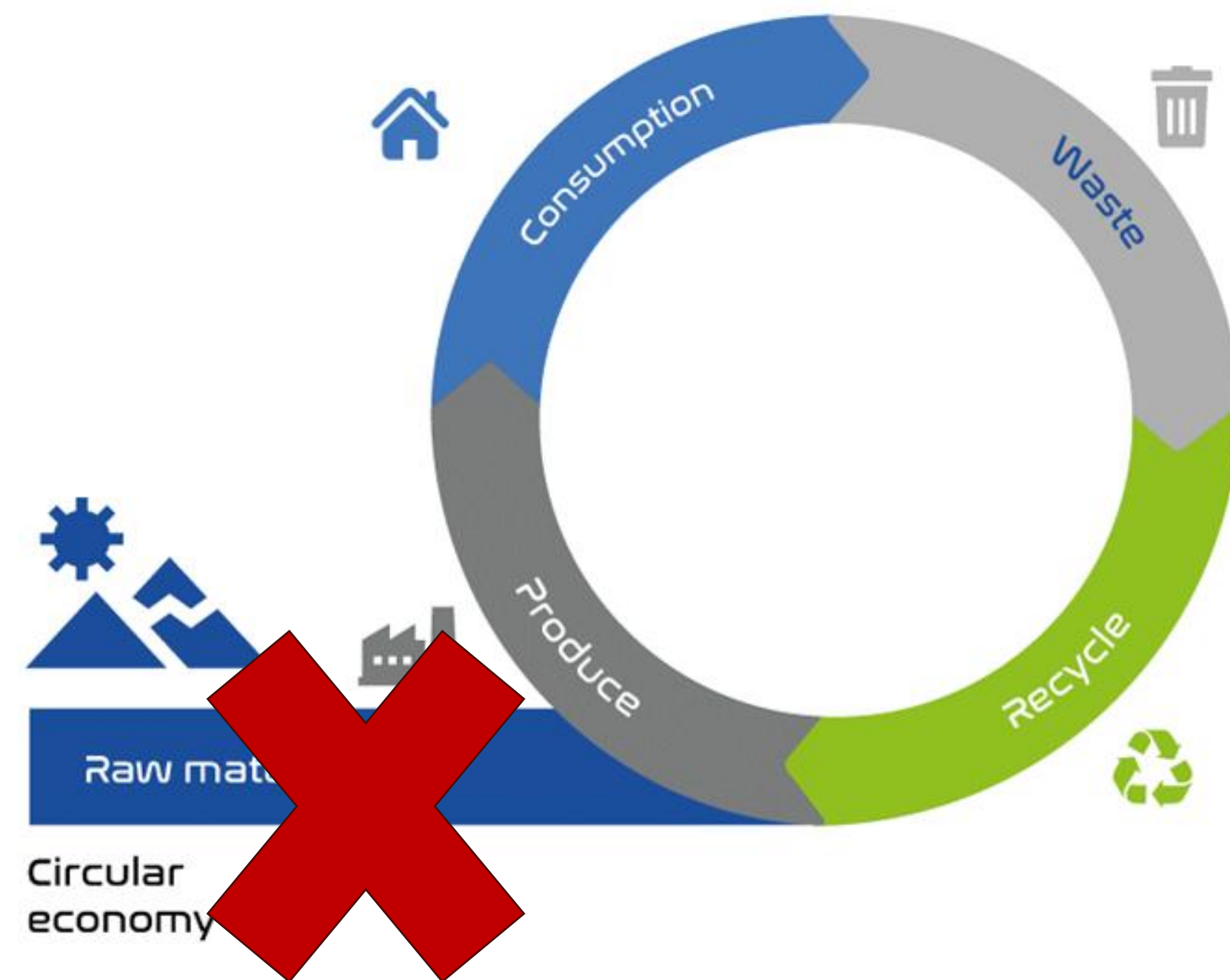


ΔG

$$\Delta S > 0$$



Dall'economia circolare a quella rigenerativa



$$\Delta S \rightarrow 0$$



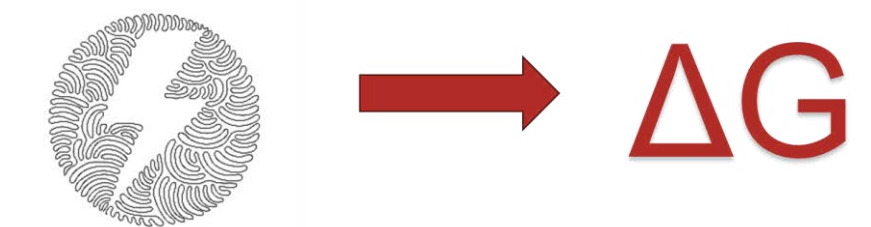
$$\rightarrow \Delta G$$



Il problema dello ambientale dello **scaling up**

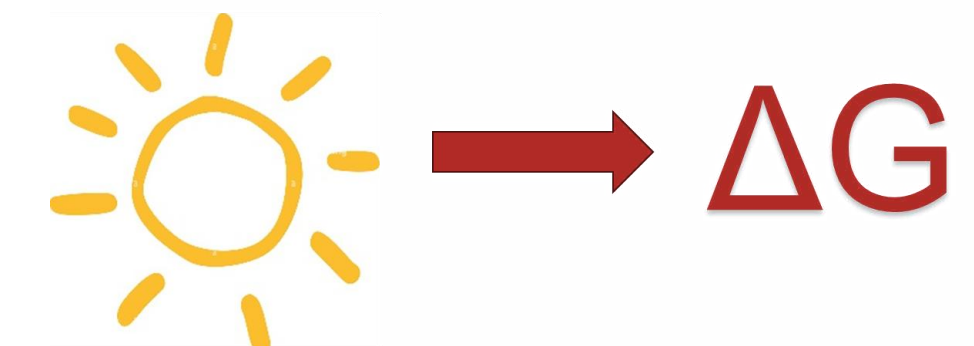
npj | science of food

Carne artificiale



$$\Delta S > 0$$

Carne naturale



$$\Delta S \rightarrow 0$$

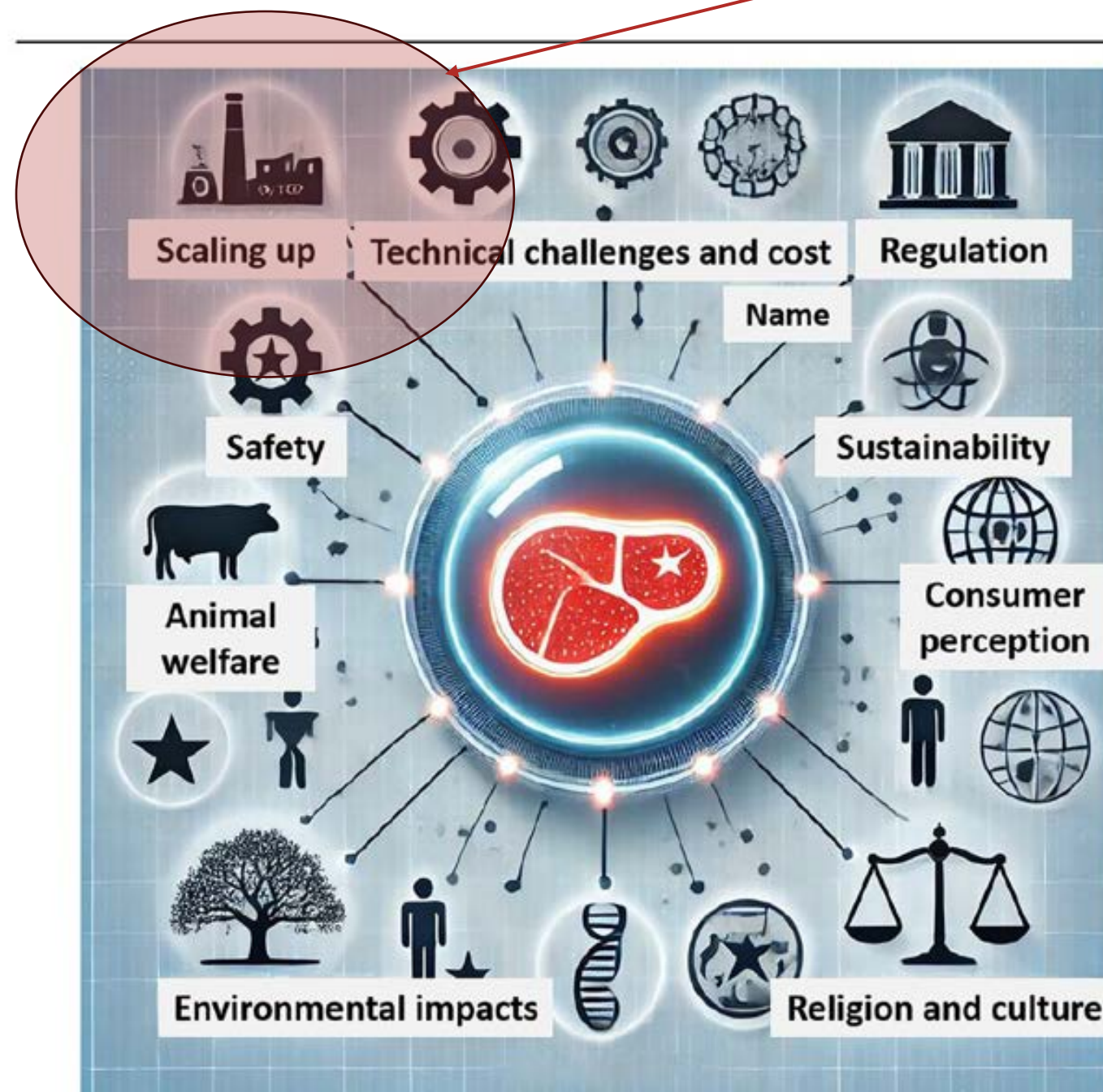
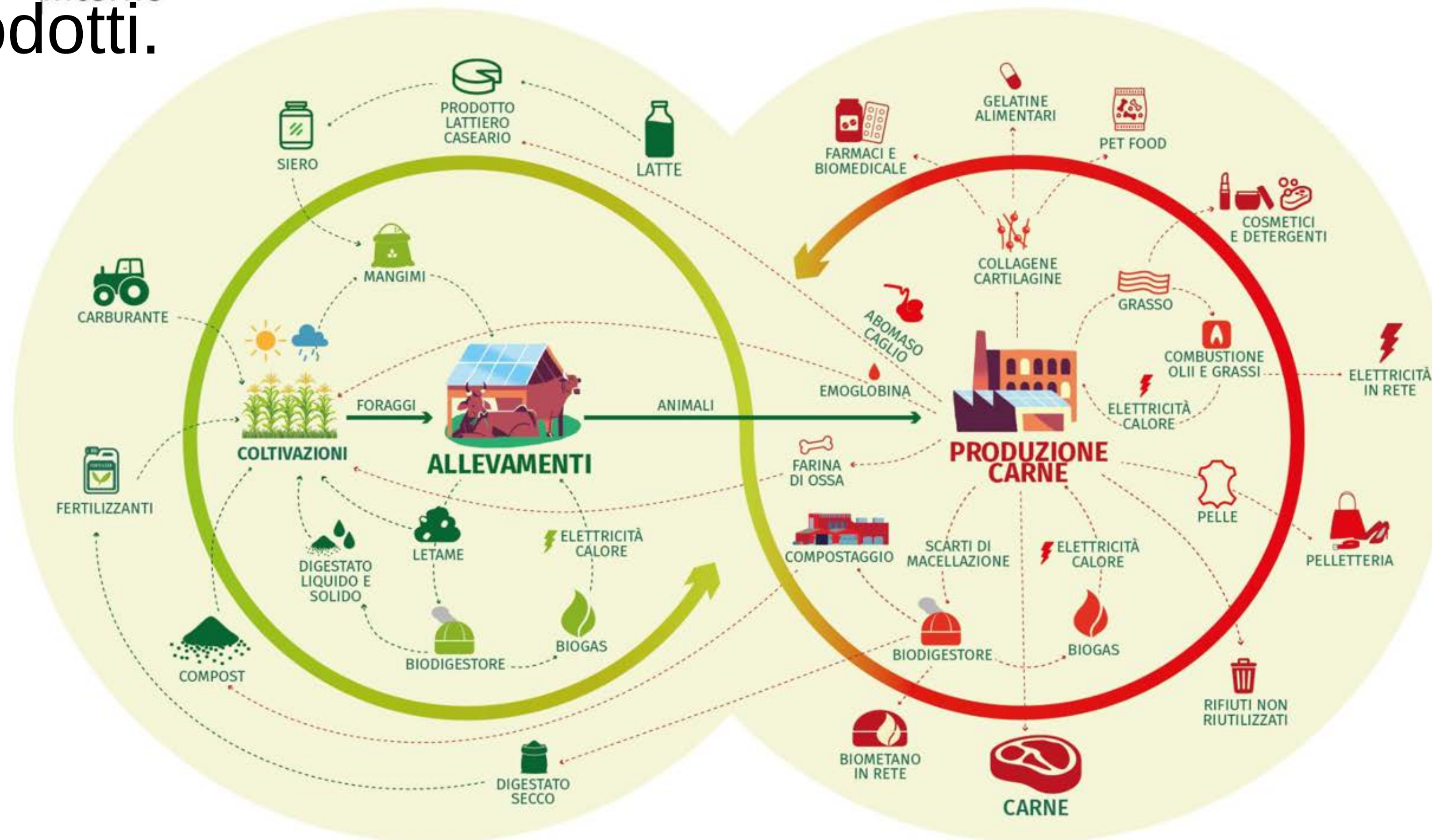


Fig. 1 | Research gaps that need to be filled to better meet the expectations of cell-based food production. The research gaps in cell-based food production are

Le filiere carni naturali sono [a] un sistema ad alto grado di rigeneratività e le cui **emissioni** sono [b] **allocate** oltre che sul prodotto principale su una vasta gamma di co-prodotti e sottoprodotti.



