WORLD MEAT CONGRESS

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GHG emission in beef production: the issue of metrics

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Some preliminary warnings

The entire debate on GHG emissions and the metrics used in meat production is still evolving and undergoing constant review.

Various scientific groups (IPCC, FAO, universities, think tanks, etc.) are continuously refining approaches, assumptions and methods as new data becomes available.

The metrics we use today are based on models. Therefore, they should be considered useful tools, but not absolute truths.

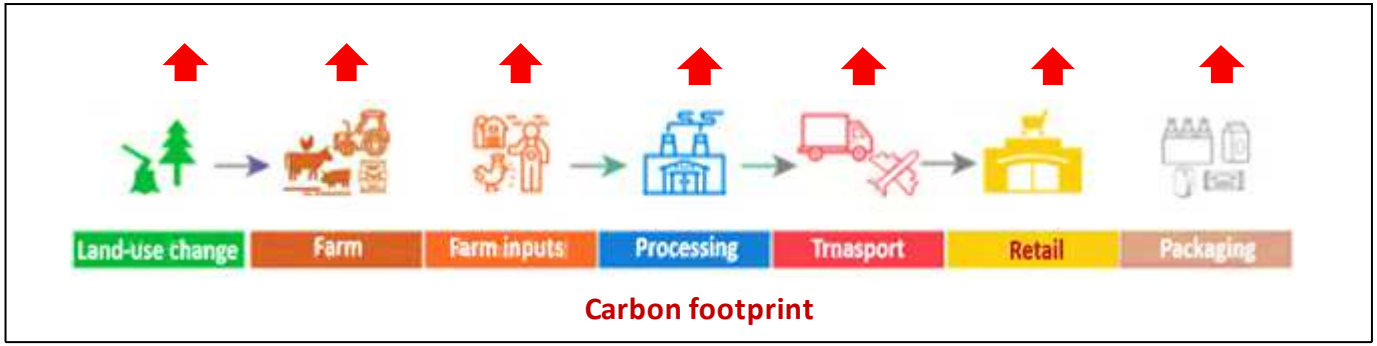
Different insights on carbon metrics

The mainstream metric, which evaluates carbon emissions per unit of product, scientific reports show that animal-based food emit several fold higher carbon than that of plant-based food. By the way, such comparison gives the vegan and environmental activism ground to launch criticism to meat production, influencing both consumers opinion and policies.

A different metric emerges when carbon emissions and carbon balances are assessed per unit of land (hectare or acre). This metric seems to be best suited to the extensive South American cattle-production systems, where beef producers tend to evaluate the performance of their farms per unit of land.

A third, less common metric, arises when the nutritional value of meat and grains is incorporated into the carbon-assessment metrics. Comparing the protein quality of meat and crops can change both the carbon emission and carbon balance ratios in land-based assessments.

Emissions throughout the food-supply chain
(kg C emitted at each stage)



