

The Role of “Dilution & Reduction of Maintenance” in Reducing Animal Production’s Environmental Footprint

29 Aug 2016

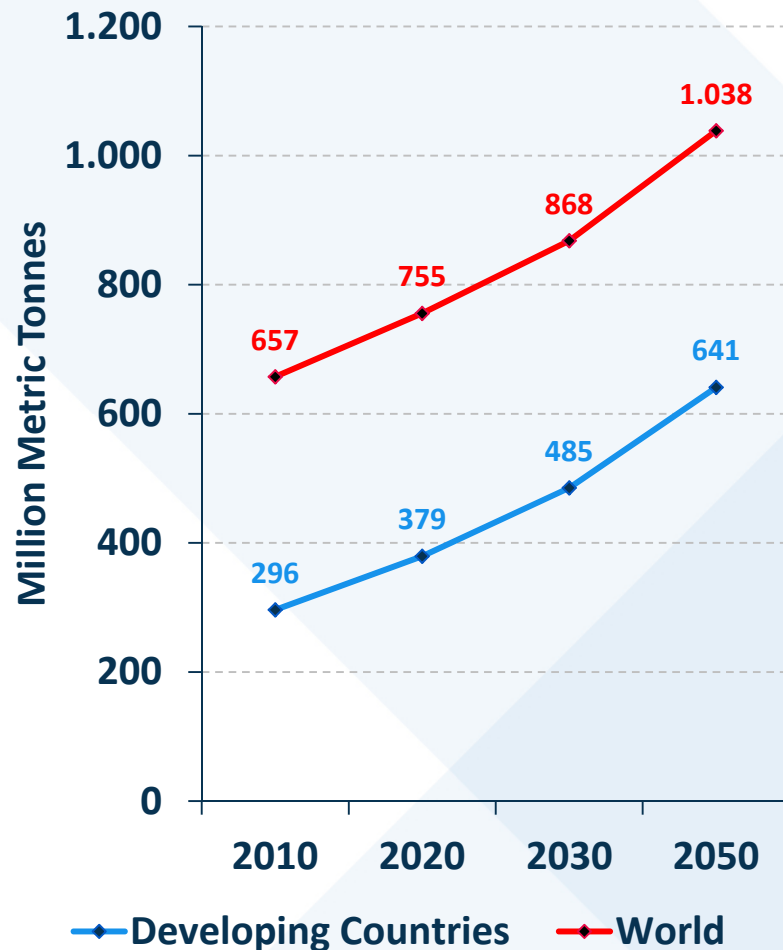
Roger Cady, Global Sustainability Lead
EAAP Meetings, Belfast, Ireland

Elanco

My Why



The Challenge



- Meeting a 60% forecast increase in dairy demand
- Without increasing the environmental footprint of milk production