3. Asimmetria delle informazioni scientifiche



LCA applicato alla
produzione di carne
naturale > 150 articoli

LCA applicato alla carne
artificiale < 10 articoli
(comprese le review)



LCA classici

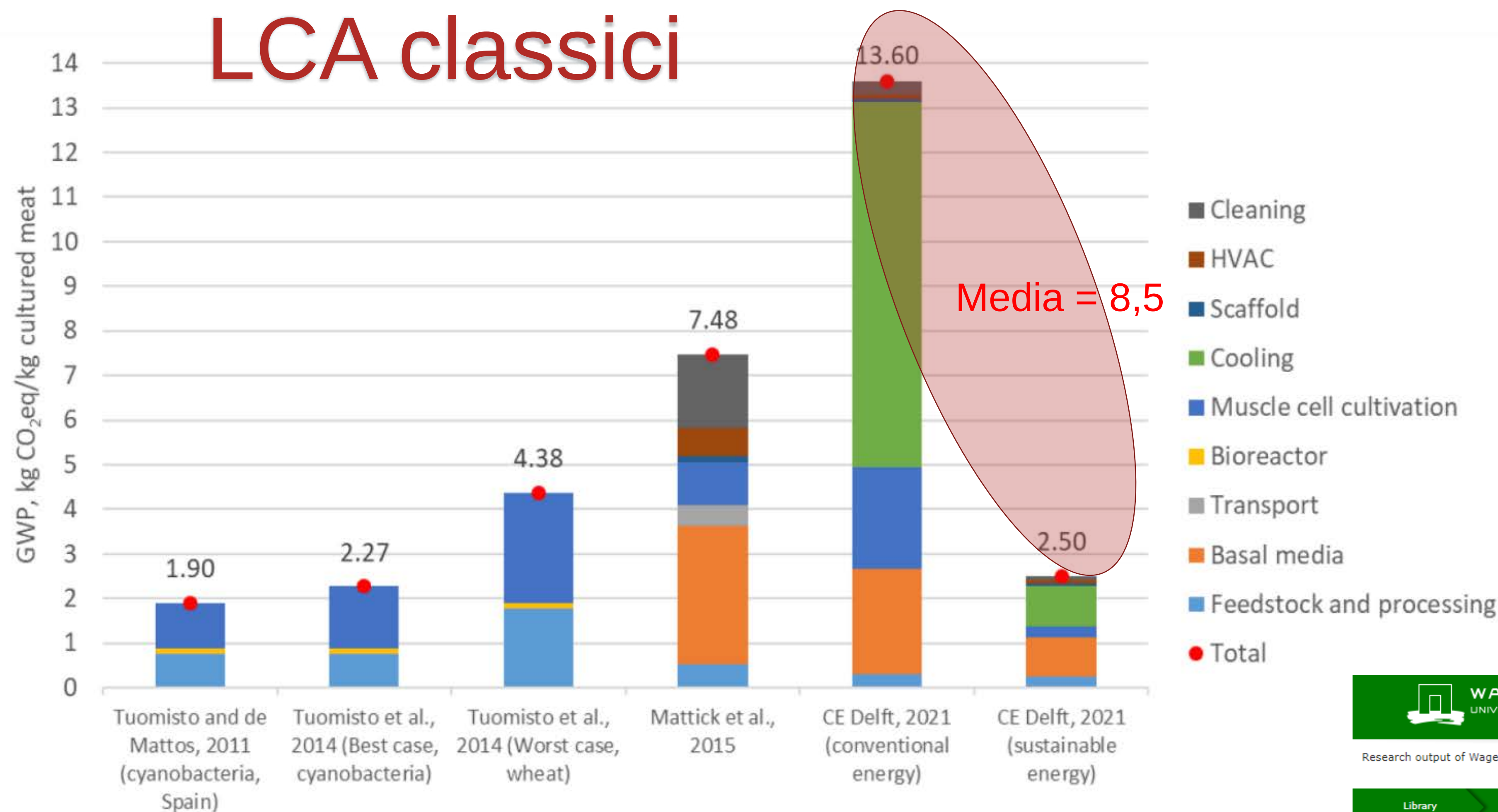
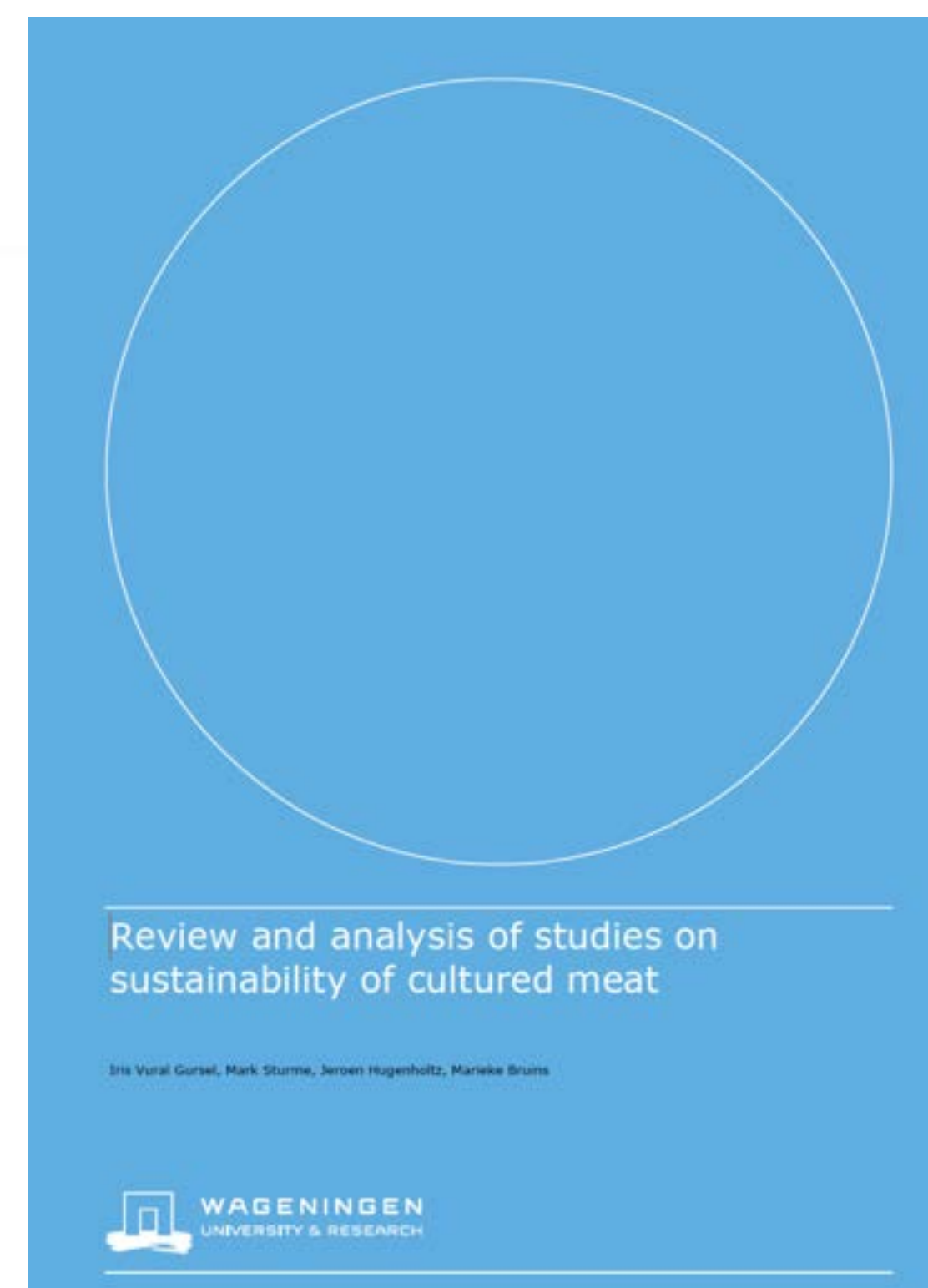
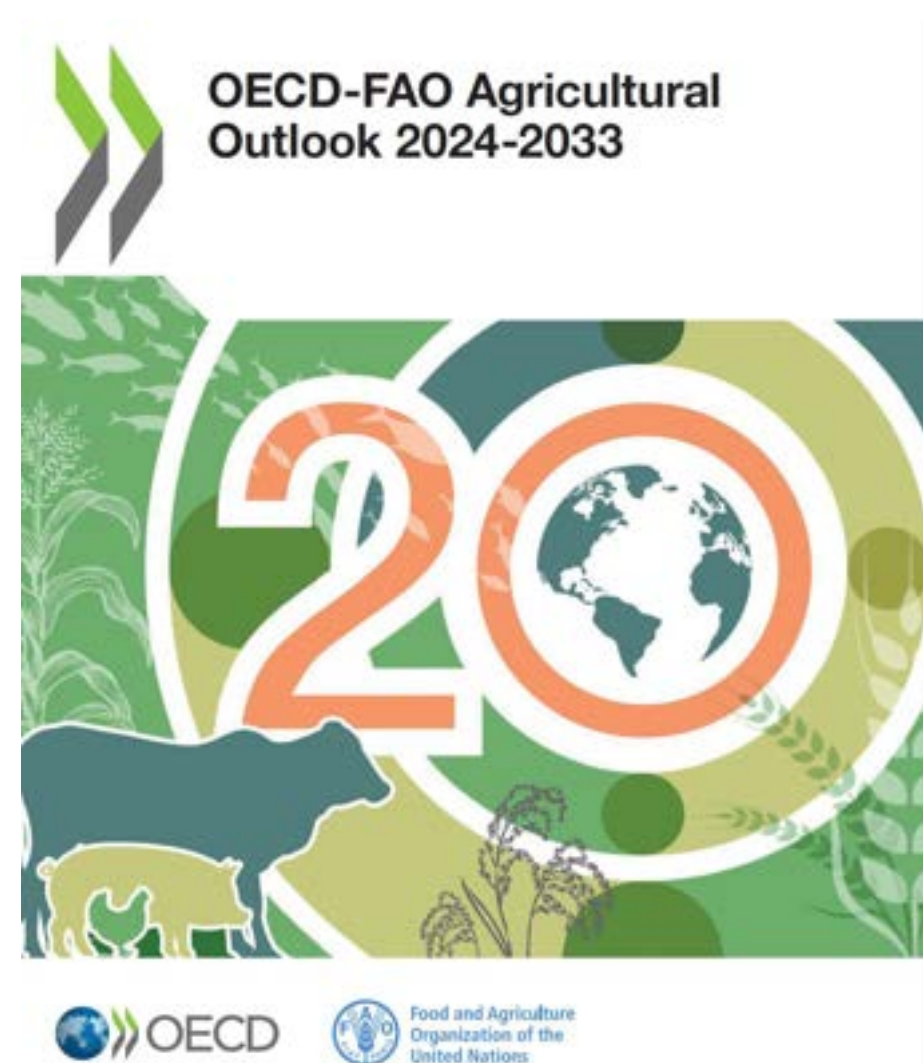


Figure 2 Global warming potential (GWP) of cultured meat

Current global electricity mix (13% renewables) = 12.15 kg CO₂e/kg artificial meat



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Research output of Wageningen University & Research staff	
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Record number	593622
Title	Review and analysis of studies on sustainability of cultured meat
Author(s)	Vural Gursel, Iris ; Sturme, Mark ; Hugenholtz, Jeroen ; Bruins, Marieke
Source	Wageningen : Wageningen Food & Biobased Research (Report / Wageningen Food & Biobased Research 2248) - 44
Department(s)	BBP Biorefinery & Sustainable Value Chains BBP Bioconversion VLG
Publication type	Research report
Publication year	2022



Di quanta carne in più avremo bisogno al 2033?

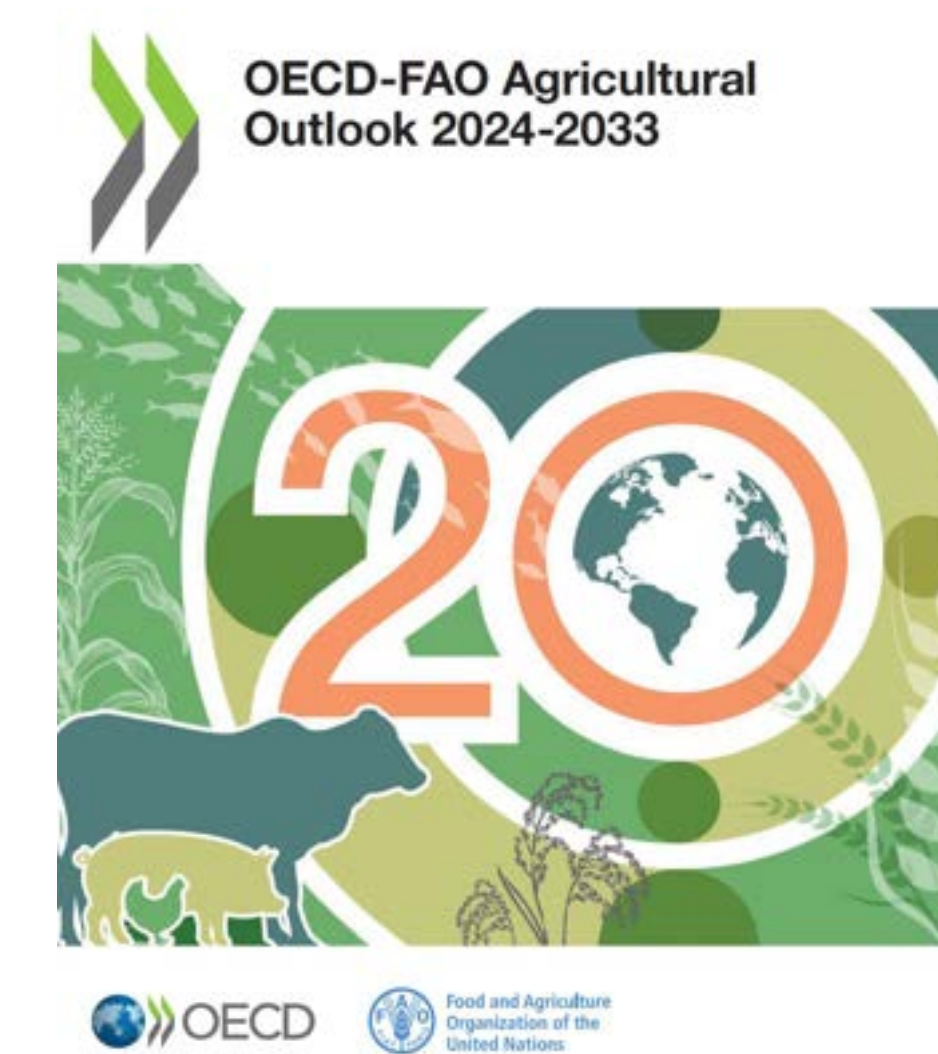
Produzione mondiale di carne: **354 milioni/anno di tonnellate**

Produzione mondiale di carne aumenterà al 2033 a 391 Mt = **+ 37 milioni di tonnellate/anno finale**

Tipo di carne	Produzione media 2021-2023 (Mt)	Produzione 2033 (Mt)	Aumento (Mt)
Beef and veal	74 Mt	81 Mt	+7 Mt
Pig meat	122 Mt	131 Mt	+9 Mt
Poultry meat	139 Mt	160 Mt	+21 Mt
Sheep meat	17 Mt	19 Mt	+2 Mt

Scenario dal 2023 al 2033: emissioni di CO_{2e}

Con un mix FCE/RFE al 50% per produrre 1 kg di carne artificiale sono rilasciati **8,5 kg di CO_{2e}**



Ipotizziamo di soddisfare la richiesta di ulteriori 46 milioni di t/anno di carne solo con la carne artificiale (FAO OECD, 2023)

8,5 t di CO_{2e} X 37 milioni di tonnellate = 315 milioni di ton di CO_{2e} → Carne artificiale

Stima che per la produzione totale di carne = 3,3 Miliardi di ton di **di CO_{2e}**

Stima che le emissioni legate all'incremento della produzione di carne (+ 37 milioni di ton) saranno del **+6%**

Pari a 200 milioni di ton di CO_{2e} → Carne naturale



Scenario al 2033: investimenti in impianti

Per la produzione di 37 milioni di tonnellate di carne

✓ **1.233.333 bioreattori** da 20.000 litri

Capacità di 1 bioreattore: 3 t di prodotto/ciclo per 10 cicli/anno = 30 t/anno.