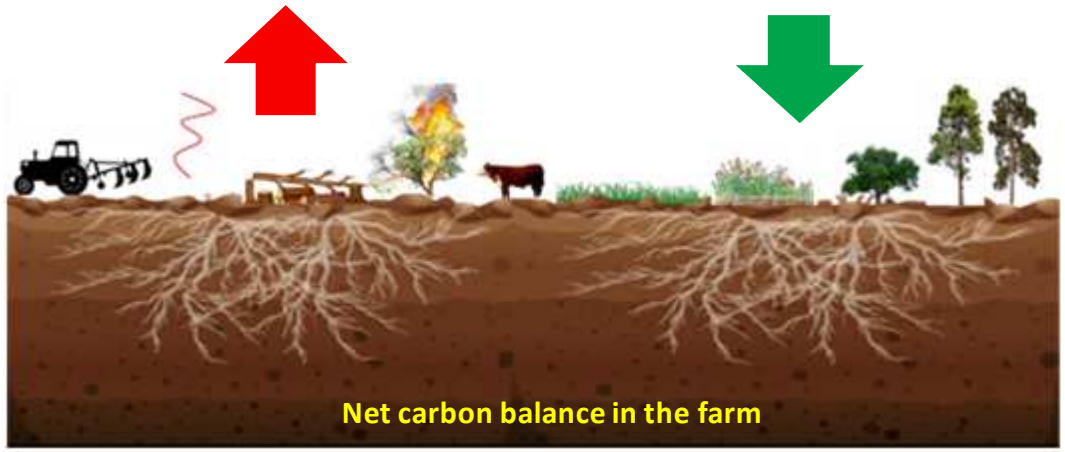

Beef


Maize

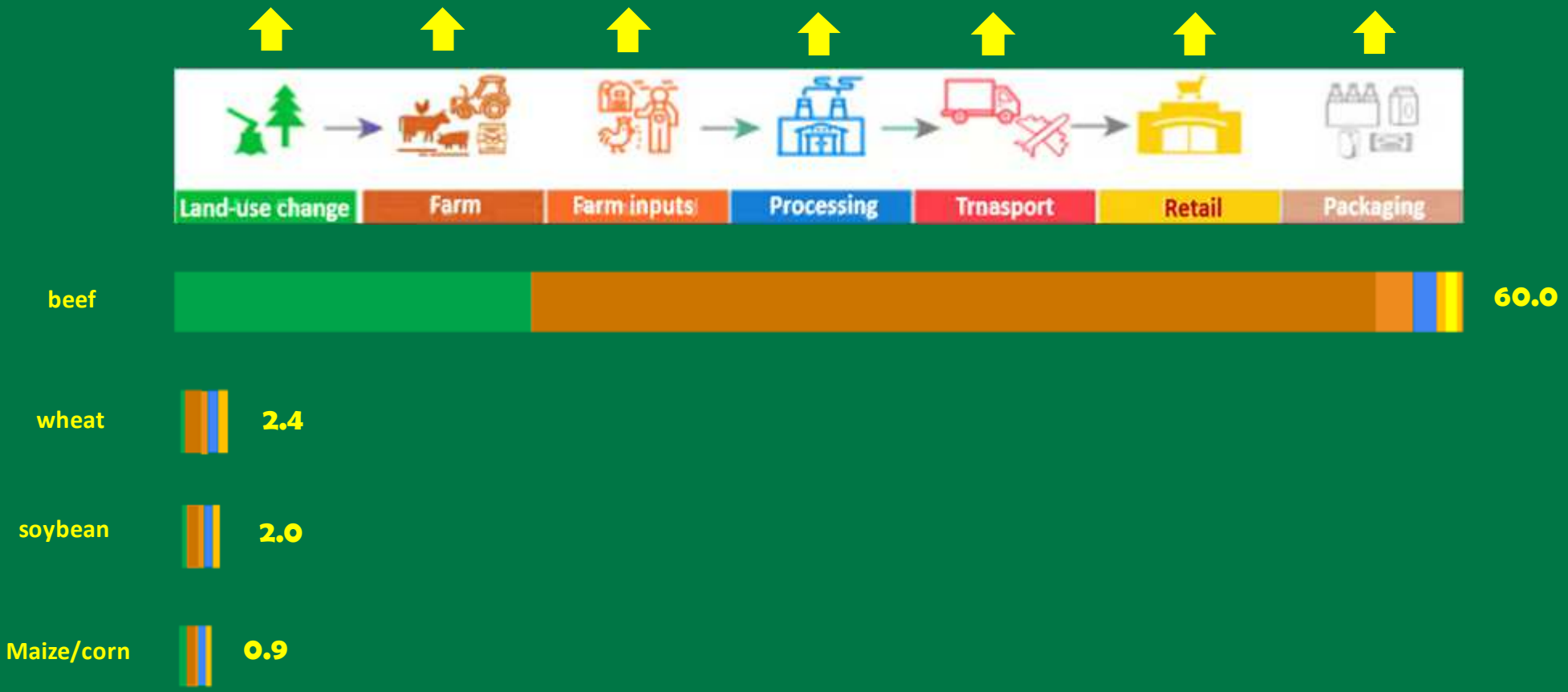

Soybean


Wheat

Net carbon balance in the farm
(kg C/ha/year)