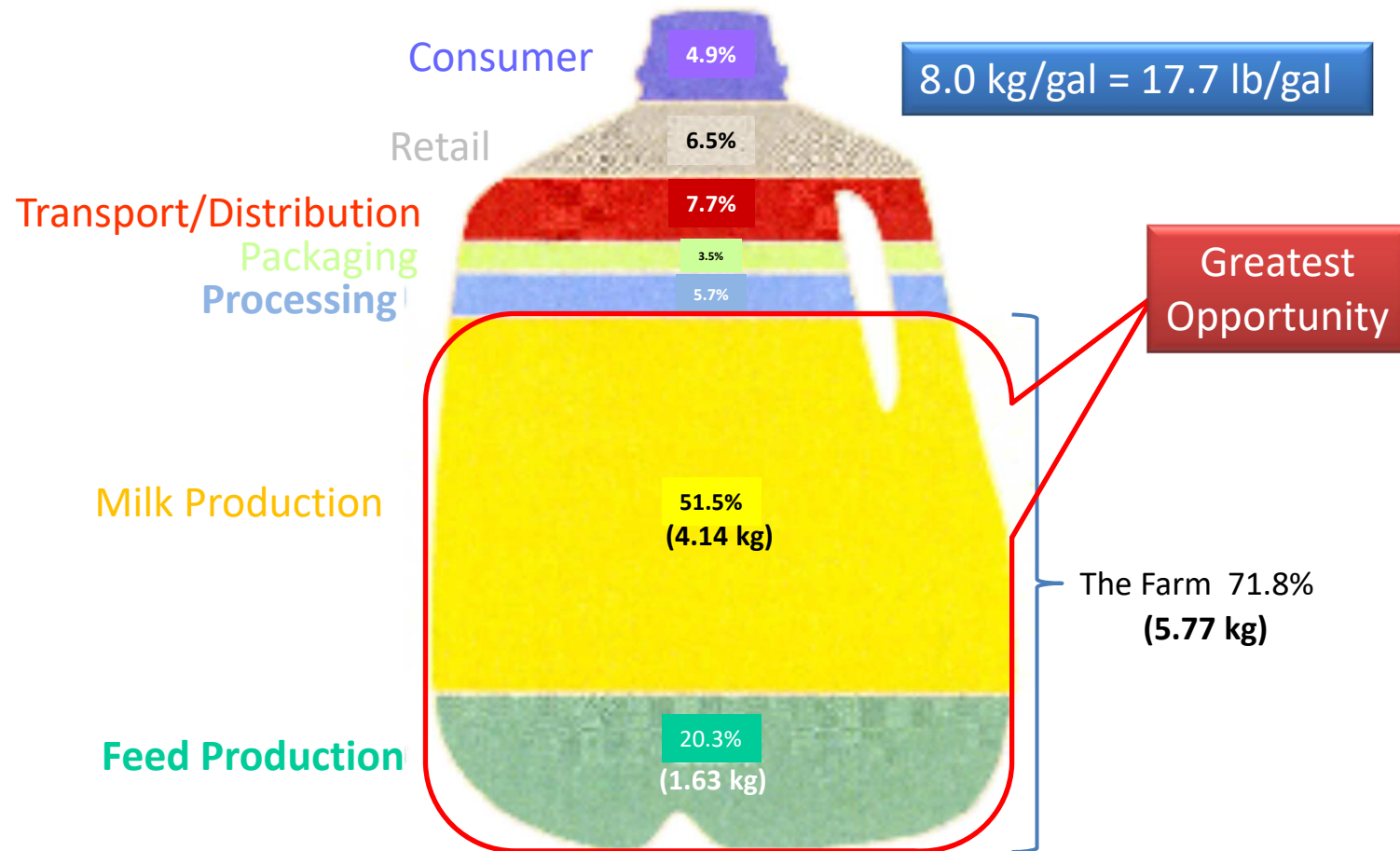
Source: World Livestock Report 2011: Livestock in food security. FAO, Rome, 2011. pgs 11-12, 79



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U.S. Supply Chain GHG Emissions for Fluid Milk (2007 – 2008)



Source: Dairy Innovation Center Report, Greenhouse Gas Emissions of the United State, University of Arkansas, 2010
<http://www.usdairy.com/~media/usd/private/ghgreductionchart4-30-10.pdf.pdf>