Da installare (esattaemnte) 137.037 nuovi bioreattori/anno dal 2025 al 2033



LCA per la CFP della carne artificiale si arricchisce di informazioni: i fattori di crescita

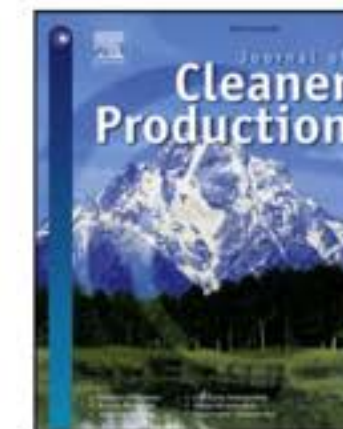
Journal of Cleaner Production 419 (2023) 138153



Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro



Environmental life cycle assessment of recombinant growth factor production for cultivated meat applications

Kirsten R. Trinidad^{a,1}, Reina Ashizawa^{b,1}, Amin Nikkhah^c, Cameron Semper^d,
Christian Casolaro^c, David L. Kaplan^a, Alexei Savchenko^d, Nicole Tichenor Blackstone^{c,*}

^a Graduate School of Engineering, Department of Biomedical Engineering, Tufts University, 419 Boston Ave, Medford, MA 02155, USA

^b Graduate School of Arts and Sciences, Department of Biology, Tufts University, 419 Boston Ave, Medford, MA 02155, USA

^c Friedman School of Nutrition Science and Policy, Tufts University, Boston, MA, USA

^d Department of Microbiology, Immunology and Infectious Diseases, University of Calgary, Calgary, AB T2N 4N1, Canada

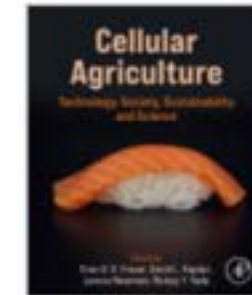
Gli autori stimano un impatto aggiuntivo non trascurabile, da un minimo dello 0,4 al massimo del 23% sul totale



LCA per la CFP della carne artificiale si arricchisce di informazioni: la purificazione da endotossine [1]

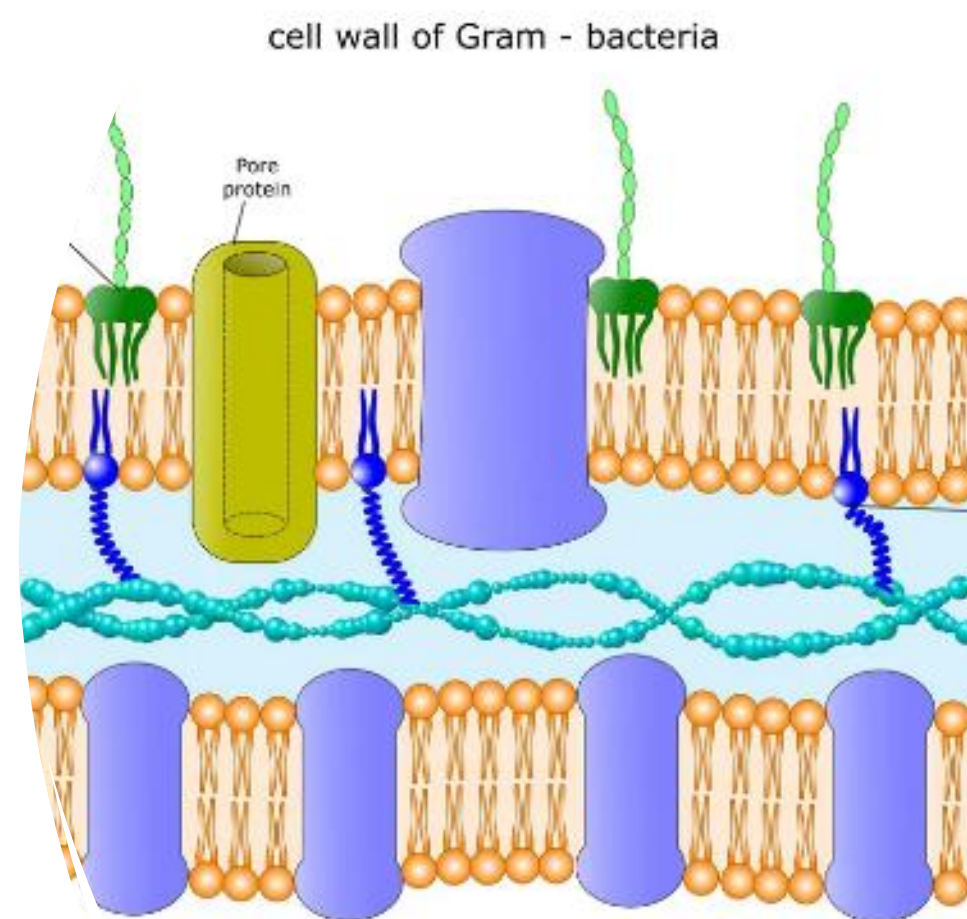


Cellular Agriculture
Technology, Society, Sustainability and Science
2024, Pages 469-486



Chapter 30 - Techno-economic assessments of cellular agriculture

Derrick Risner¹, Karen A. McDonald^{2,3}, Justin B. Siegel^{4,5,6,7}, Edward S. Spang^{1,7}



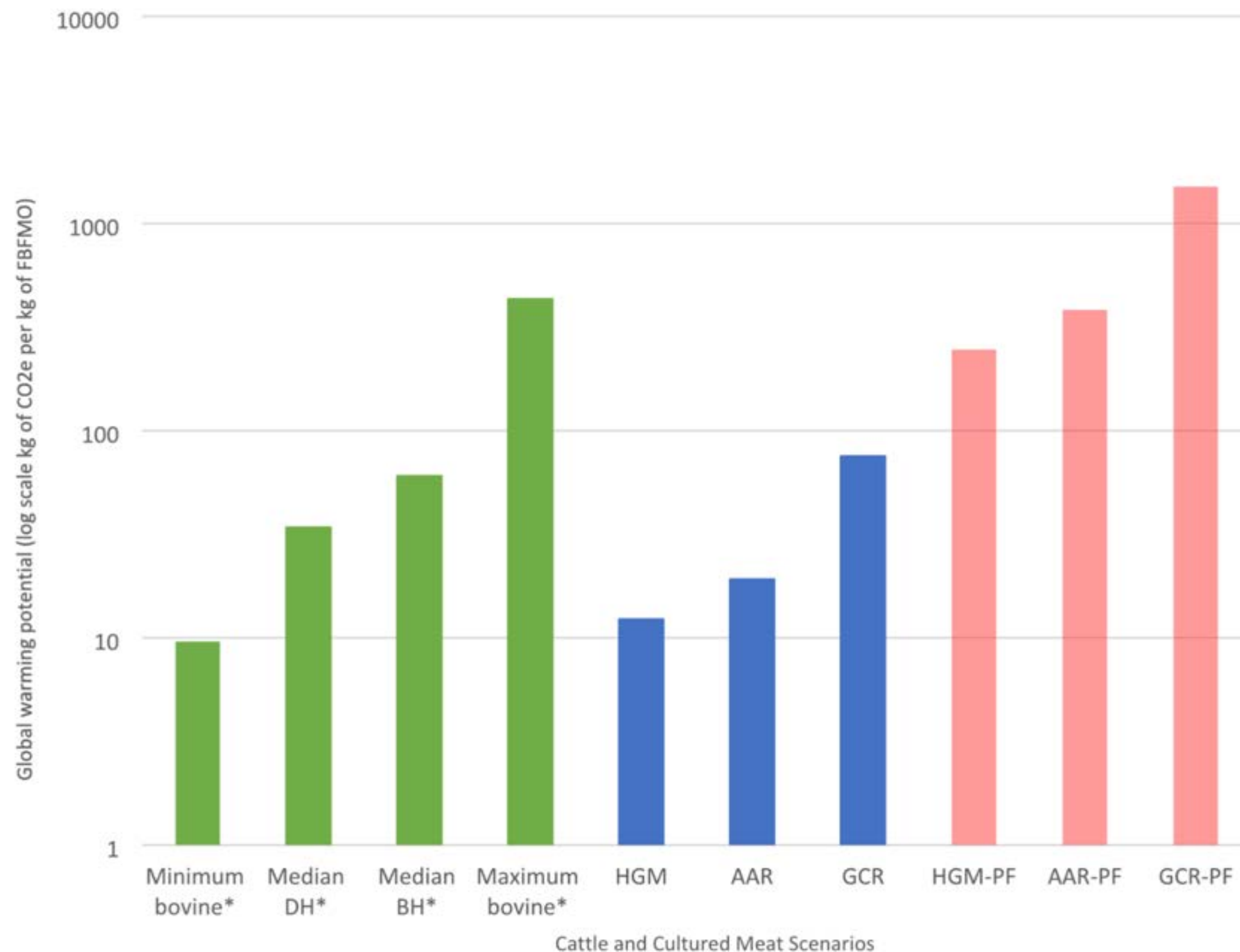
I batteri Gram negativi rilasciano piccole quantità di endotossina nell'ambiente quando proliferano e ne rilasciano grandi quantità quando sono inattivati.

Le LCA della CC condotte in precedenza presentano limitazioni significative, nella ***mancata considerazione della rimozione delle endotossine (tossiche per le colture cellulari)***.

La purificazione del medium dalle endotossine richiede ***20-25 volte più energia*** che produrre un medium non purificato



LCA per la CFP della carne artificiale si arricchisce di informazioni: la purificazione da endotossine [2]



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Article

Environmental Impacts of Cultured Meat: A Cradle-to-Gate Life Cycle Assessment

Published as part of ACS Food Science & Technology *special issue* "Alternative Protein Sources for Responsible Food Consumption and Production".

Derrick Risner, Patrick Negulescu, Yoonbin Kim, Cuong Nguyen, Justin B. Siegel, and Edward S. Spang*

Cite This: ACS Food Sci. Technol. 2025, 5, 61–74

Read Online

Il GWP (Global Warming Potential) per tutti gli scenari di carne artificiale (compreso tra **12 e 1508 kg di CO₂ equivalente per chilogrammo di carne artificiale**) variava da circa l'80% in meno fino a circa il 2513% in più rispetto al GWP mediano della carne bovina al dettaglio, ma in tutti i casi risultava superiore al valore minimo riportato per la carne bovina al dettaglio (9,6 kg di CO₂ equivalente per kg di FFBMO = ***Fat-and-Protein-Corrected Boneless Meat Output***). Il GWP di tutti gli scenari con purificazione variava da **246 a 1508 kg di CO₂ equivalente per chilogrammo di carne artificiale**, ovvero da 4 a 25 volte superiore rispetto al GWP mediano della carne bovina al dettaglio (circa 60 kg di CO₂ equivalente per kg di FFBMO).

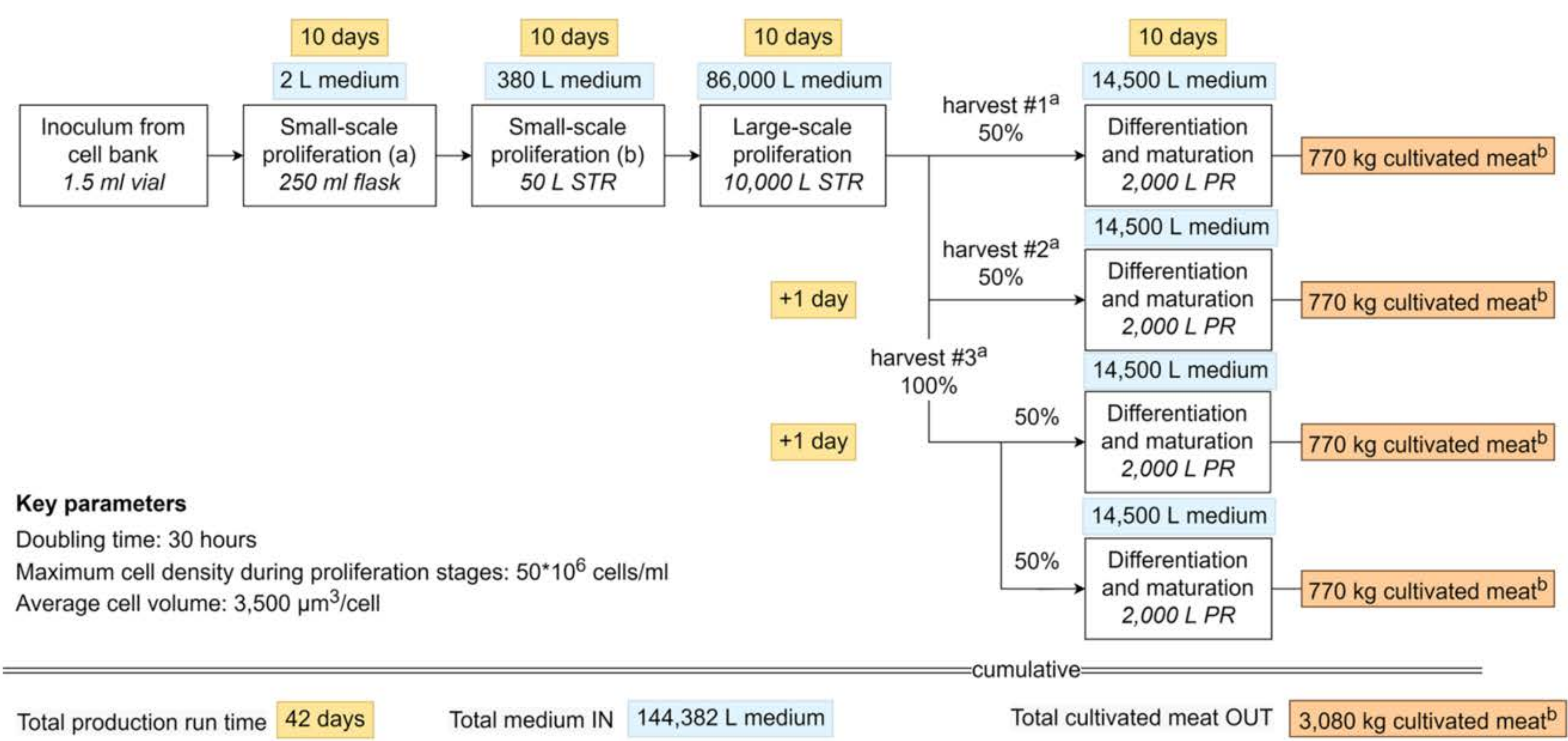


Up date su LCA e scenari per la carne artificiale

Ex-ante life cycle assessment of commercial-scale cultivated meat production in 2030

Pelle Sinke¹ · Elliot Swartz² · Hermes Sanctorum³ · Coen van der Giesen¹ · Ingrid Odegard¹