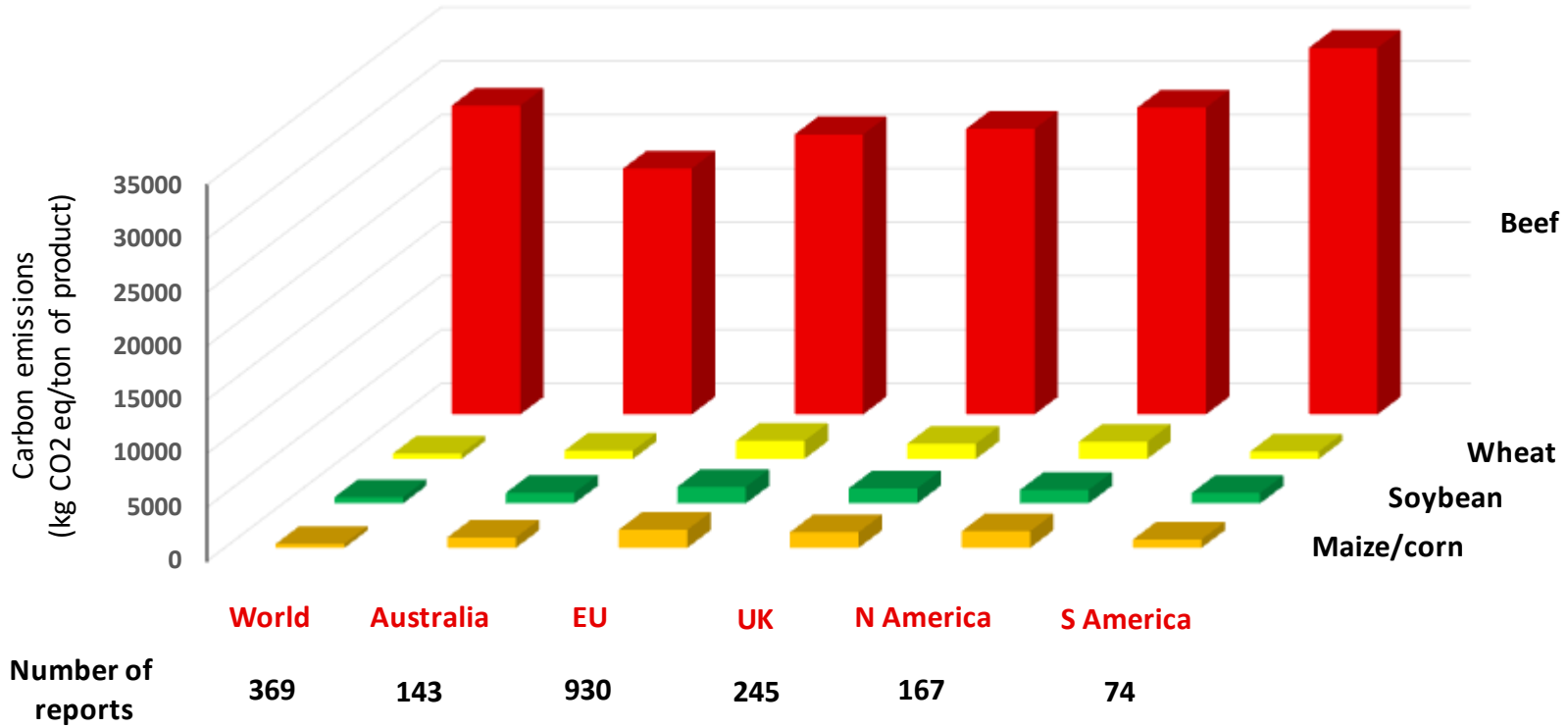


Comparison of four agricultural activities using two different approaches: Carbon Footprint of the food-supply chain *versus* Net Carbon Balance in farms *(Source: Data from Viglizzo & Ricard, 2023).*