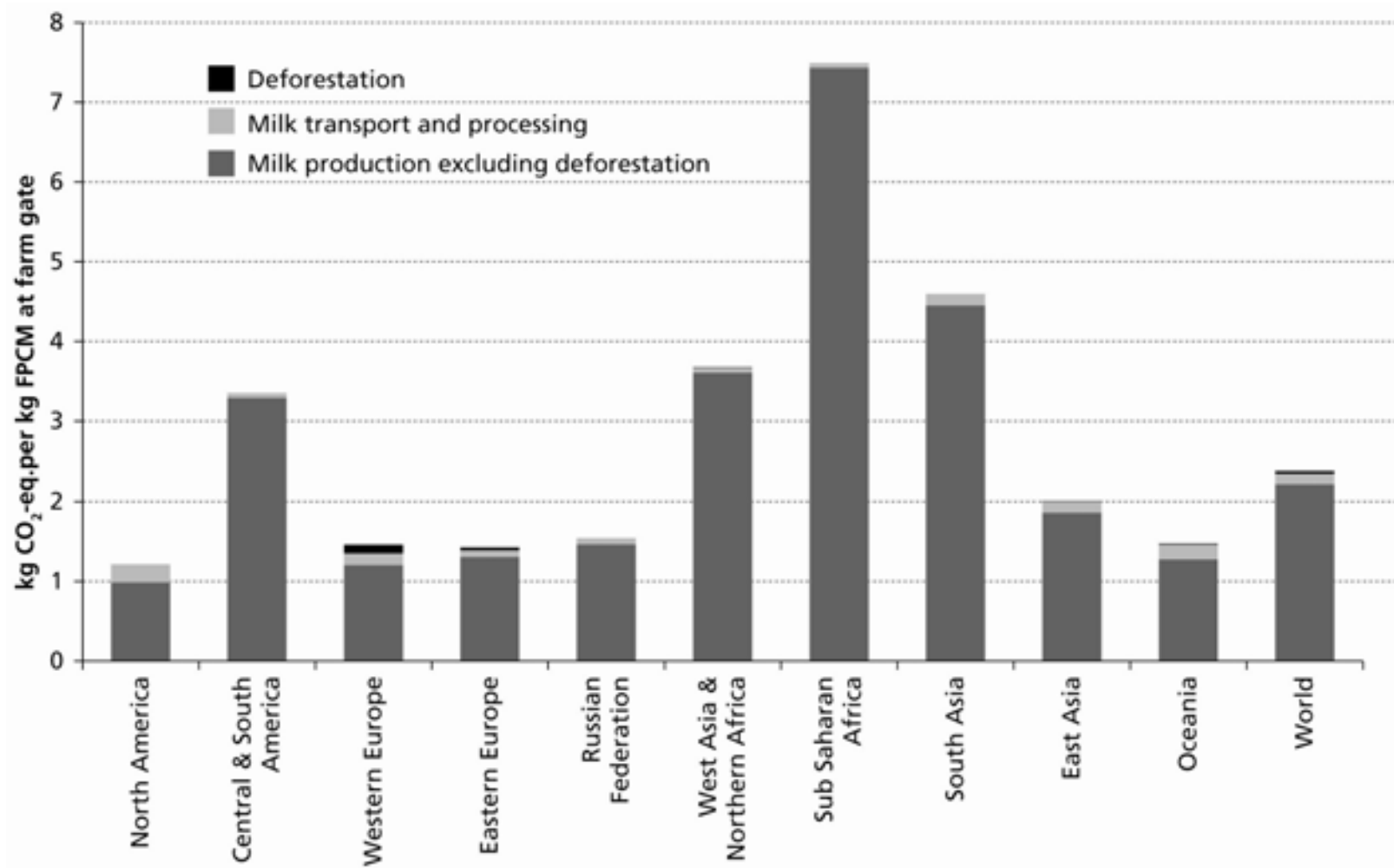