The International Journal of Life Cycle Assessment (2023) 28:234–254 239

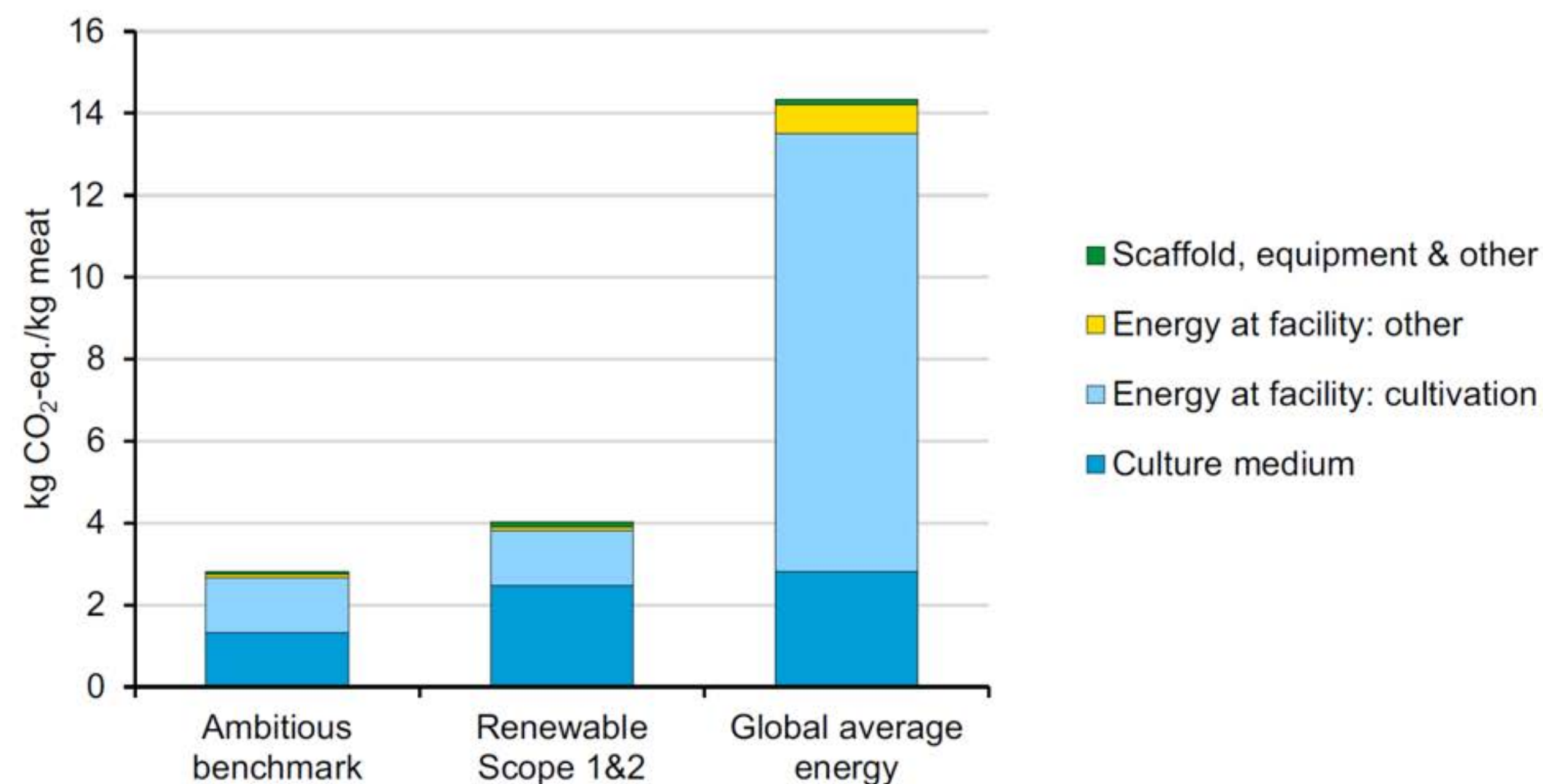


Tre gli scenari esplorati al 2030

The International Journal of Life Cycle Assessment (2023) 28:234–254

243

Fig. 3 Carbon footprint of cultivated meat in 2030, baseline scenario with different energy mixes



Energy Two energy mixes were modeled for this study. The conventional energy mix was based on a global average stated policies scenario for 2030 in the World Energy Outlook (IEA 2019) (for composition see Appendix D), and heat is generated using natural gas (European market mix for industrial heat production from Ecoinvent). The sustainable energy mix was based on on-shore wind and solar PV electricity (both 50%) and heat from geothermal sources. Three energy scenarios were defined, using the energy mixes as an input into different parts of the model, delineated by scope 1, 2, and 3 as defined in the Greenhouse Gas Protocol (GHG Protocol 2011):

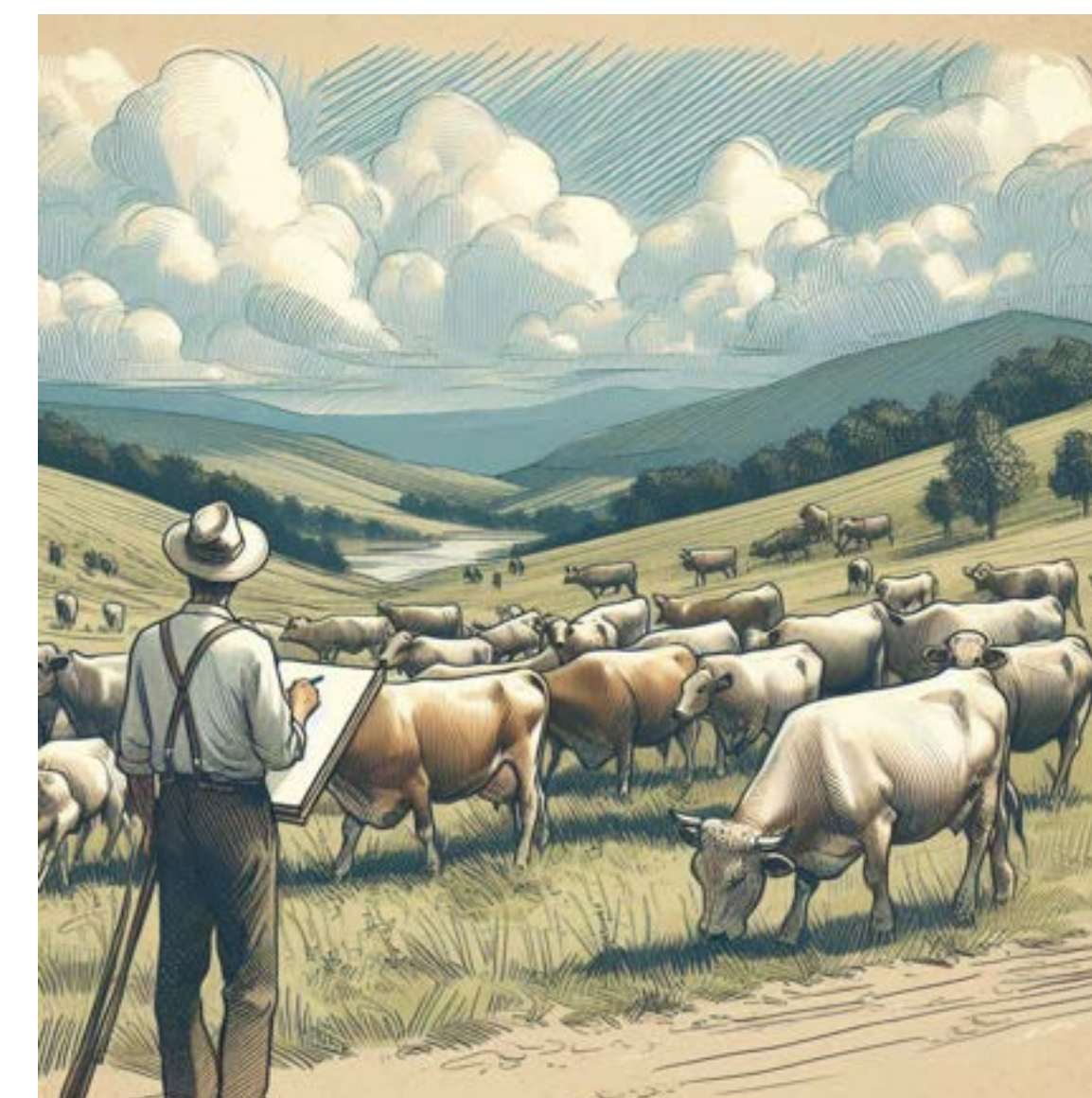
- Ambitious Benchmark 2030: Renewable energy for scope 1, 2, and 3 (scope 3 modeling only for culture medium ingredients, scaffold, filters, and water purification)
- Renewable scope 1 and 2: Renewable energy for scope 1 and 2 (at the facility), average mix for scope 3 (upstream)
- Global average energy: Global average energy mix for scope 1, 2, and 3*

Consumo energetico = 22,6 KWh/kg di biomassa

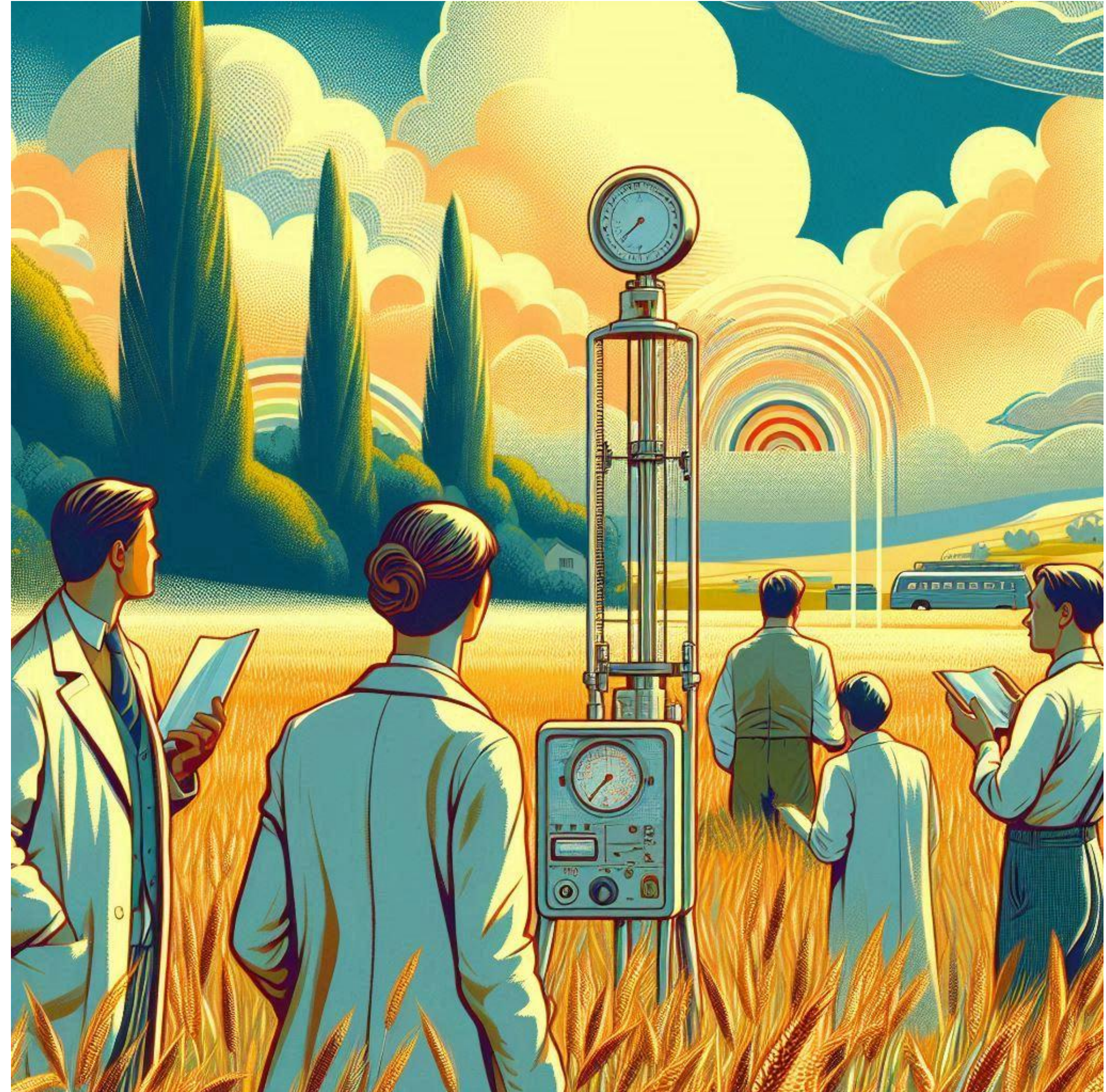


Quali FER per una produzione supplementare energeticamente più sostenibile al 2033 di carne artificiale?

- Consumo di 0,0223 GWh/ton (*Sinke et al., 2022*) artificiale x 37 mln tons/anno = fabbisogno **825.100 GWh**
- Solo fotovoltaico [rendimento 0,550- 0,175- GWh/ha] = **1,50 – 4,71 mln di ha (agrivoltaico) di impianti** [senza perdite di rete]
- Solo eolico [turbine da 3,5-4,5 MW, rendimento con vento 6 m/s 10 GWh/anno]= **82.510 turbine** [altezza 250-300 m, senza perdite di rete]



4. Le metriche utilizzate (standard IPCC) sono corrette?



Nel calcolo degli impatti del Carbonio si utilizzano
equivalenze IPCC (*Intergovernmental Panel on Climate Change*)

1



CH_4

= 28



CO_2



L'emivita del CH_4 (SLPG) è di circa 10 anni e dopo 50 anni è praticamente scomparso; quella della CO_2 (LLPG) è di 42 anni, ma questa permane in atmosfera per oltre 1,000 anni

(Muller RA, Muller EA (2017) *Fugitive Methane and the Role of Atmospheric Half-Life*. *Geoinfor Geostat: An Overview* 5:3. doi: 10.4172/2327-4581.1000162)