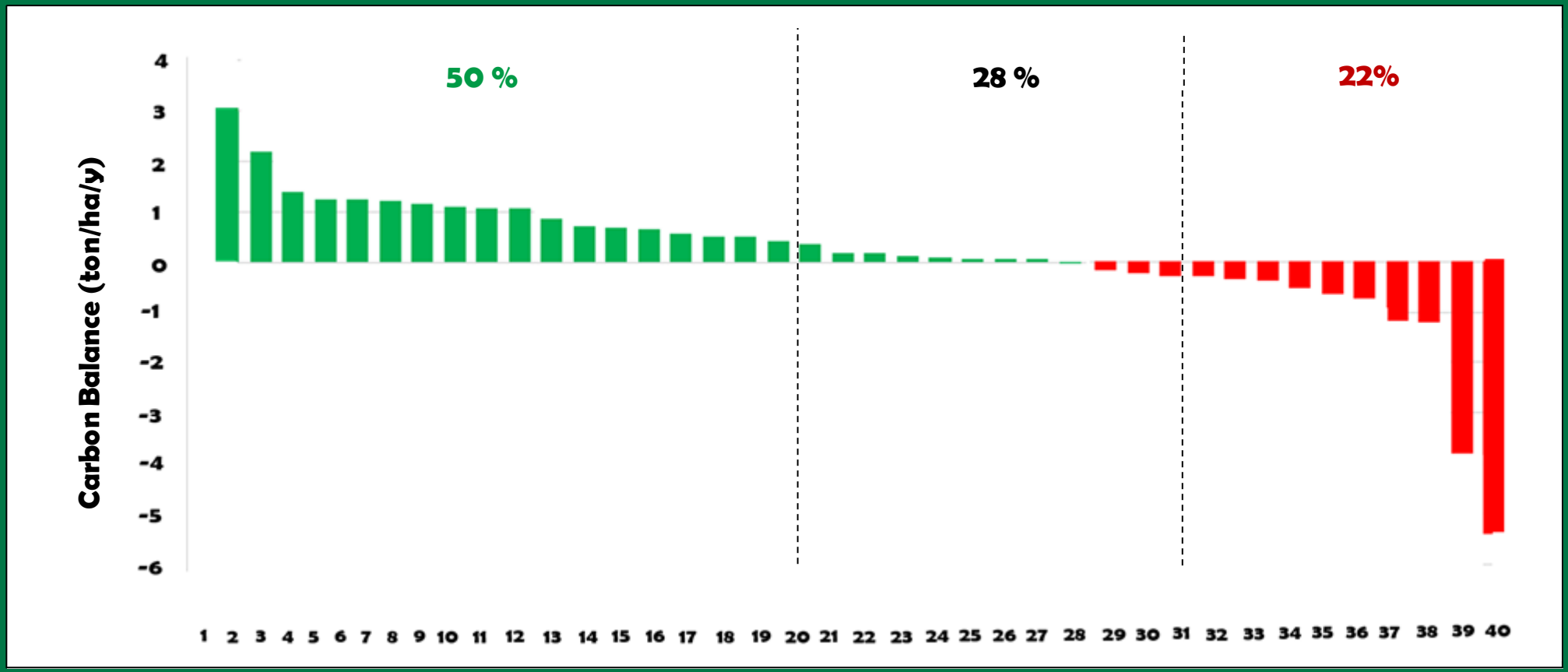
Carbon emissions (kg CO_2eq por kg of food product) across the supply chains of beef, wheat, soybean and maize/corn *(Sources: Poore & Nemecek (2018); Ritchie (2020). Retrieved from Our World in Data (2025).*

The methodological rigidity of life cycle assessments(LCA) puts the beef supply chain at a clear disadvantage compared to plant-based food chains.