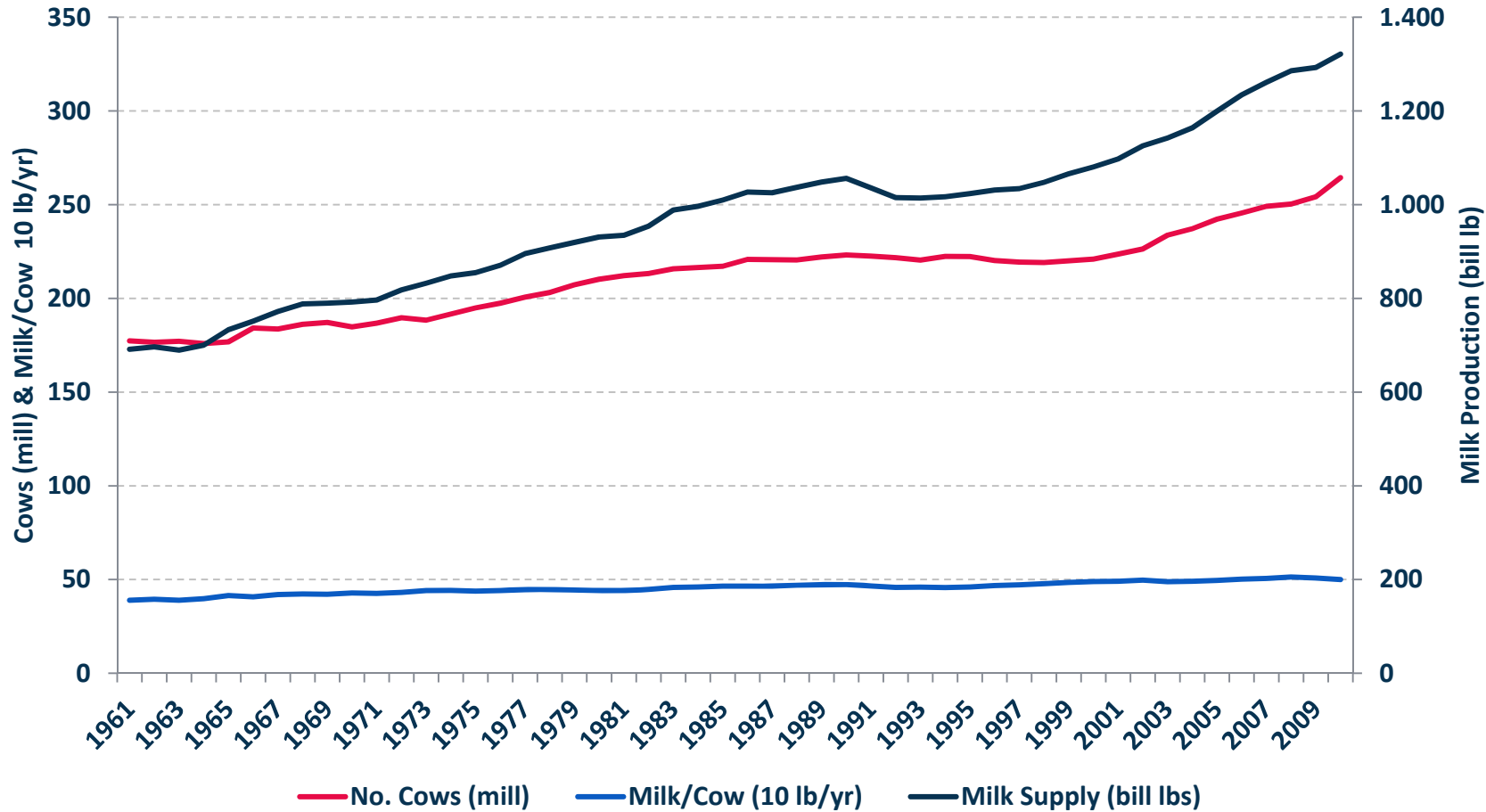