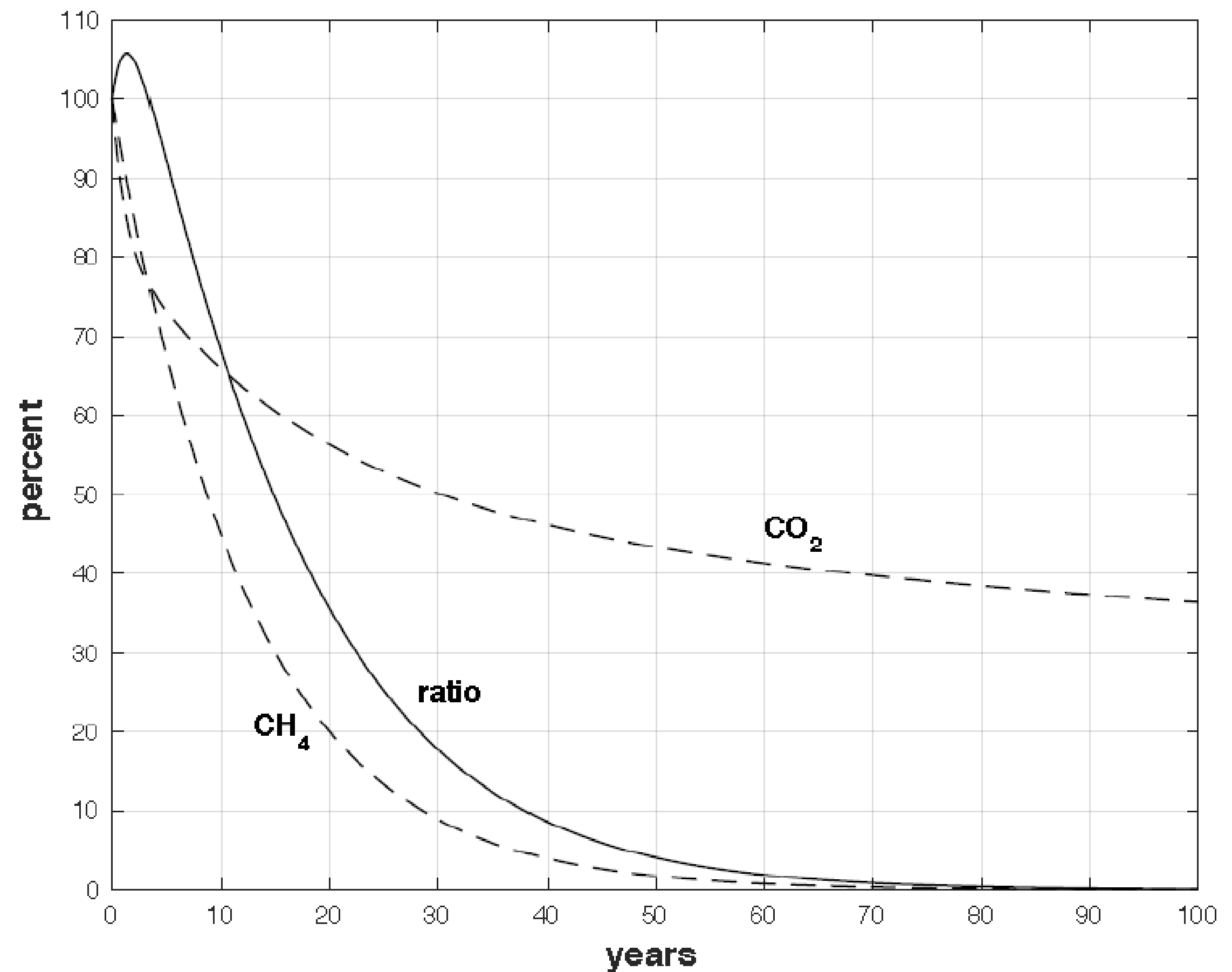
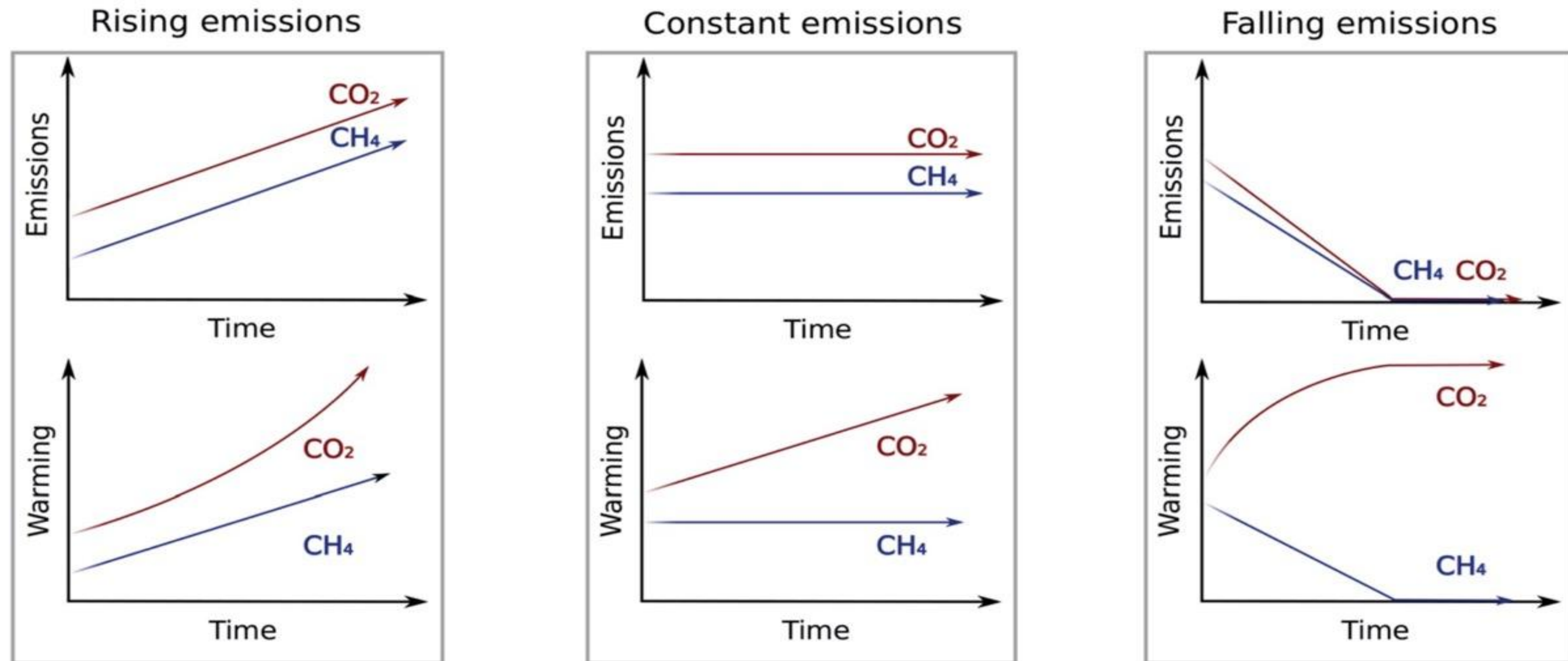


Figure 1: The persistence of carbon dioxide and methane in the atmosphere as a function of time. The chart begins when a pulse of the gas is injected into the atmosphere. The legacy effect of methane is miniscule compared to that of carbon dioxide.

Debolezza dello [Standard] Global Warming Potential



Source: Oxford Martin, *Climate Metrics for Ruminant Livestock*, July 2018, <https://www.oxfordmartin.ox.ac.uk/downloads/reports/Climate-metrics-for-ruminant-livestock.pdf%C2%A0>



Risk to rely on soil carbon sequestration to offset global ruminant emissions

Received: 7 August 2023
Accepted: 9 November 2023
Published online: 22 November 2023

Yue Wang¹✉, Imke J. M. de Boer¹, U. Martin Persson²,
Raimon Ripoll-Bosch¹, Christel Cederberg², Pierre J. Gerber^{1,3},
Pete Smith⁴ & Corina E. van Middelaar¹

Un impulso su Radiative Forcing

Un impulso su Temperatura

Flusso continuo su Radiative Forcing

Flusso continuo su Temperatura

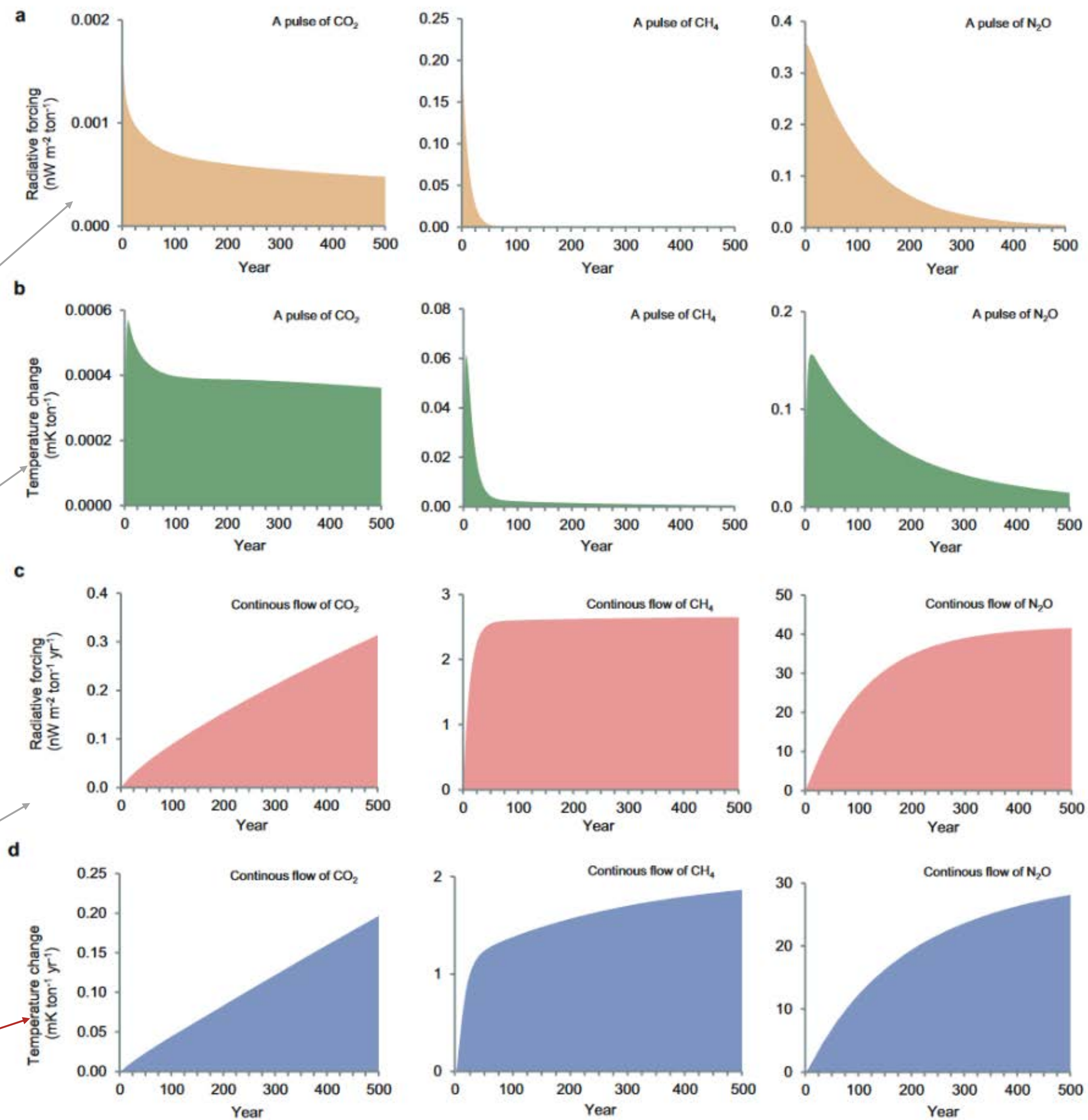


Fig. 1 | Climate impact related to the emission of a greenhouse gas (GHG) including CO₂, CH₄ and N₂O. a Radiative forcing of one pulse emission of a tonne (t) of GHGs during 500 years. The area under the graph represents the cumulative radiative forcing. **b** Global surface temperature change of one pulse emission of a t of GHGs during 500 years. **c** Cumulative radiative forcing of a continuous yearly emission of one t of GHGs during 500 years. **d** Cumulative global surface temperature change of a continuous yearly emission of one t of GHGs during 500 years. Note the difference in scale on the y-axis. The calculations are based on a simple climate model²⁷. Source data are provided as a Source Data file.

LE NUOVE METRICHE

GWP e GWP*

npj | Climate and Atmospheric Science www.nature.com/npjclimatsci

ARTICLE OPEN

A solution to the misrepresentations of CO₂-equivalent emissions of short-lived climate pollutants under ambitious mitigation

Myles R. Allen^{1,2}, Keith P. Shine³, Jan S. Fuglestvedt⁴, Richard J. Millar¹, Michelle Cain^{1,5}, David J. Frame⁶ and Adrian H. Macey⁷

npj | Climate and Atmospheric Science www.nature.com/npjclimatsci

ARTICLE OPEN

Improved calculation of warming-equivalent emissions for short-lived climate pollutants

Michelle Cain^{1,2}, John Lynch³, Myles R. Allen^{1,3}, Jan S. Fuglestvedt⁴, David J. Frame⁵ and Adrian H Macey^{6,7}

ENVIRONMENTAL RESEARCH LETTERS

LETTER • OPEN ACCESS

Stable climate metrics for emissions of short and long-lived species—combining steps and pulses

William J Collins^{4,1}, David J Frame², Jan S Fuglestvedt³ and Keith P Shine¹

npj | Climate and Atmospheric Science www.nature.com/npjclimatsci

MATTERS ARISING OPEN [Check for updates](#)

Further improvement of warming-equivalent emissions calculation

M. A. Smith^{1,2}, M. Cain^{1,3} and M. R. Allen^{1,2}



LE NUOVE METRICHE

GWP e GWP*

GWP	$ECO_2-e = E \times GWP_H$	IPCC, 1990
GWP*	$ECO_2-we = (\Delta ESLCP / \Delta t) \times GWP_H \times H$	Allen et al., 2018
Evoluzione del GWP*	$ECO_2-we = GWP_H \times [r \times (\Delta ESLCP / \Delta t) \times H + s \times ESLCP]$	Cain et al., 2019

- E è l'emissione per un dato GHG, H è l'orizzonte temporale e GWP_H è il GWP per un GHG secondo lo standard IPCC (1990) per un tempo H .
- ΔE_{SLCP} è la variazione del tasso di emissione di un dato SLCP per un intervallo di tempo Δt , H è l'orizzonte temporale.
- **red s**: importanza dell'accumulo (**s**, stock) e del tasso di emissione (**r**, rate) per un dato orizzonte temporale H , calcolati usando una regressione multipla sulla risposta alle emissioni di metano in comuni scenari incentrati sul periodo 1900-2100. $r = 0.75$, $s = 0.25$.

Affinamento GWP*	$ECO_2-we = GWP_{100} \times [4.53 \times ESLCP(t) - 4.25 \times ESLCP(t-20)]$	Smith et al., 2021
------------------	--	--------------------



Confronto fra vecchie e nuove metriche

Stima del GWP e del GWP* cumulativo a 20 anni di 1 t di metano emesso al primo anno e con modifiche annuali da -2% a +2%

(Correddu et al., 2023)