Data review from nearly 2,000 studies published in scientific journals. *Source: Clune et al. (2016).*

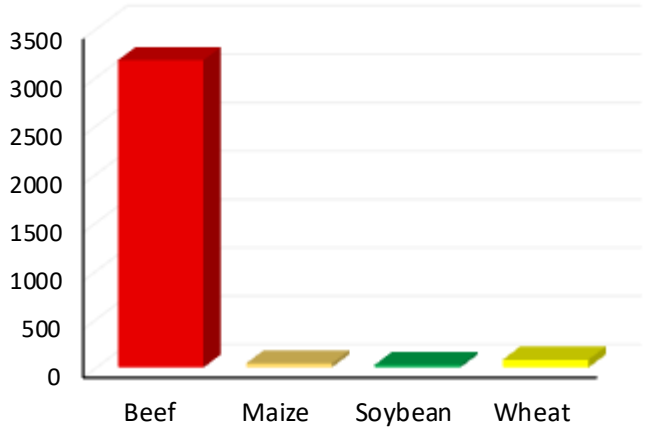
The carbon balance per unit of land (rather than carbon emissions per unit of output) offers an alternative metric for assessing the impact of farming systems on global warming. And the relative emissions of beef and crops may differ.



40 cattle-production farms surveyed in Argentina for estimating their Carbon Balance *(Source: Viglizzo y Ricard, 2024).*

C emissions/unit of product according to LCA

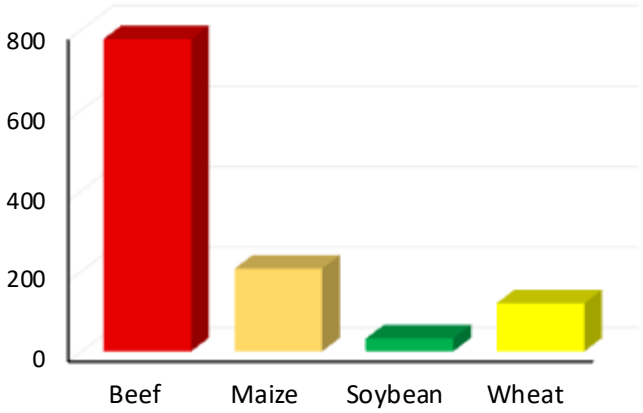
Emissions per unit of product
(kg carbon/ton product)



Beef	Maize	Soybean	Wheat
100,0	1,4	0,9	2,6

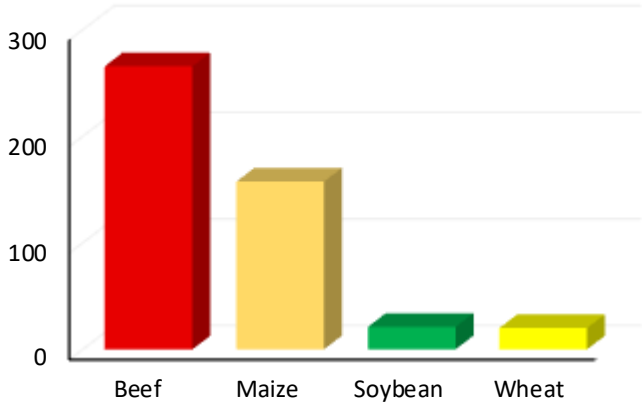
C emissions and C balance/unit of land

Emissions per unit of land
(kg carbon/ha/year)



Beef	Maize	Soybean	Wheat
100,0	26,5	4,1	15,5

Carbon balance per unit of land after deducting carbon accumulation in biomass(kg carbon/ha/year)