Figure 4.1. Estimated GHG emissions per kg of FPCM* at farm gate, averaged by main regions and the world

* **Note:** FPCM = Fat-Protein Corrected Milk

Source: Vellinga, T., et al. 2010. Greenhouse Gas Emissions from the Dairy Sector : A Life Cycle Assessment, FAO Report, pg 35

The Problem: Global milk supply is increasing primarily by adding production animals



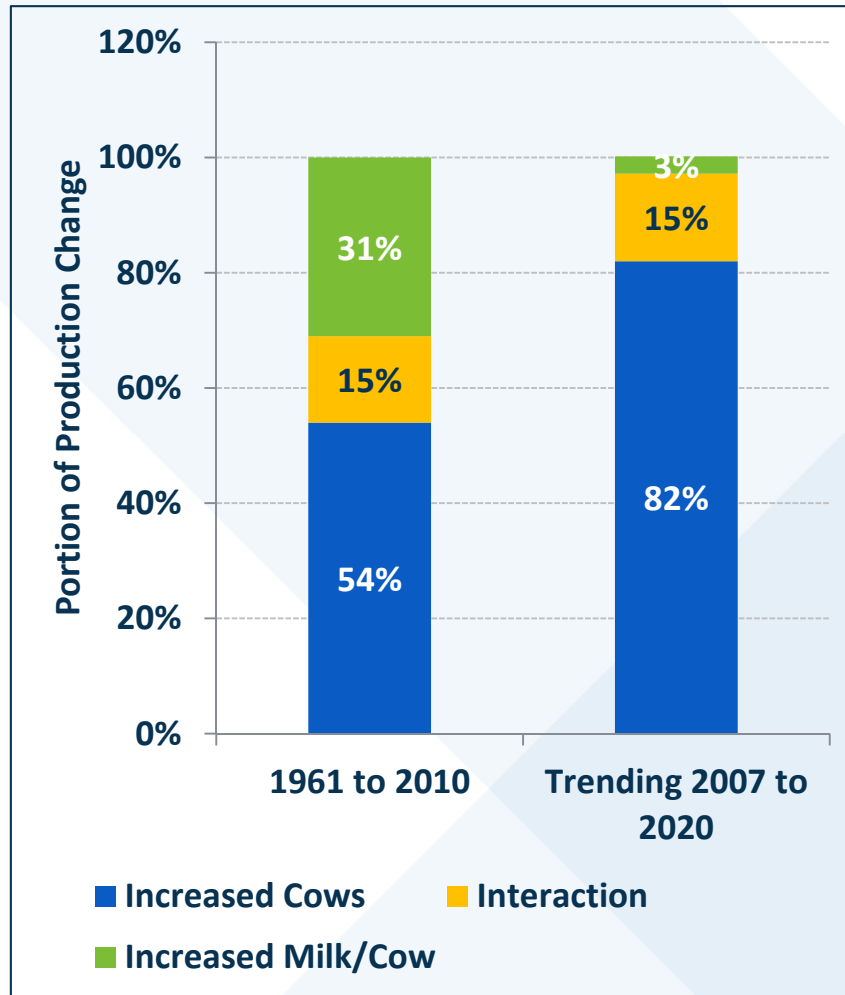
Source: FAO FAOSTAT Databases, Accessed 14 May 13



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Impact of Adding More Cows



Source: FAOSTAT, accessed 9JUL14

GHG Maintenance Footprint of One Additional Cow

- +8.7 to 12.8 MT/yr
- Highly dependent on cow size
- Includes GHG footprint of support population
 - Replacement heifers
 - Bulls

Source: 2012, Capper, J.L. & R.A. Cady, J. Dairy Sci.

Question: Which vehicle will be the most environmentally responsible to use?

Task: Transport 48 people 640 km



Holds 48 Passengers

Fuel Efficiency: 2 km/ℓ
vehicles: 1
Energy use: 320 ℓ fuel
People distance: 30,720 pkm
People km/ℓ: 96 pkm/ℓ

or



Holds 4 Passengers

Fuel Efficiency: 16 km/ℓ
vehicles: 12
Energy use: 480 ℓ fuel
People distance: 30,720 pkm
People km/ℓ: 64 pkm/ℓ

Question: Which vehicle will be the most environmentally responsible to use?

Task: Transport 4 people 640 km



Holds 48 Passengers

Fuel Efficiency: 2 km/ℓ

vehicles: 1

Energy use: 320 ℓ fuel

People distance: 2,560 pkm

People km/ℓ: 8 pkm/ℓ

or



Holds 4 Passengers

Fuel Efficiency: 16 km/ℓ

vehicles: 1

Energy use: 40 ℓ fuel

People distance: 2,560 pkm

People km/ℓ: 64 pkm/ℓ

Functional Unit



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Assessing Animal Production Impact

Animals are not machines

- Energy efficiency can be used as a proxy for environmental impact
- The mathematical functions remain the same
- Only the key metrics change