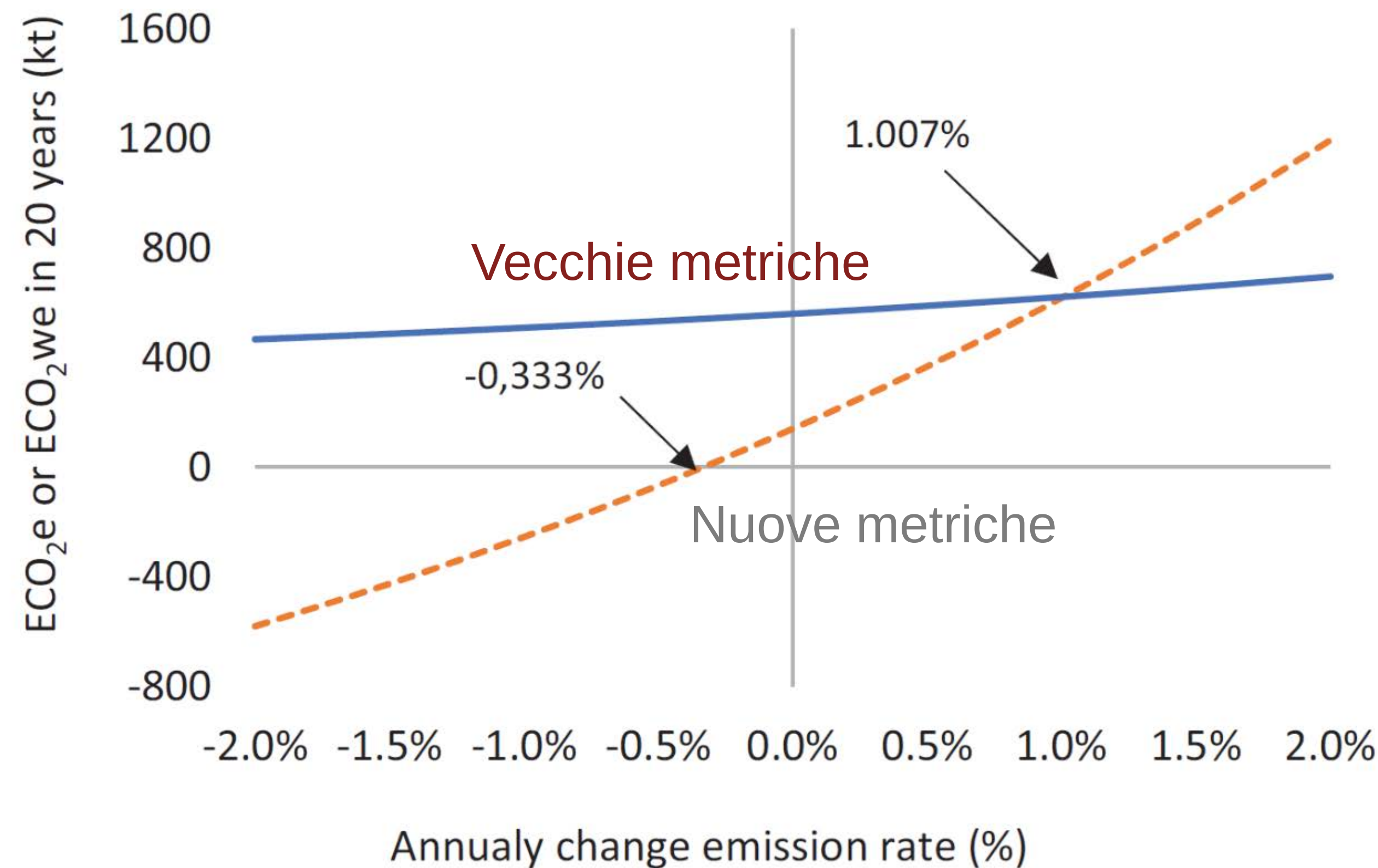
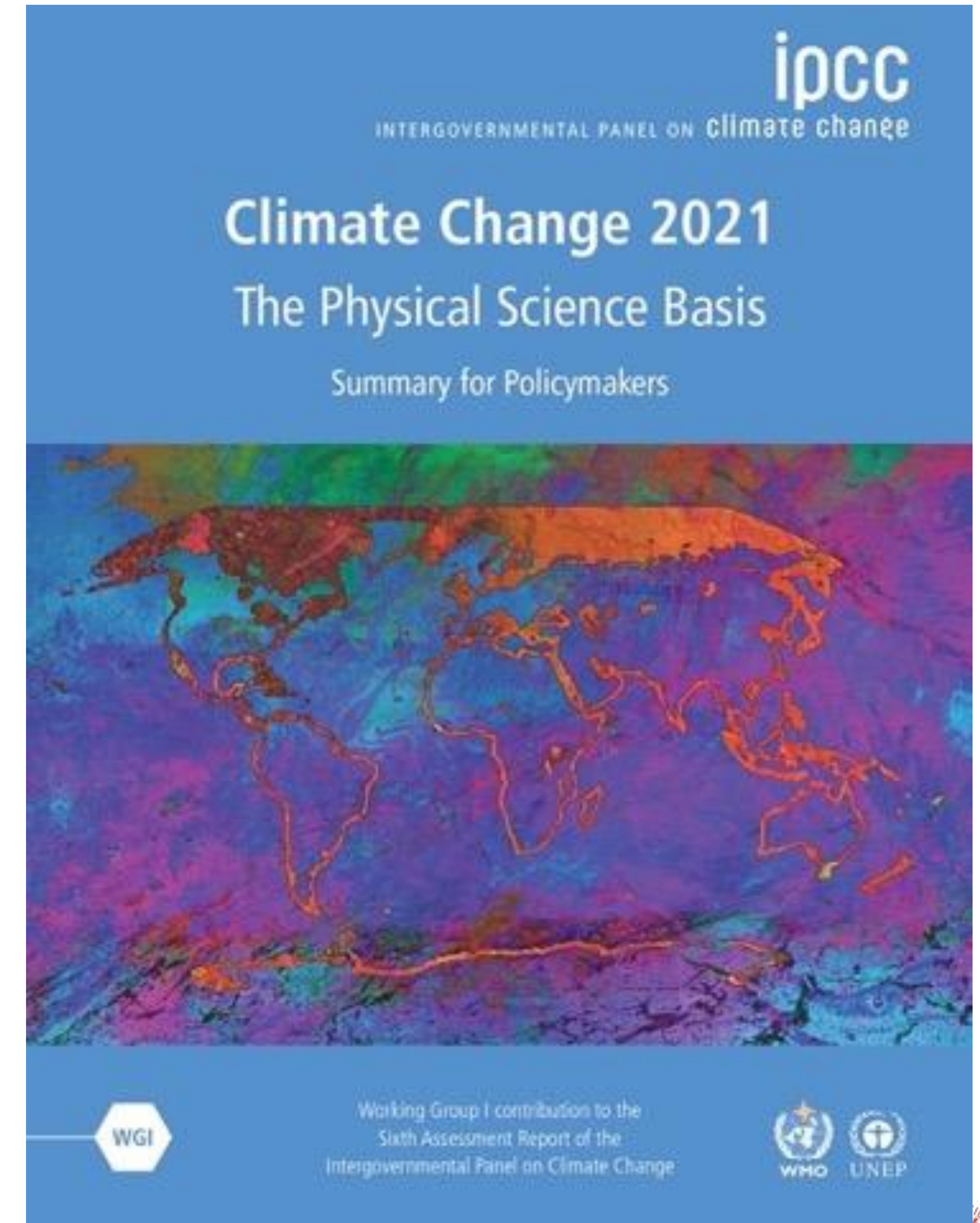


Figure 1. Estimated twenty-year cumulative CO₂ equivalents (ECO₂e) and twenty-year cumulative CO₂ warming equivalents (ECO₂we), calculated applying the global warming potential (GWP) and the global warming potential star (GWP*), respectively, on twenty-year methane emissions. Starting emission was 1 kt of CH₄/year. (Adapted from Cady (2020), with recal-

IPCC ha iniziato a considerare le nuove metriche :

In summary, new emissions metric approaches such as GWP* and CGTP are designed to relate emissions changes in short-lived GHGs to emissions of CO₂ as they better account for the different physical behaviours of short- and long-lived gases. Through scaling the corresponding cumulative CO₂ equivalent emissions by the TCRE, the GSAT response from emissions over time of an aggregated set of

<https://www.ipcc.ch/report/ar6/wg1/>



E anche la FAO nel report sul metano pubblicato a settembre 2023 (<https://www.fao.org/3/cc2468en/cc2468en.pdf>)

GWP* is a useful metric if a time-series of emissions is being evaluated, or compared to another emission scenario, based on impact on temperature e.g. comparison of benefits from several competing mitigation pathways.

The equation to convert a methane emission ($\text{CH}_4(t)$) to a CO_2 -warming-equivalent ($\text{CO}_2\text{-we}(t)$) emission, using GWP^* , is:

$$\text{CO}_2\text{-we}(t) = \text{GWP}_{100} \times (4.53 \times \text{CH}_4(t) - 4.25 \times \text{CH}_4(t-20))$$

which simplifies to:

$$\text{CO}_2\text{-we}(t) = 8 \times \text{CH}_4(t) + 120 \times \Delta\text{CH}_4(t)$$



C'è bisogno di nuove metriche

La comunità scientifica dei fisici dell'atmosfera chiede una **nuova metrica** per gli LLCP e SLCP

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<https://doi.org/10.1088/1748-9326/ace204>

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LETTER

Are single global warming potential impact assessments adequate for carbon footprints of agri-food systems?

Graham A McAuliffe^{1,*}, John Lynch², Michelle Cain³, Sarah Buckingham⁴, Robert M Rees⁴, Adrian L Collins¹, Myles Allen⁵, Raymond Pierrehumbert⁵, Michael R F Lee⁶ and Taro Takahashi^{1,7,8}

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⁵ E

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⁷ U

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E-n

Key

Sup

Given its dynamic nature and previously proven strong correspondence with climate models, out of the three assessments covered, GWP* provides the most complete coverage of the temporal evolution of temperature change for different greenhouse gas emissions. We extend previous discussions on the limitations of static emission metrics and encourage LCA practitioners to consider due care and attention where additional information or dynamic approaches may prove superior, scientifically speaking, particularly in cases of decision support.

npj | Climate and Atmospheric Science

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COMMENT OPEN



Indicate separate contributions of long-lived and short-lived greenhouse gases in emission targets

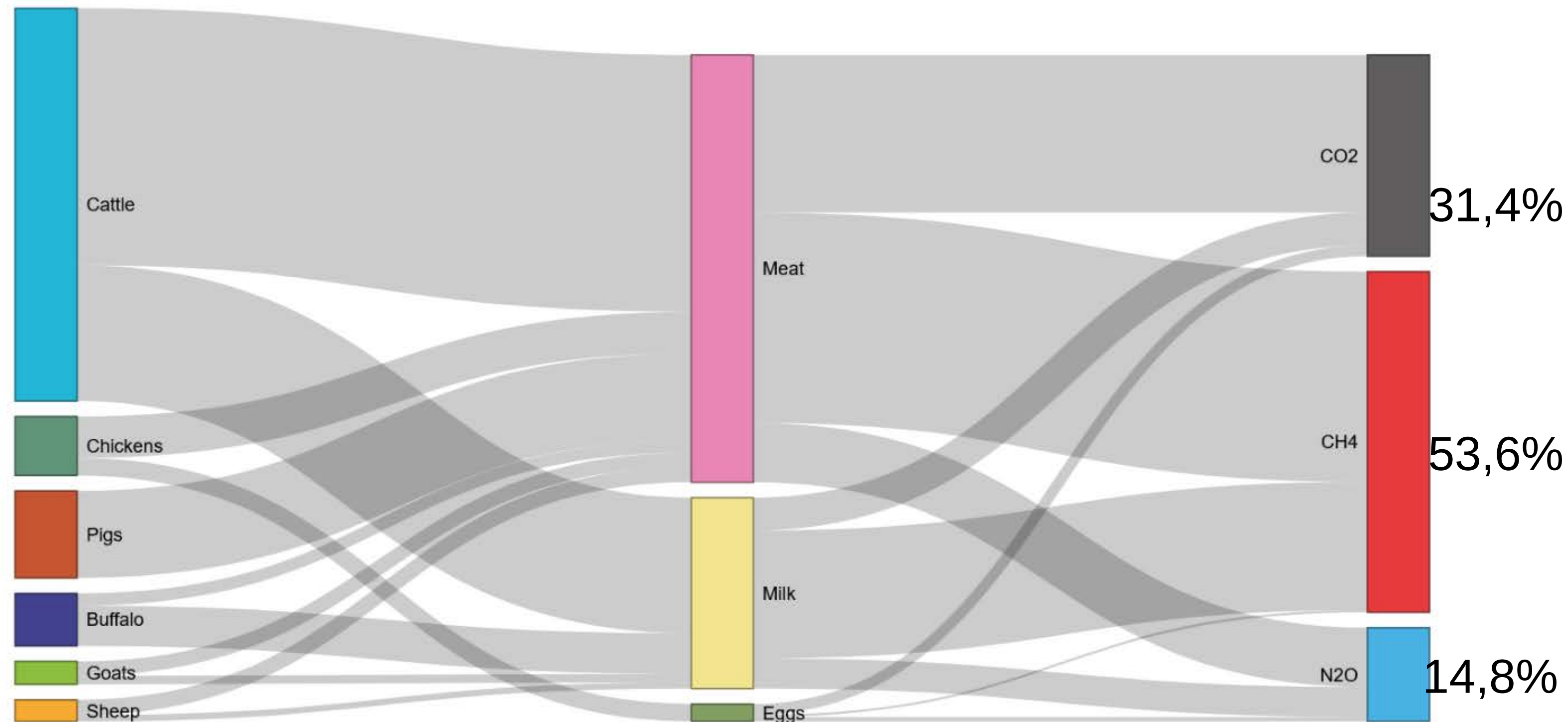
Myles R. Allen¹, Glen P. Peters², Keith P. Shine³, Christian Azar⁴, Paul Balcombe⁵, Olivier Boucher⁶, Michelle Cain⁷, Philippe Ciais⁸, William Collins⁹, Piers M. Forster¹⁰, Dave J. Frame¹¹, Pierre Friedlingstein¹², Claire Fyson¹³, Thomas Gasser¹⁴, Bill Hare¹⁵, Stuart Jenkins¹⁵, Steven P. Hamburg¹⁶, Daniel J. A. Johansson⁴, John Lynch¹⁵, Adrian Macey¹¹, Johannes Morfeldt¹⁵, Alexander Nauels¹³, Ilissa Ocko¹⁶, Michael Oppenheimer¹⁷, Stephen W. Pacala¹⁷, Raymond Pierrehumbert¹⁵, Joeri Rogelj¹⁸, Michiel Schaeffer¹³, Carl F. Schleussner¹³, Drew Shindell¹⁹, Ragnhild B. Skeie¹⁵, Stephen M. Smith¹⁵ and Katsumasa Tanaka¹⁰

npj Climate and Atmospheric Science (2022)5:5; <https://doi.org/10.1038/s41612-021-00226-2>

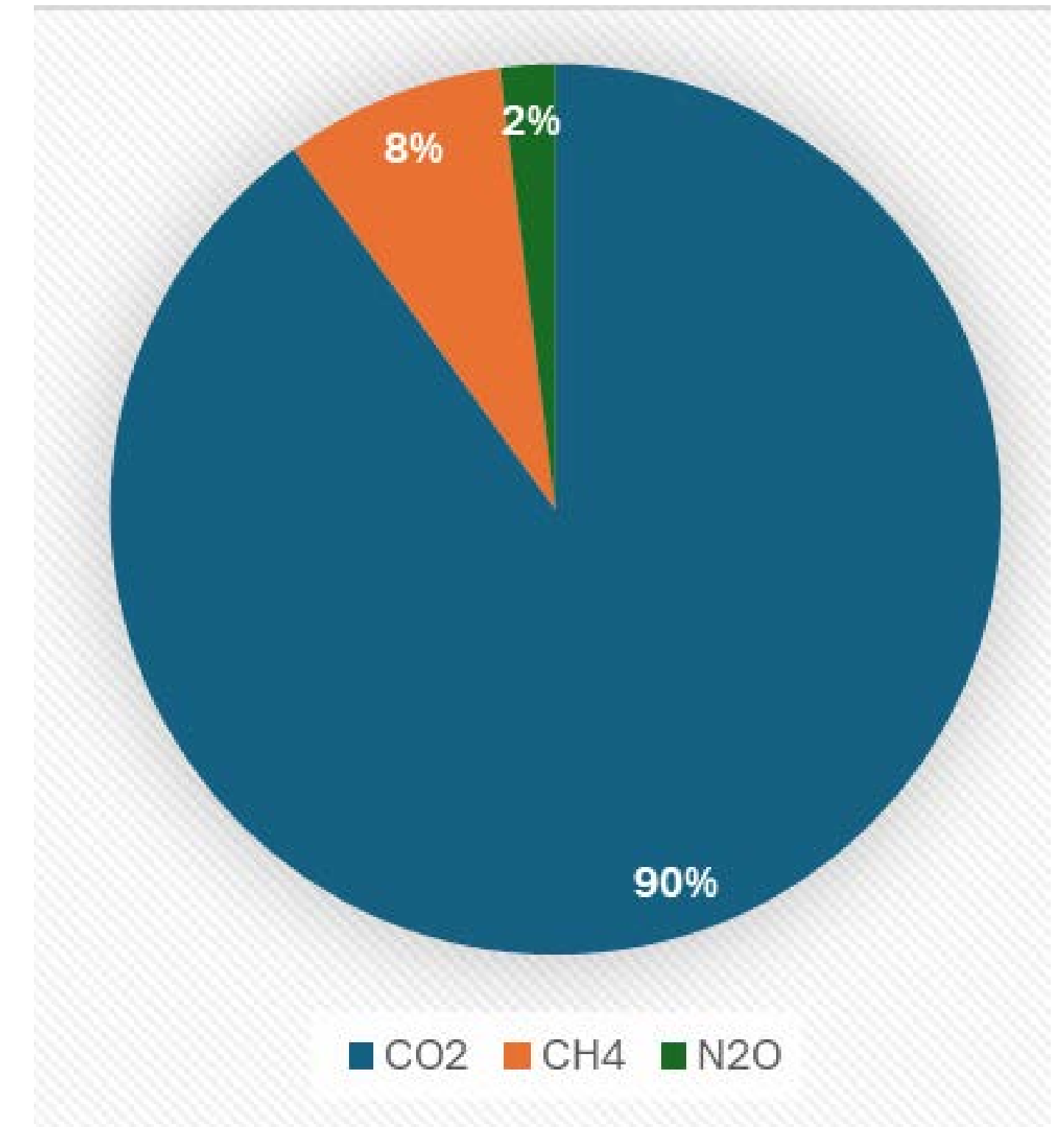


Che tipo di GHG emettono i due tipi di carne (in CO₂e)?