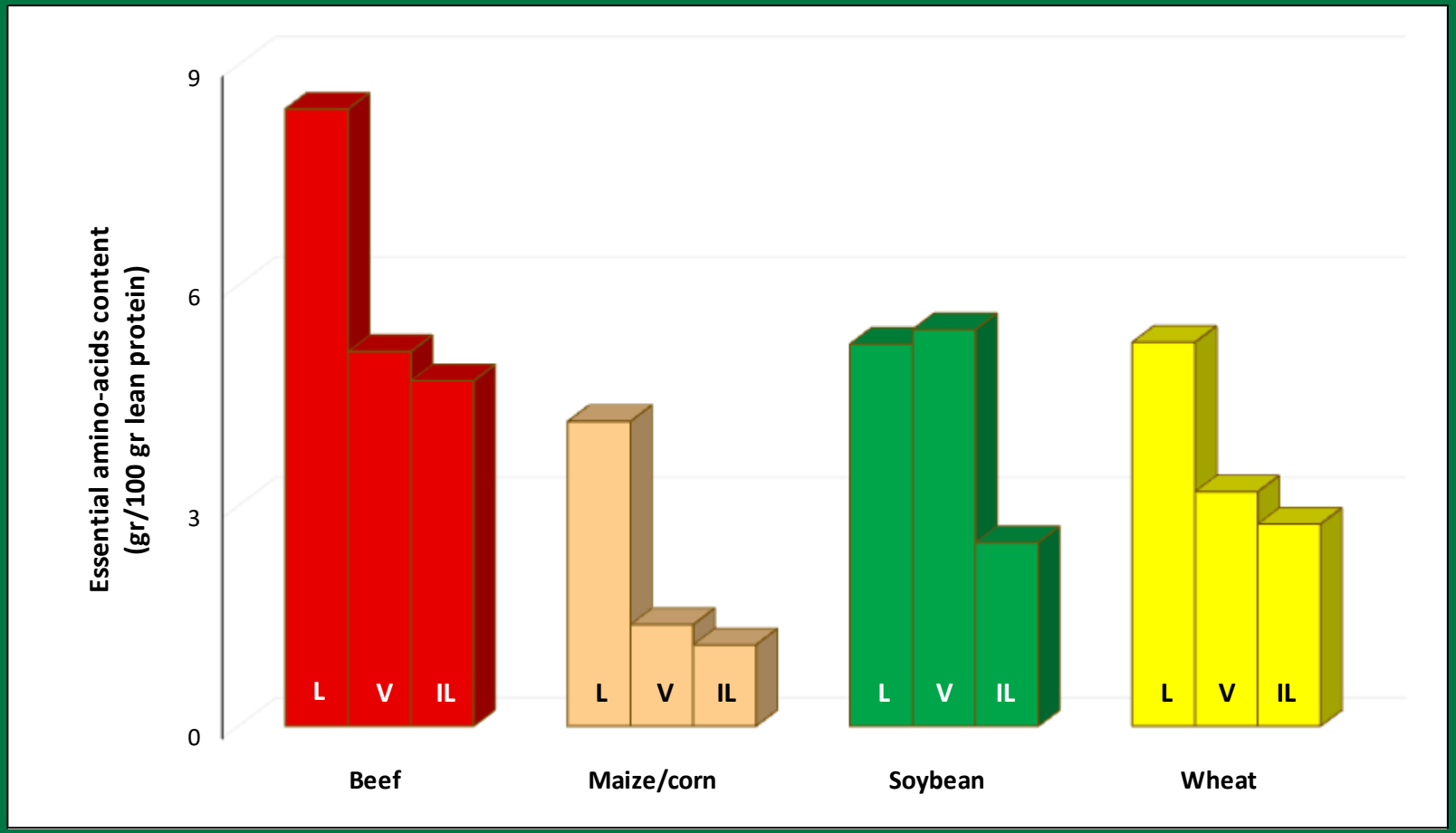


Beef	Maize	Soybean	Wheat
100,0	59,2	7,9	7,5

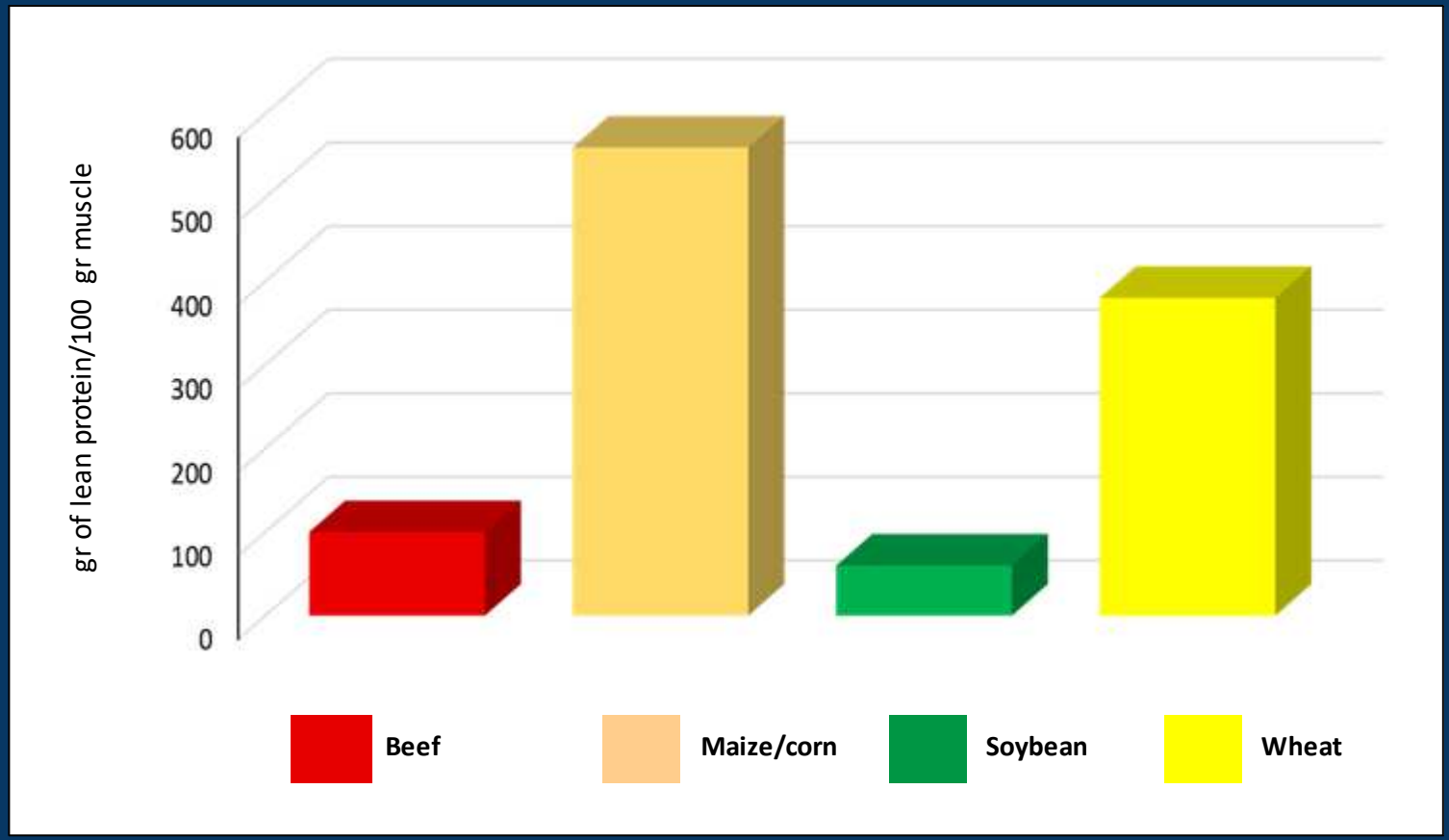
A comparative assessment of the carbon footprint and balance for beef, corn, soybean, and wheat production was based on real data from 70 farms in Argentina. Carbon emissions were measured per ton of product, and emissions and balance per hectare of land. *Source: Viglizzo & Ricard (2023).*

		Biological value of proteins
beef		80-85
maize/corn		45-55
soybean		70-75
wheat		50-60

Protein quality. The Biological Value of proteins in beef, maize/corn, soybean, and wheat