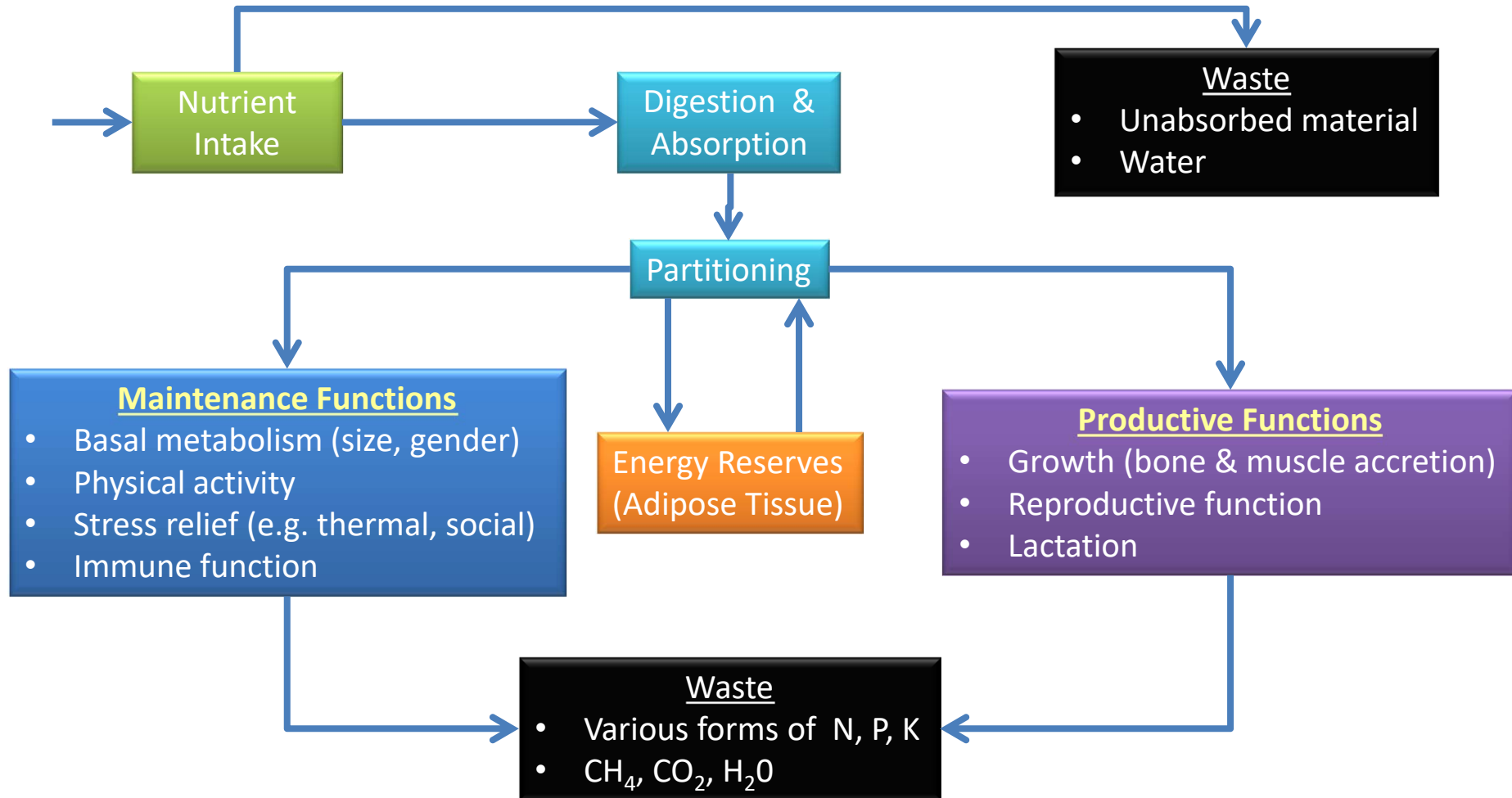
Dairy Example:

- Energy source: Fuel → Feed
- Task: Transporting people → producing milk
- Functional unit: People km/l → kg milk/kg feed
or kg feed/kg milk