Carne naturale



Carne artificiale



The International Journal of Life Cycle Assessment (2023) 28:234–254
<https://doi.org/10.1007/s11367-022-02128-8>

LCA FOR ENERGY SYSTEMS AND FOOD PRODUCTS

Ex-ante life cycle assessment of commercial-scale cultivated meat production in 2030

Pelle Sinke¹ · Elliot Swartz² · Hermes Sanctorum³ · Coen van der Giesen¹ · Ingrid Odegard¹



Food and Agriculture
Organization of the
United Nations

GLEAM 3 dashboard

Qualche scenario con le nuove metriche GWP*



Climate Impacts of Cultured Meat and Beef Cattle

John Lynch* and Raymond Pierrehumbert

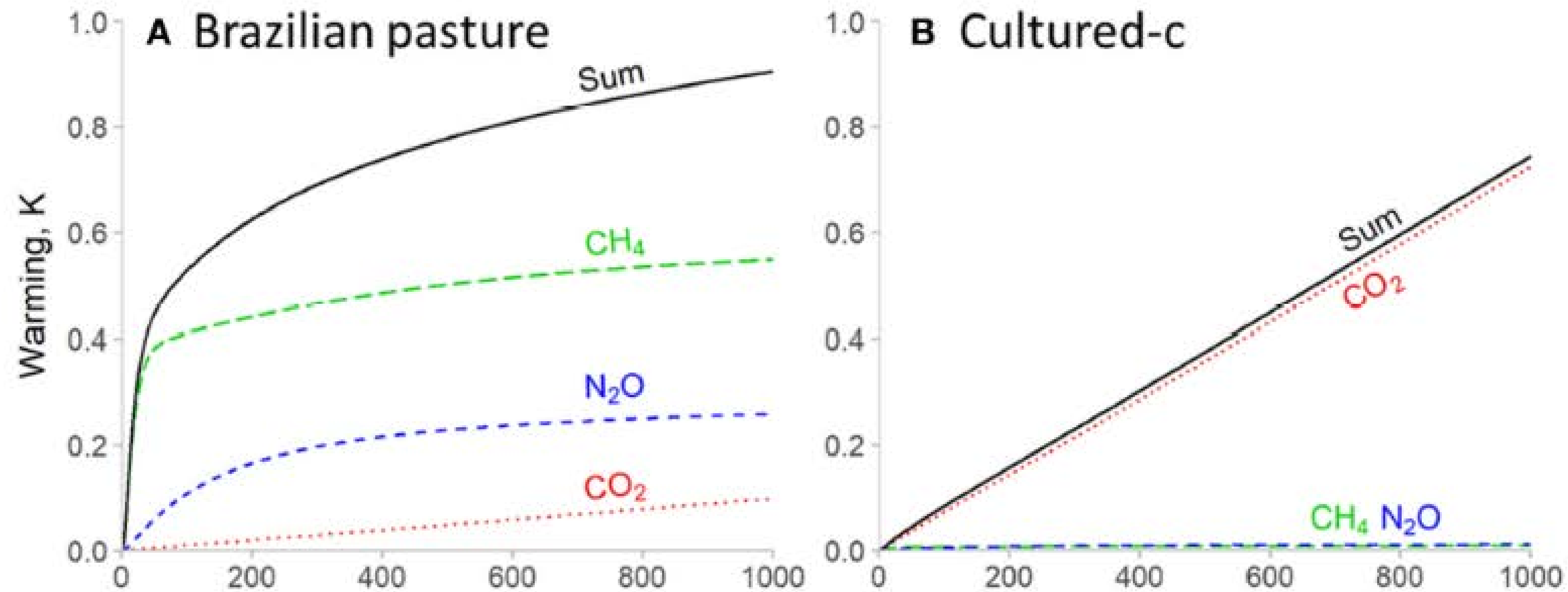
Atmospheric, Oceanic, and Planetary Physics, Department of Physics, University of Oxford, Oxford, United Kingdom

TABLE 1 | Emissions profiles of cultured meat and beef cattle production, expressed as individual gases and total IPCC 5th Assessment Report 100-Years Global Warming Potential carbon dioxide equivalent (GWP₁₀₀ CO₂e) per kg of meat output (either cultured meat or bone free beef).

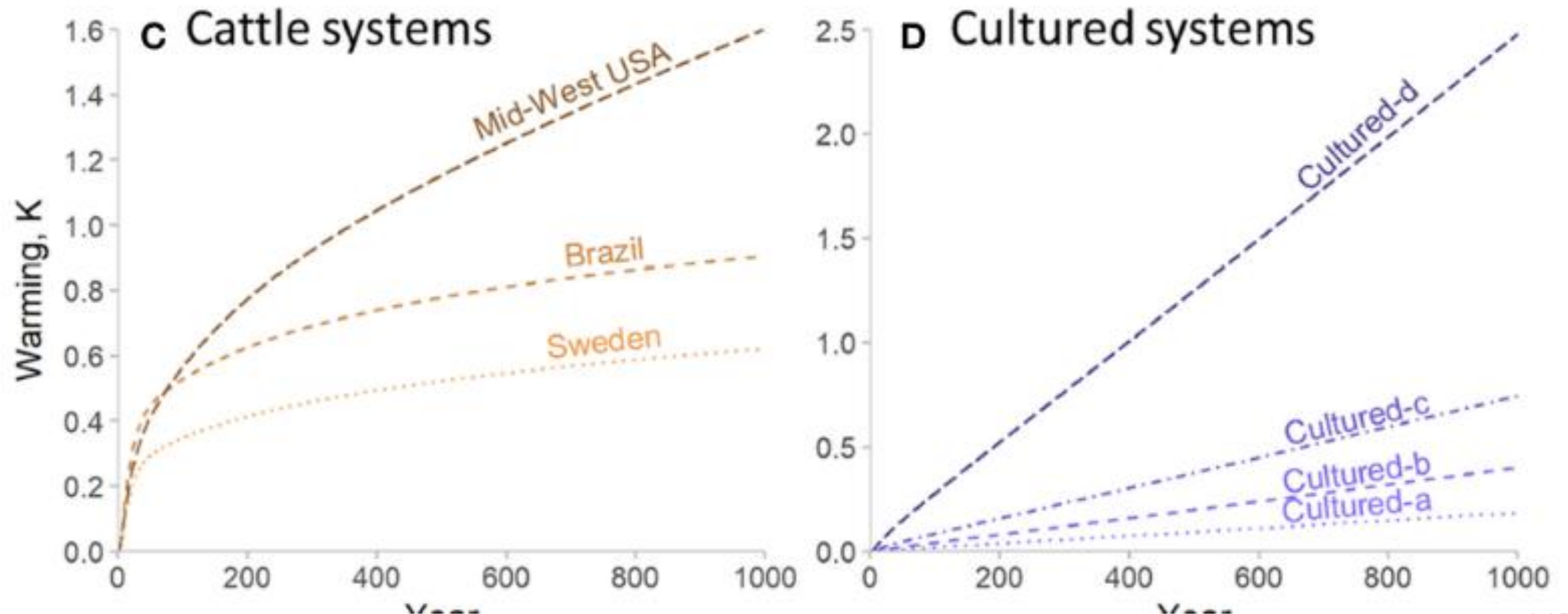
Production system	Annotation	CO ₂	CH ₄	N ₂ O	GWP ₁₀₀ CO ₂ e
CULTURED MEAT					
Tuomisto and Teixeira de Mattos (2011)—low	Cultured-a	1.69			1.69
Tuomisto et al. (2014)—average	Cultured-b	3.67			3.67
Mattick et al. (2015b)—average	Cultured-c	6.64	0.019	0.0013	7.5
Mattick et al. (2015b)—high	Cultured-d	22.1	0.062	0.0043	25
BEEF CATTLE					
Swedish ranch	Sweden	0.90	0.8	0.02	28.6
Brazilian pasture	Brazil	0.90	1.2	0.03	42.45
USA Midwestern pasture	Mid-West USA	5.4	0.8	0.06	43.7

Risultati [1]

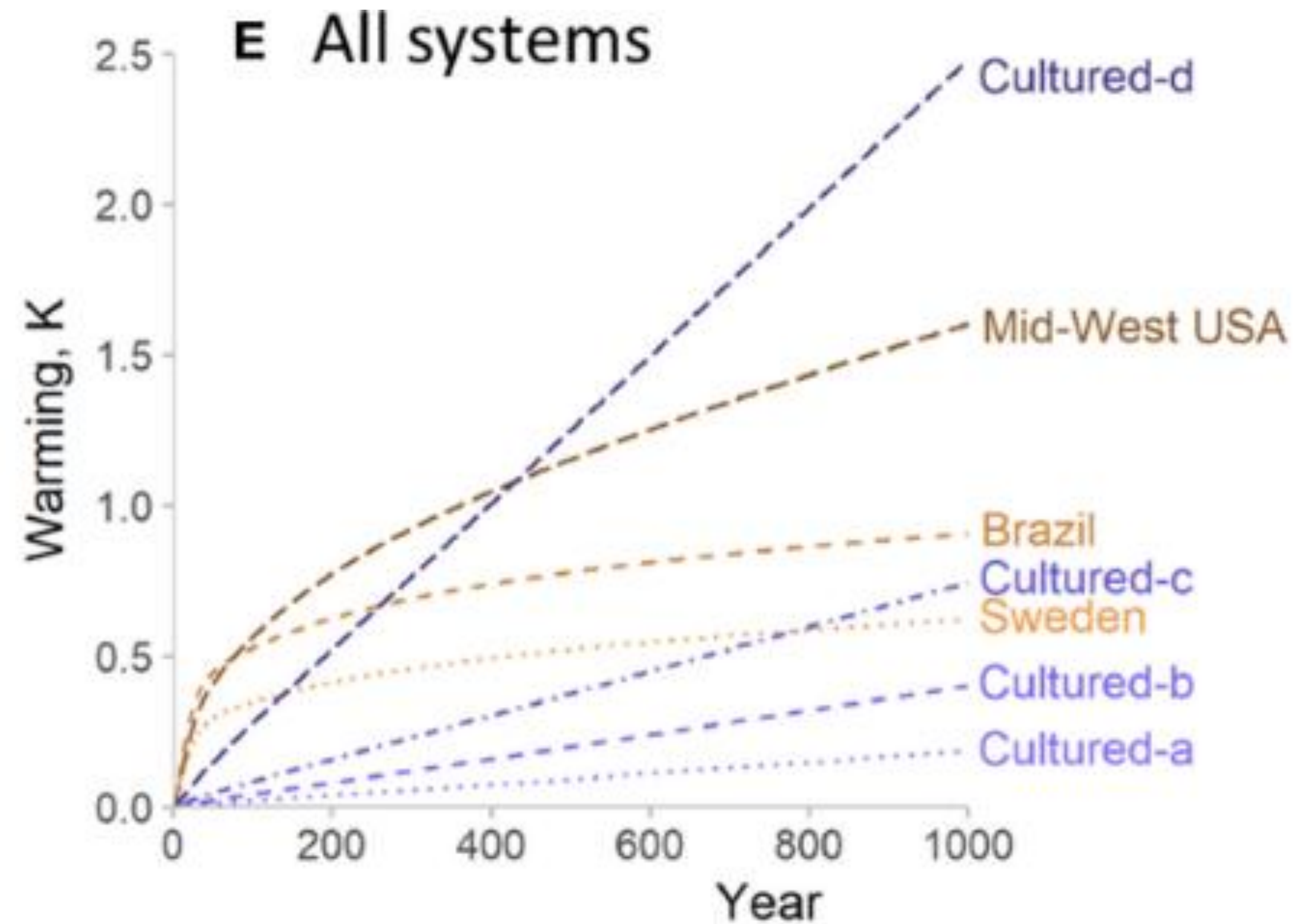
Perpetual consumption



Risultati [2]

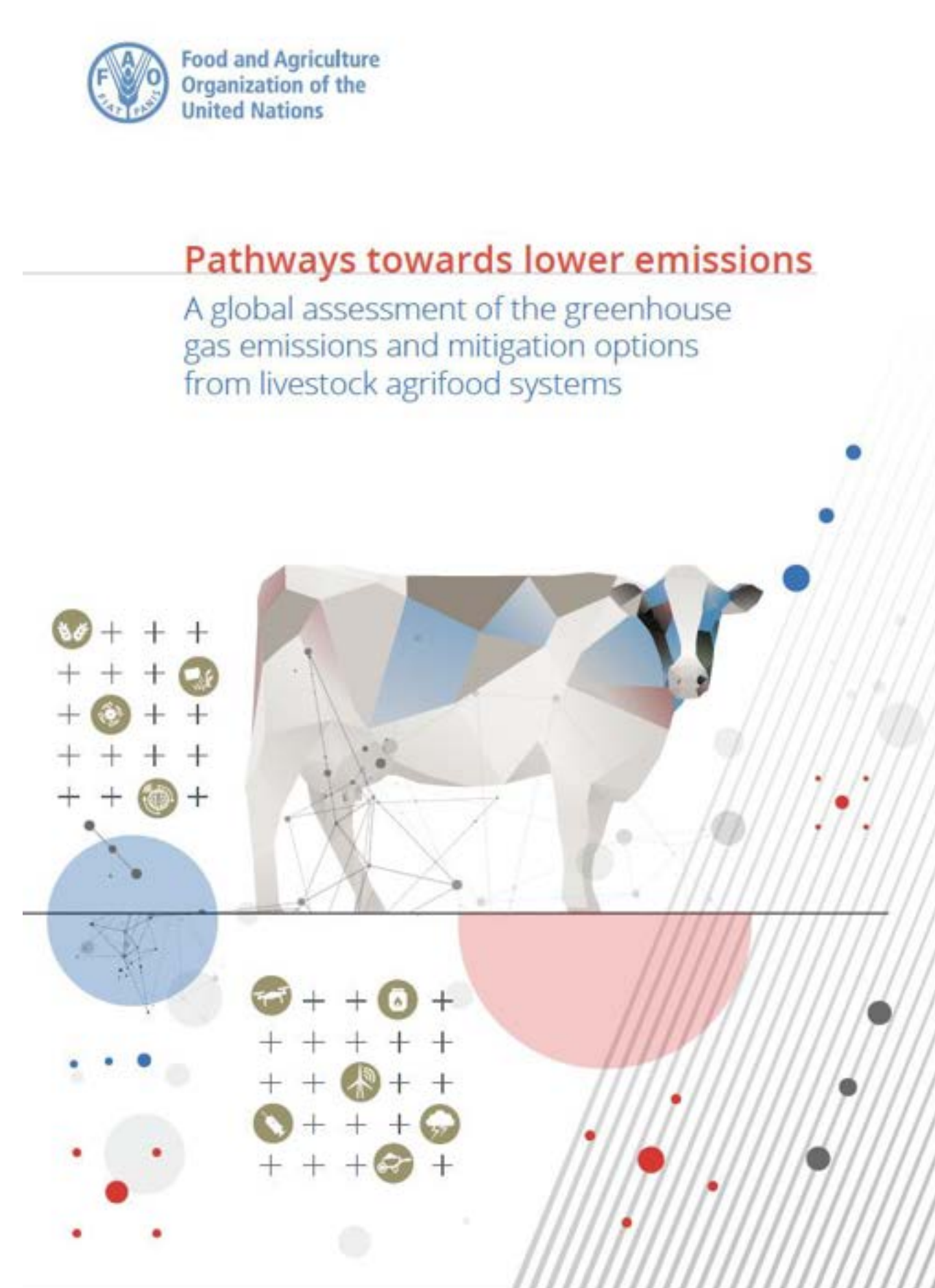


Risultati [3]