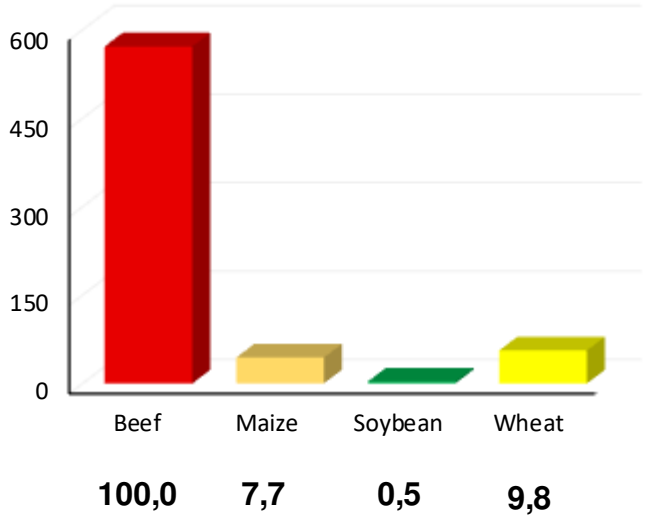
Quality of proteins provided by beef, maize, soybeans and wheat measured through their essential amino-acid content of leucine (L), valine (V) and isoleucine (IL). *Source: Ministry of Agriculture, Fisheries and Food UK (1990). Nutritive Value and Chemical Composition of Feeding-Stuffs.*



Grams of lean protein required to synthesize 100 grams of muscle in growing children
(Source: Institute for Growth and Development, Spain, 2004).

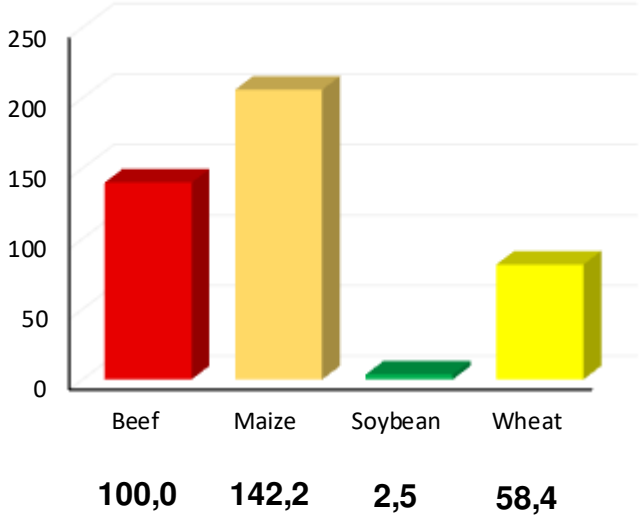
Corrected carbon per unit of product

Emissions per unit of product
(kg carbon/ton product)

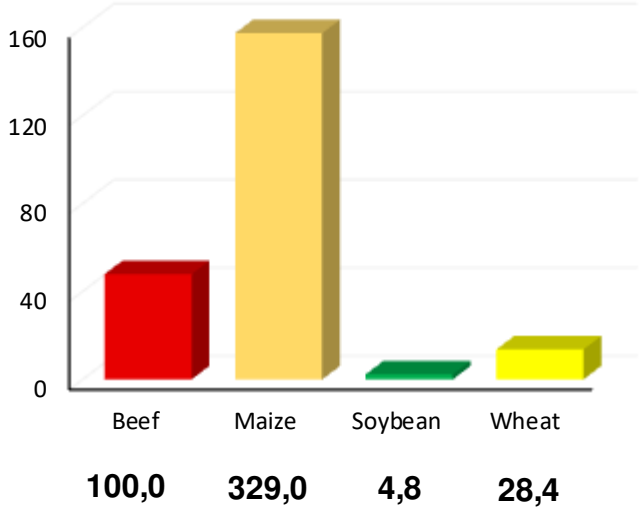


Corrected carbon emission and carbon balance per unit of land

Emissions per unit of land
(kg carbon/ha/year)



Emissions per unit of land after
deducting carbon accumulation
(kg carbon/ha/year)



Comparison of carbon emissions per unit of product and carbon emissions and balance per unit of land after correcting for a protein-quality factor. *Data from Viglizzo & Ricard (2023 / 2024).*

Concluding remarks

In human medicine doctors integrate variables and parameters to improve their diagnoses and prognoses (e.g., the metabolic index that combines weight and height, or the ratio between total cholesterol and high-density cholesterol to predict cardiovascular risk, or glycosylated hemoglobin to predict diabetes risk).

Integrating carbon emission indicators with food quality indicators broadens our understanding of the pros and cons of different food-supply chains and agricultural activities.

OBRIGADO! THANK YOU!