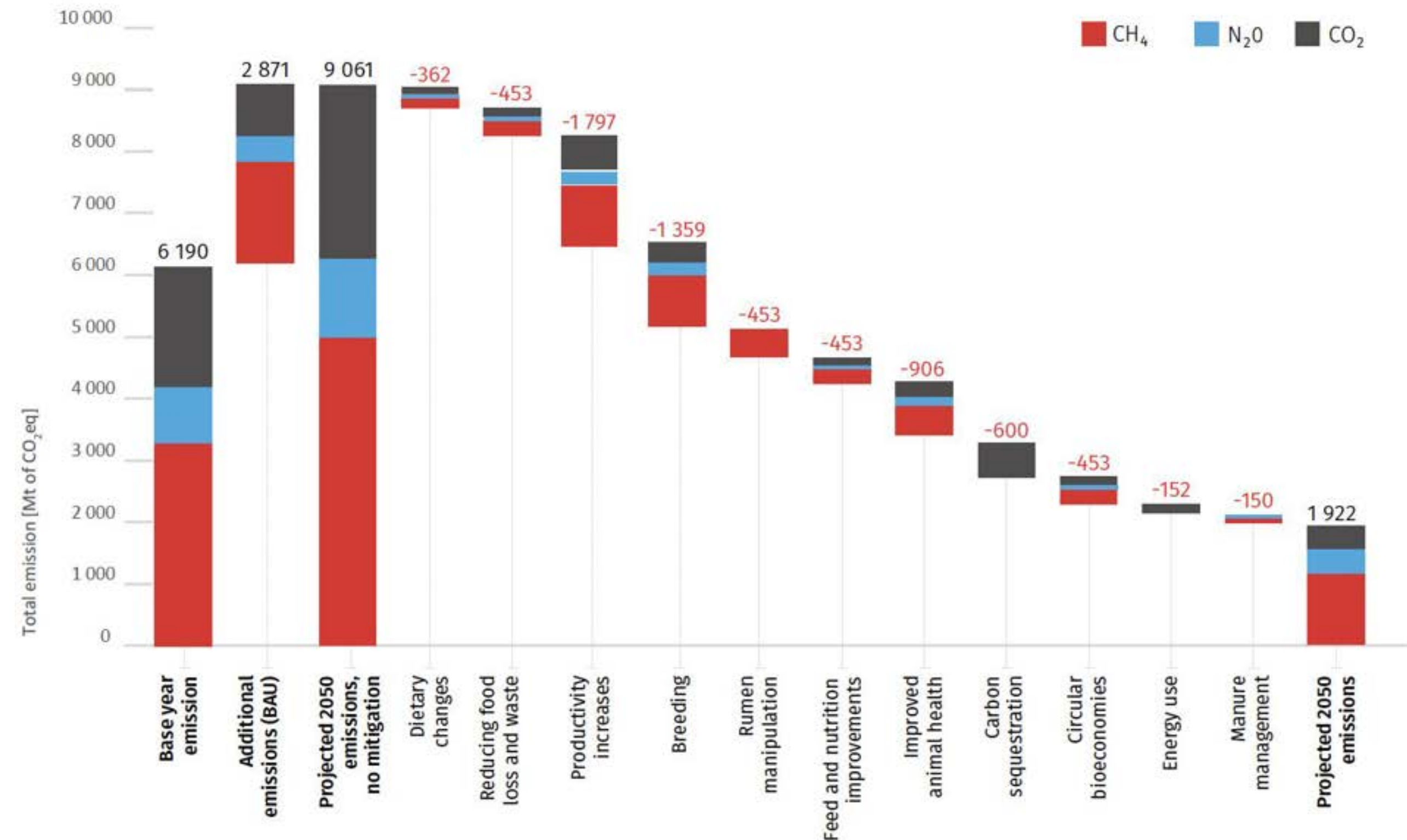


Warming impact for perpetual consumption at very high rates (250 Mt per year) for beef cattle and cultured meat production systems for 1,000 years. The individual and combined warming impact of separate greenhouse gases for representative beef cattle **(A)** and cultured **(B)** systems. **(C–E)** show impacts for all systems.

Scenario FAO di riduzione delle emissioni al 2050 per tutto il settore delle produzioni animali (*Correddu & Pulina, EAAP 2024*)



Lower emissions scenario based on the potential percentage reduction of different intervention strategies



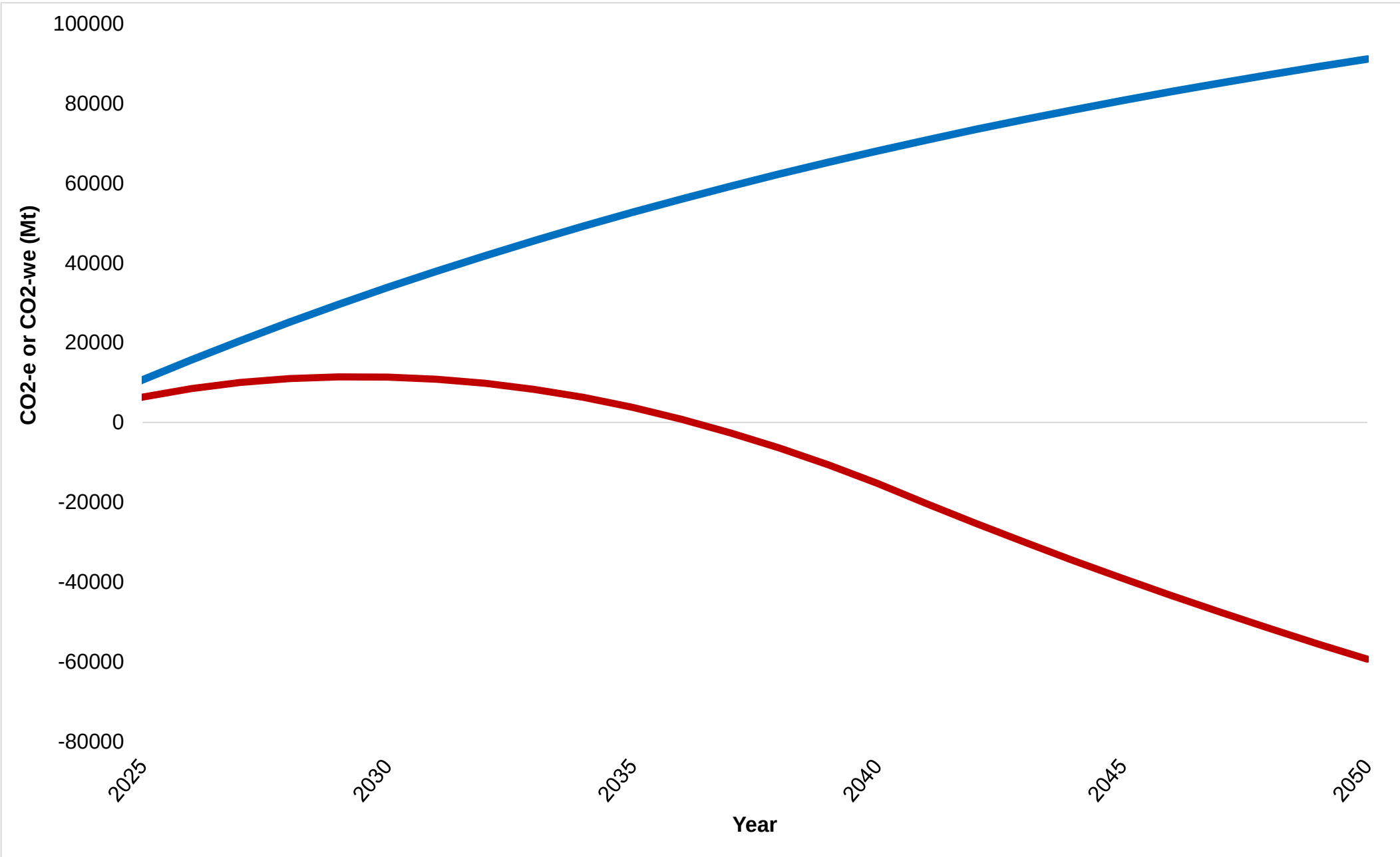
Session 80

Theatre 7

Using GWP* to assess the livestock emission impact: the Italian case study
F. Correddu¹, M. F. Lunesu¹, M. F. Caratzu¹, G. Pulina¹
¹ University of Sassari, Dipartimento di Agraria, Viale Italia 39/a, 07100 Sassari, Italy

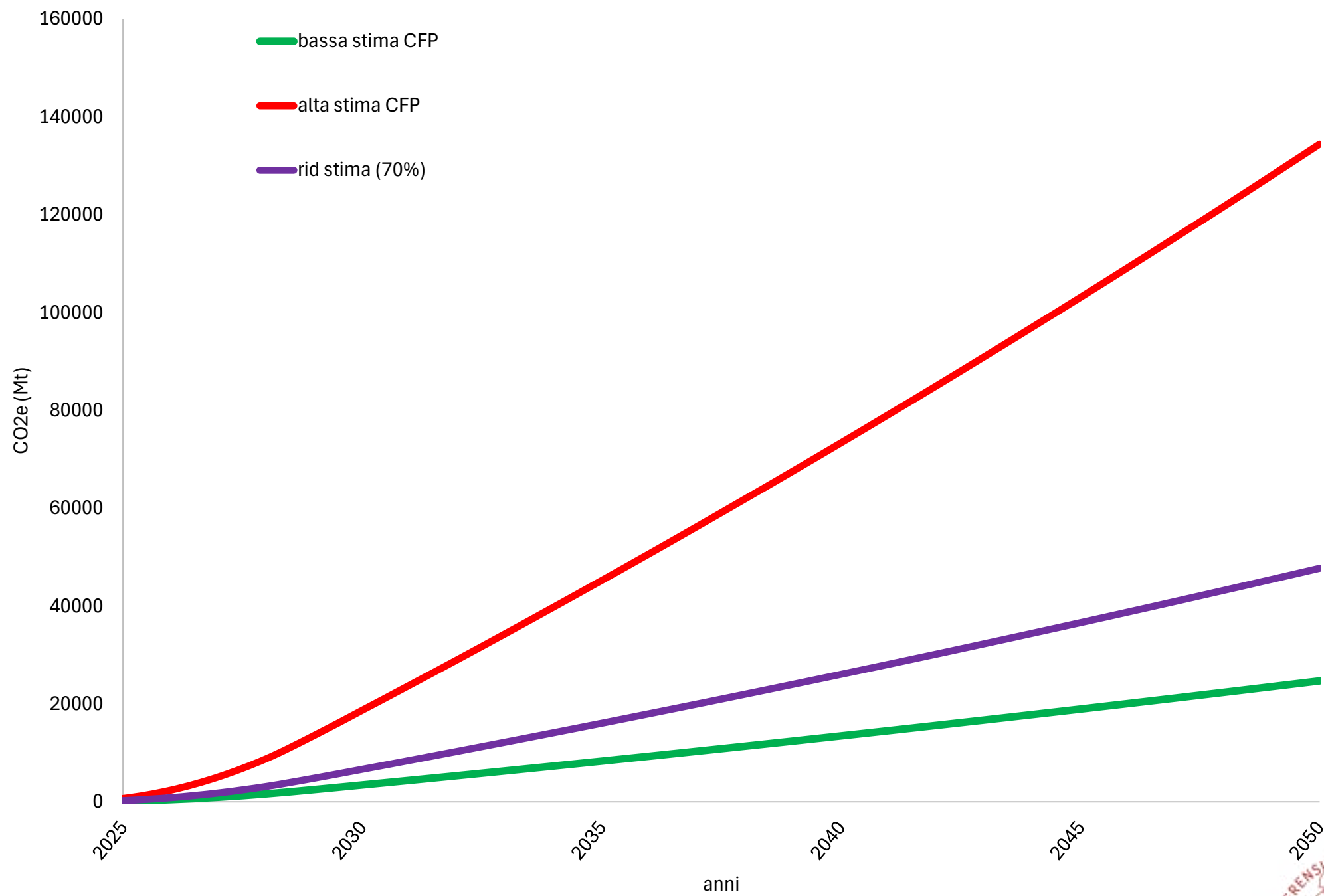
(Correddu & Pulina, EAAP 2024)

Stima CO2e e CO2we di tutte le
proteine animali secondo lo
scenario *low-emission* della FAO



Stima CO2e della produzione di carne artificiale in
funzione delle stime di consumi mondiali al 2050
(FAO); calcolati secondo 3 scenari di CFP:

Bassa stima = 2.2kg CO2e / kg carne
Alta stima = 13.6kg CO2e / kg carne
Alta stima con riduzione del 70% secondo FAO



Conclusioni



1. Carne naturale e artificiale sono due prodotti profondamente differenti sia sotto il profilo organolettico-nutrizionale sia sotto quello dei cicli con cui sono ottenute: confrontare il loro impatto climalterante senza tenere conto di questi aspetti non è corretto.
2. LCA non è in grado di cogliere l'enorme differenza fra un processo industriale e uno agricolo: anche con le migliori ipotesi, i due risultati sono poco confrontabili.
3. I dati disponibili per la LCA della carne artificiale sono scarsi e derivanti da pochi autori, mentre per la carne naturale esiste una vasta letteratura sia scientifica che grigia.
4. La produzione di carne artificiale anche con l'uso delle FER è difficilmente scalabile
5. L'impiego delle vecchie e delle nuove metriche sia in uno scenario BAU per la carne naturale che in uno FAO di riduzione delle emissioni climalteranti consente di affermare che in proiezione 2030-50 la produzione di carni naturali impatta meno sul clima di quella delle carni artificiali.

The Sustainable Livestock group



Fabio Correddu



Mondina F. Lunesu



Maria Francesca Caratzu



Sara Sechi



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