There is No Magic to the Biology: *The Basics Are the Same the World Around*

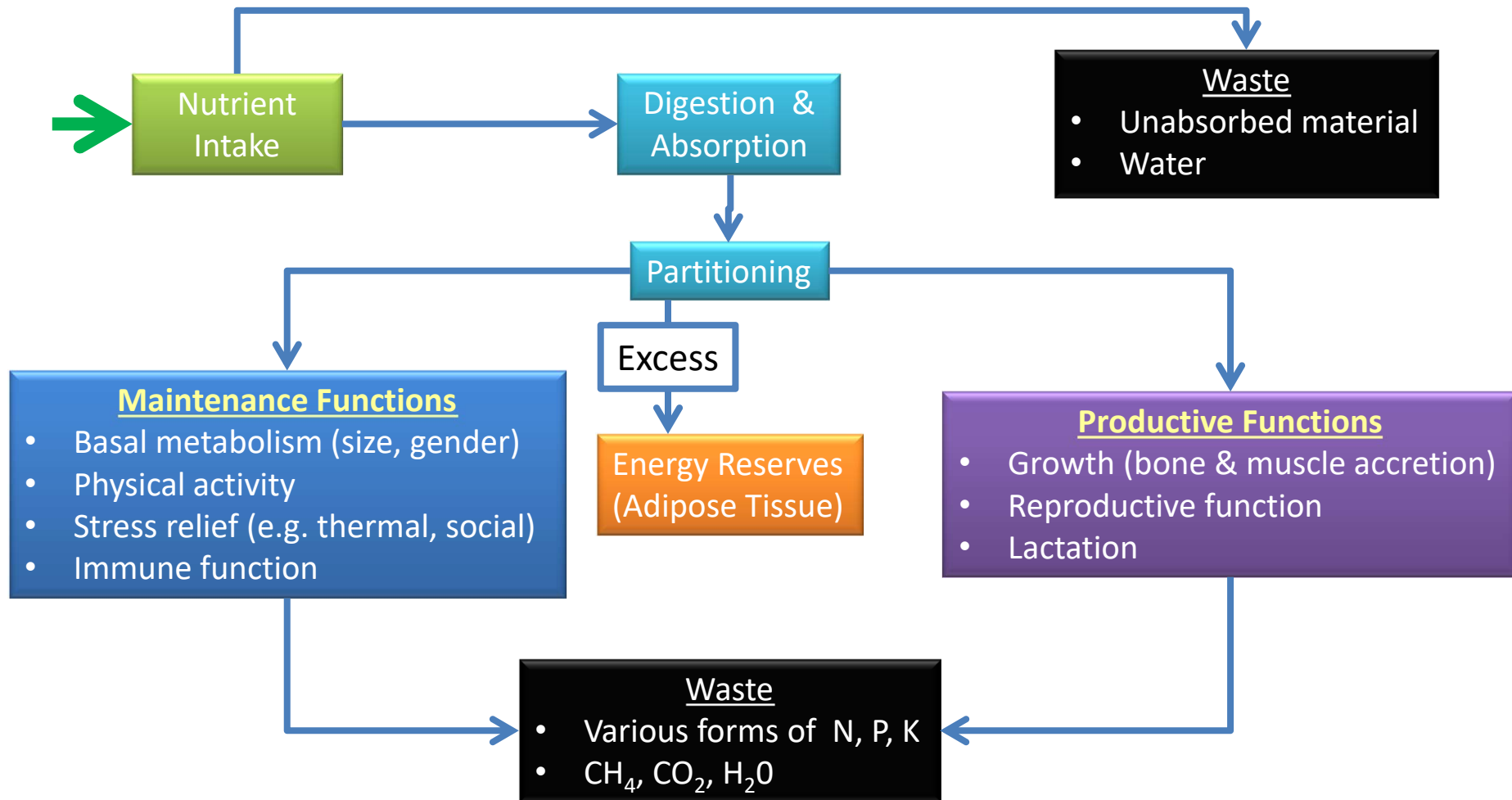
- Biology is obligated to follow the laws of physics
 - 1st Law of Thermodynamics – “Conservation of Energy”
 - A low input system cannot be a high output system
- Energy availability (*measured as calories or joules*) drives biological function
 - Carbon is the currency of energy in all higher order living beings
 - Exchange of carbon must occur for life to exist
 - There is no opportunity to change energy source ie. to solar, wind, etc.
 - Natural resource use and carbon footprint are all driven by the system’s feed utilization rate (*not just animal feed conversion*)
- Metabolic hierarchy governs utilization of energy within animal kingdom
 - First priority given to maintenance (*aka survival, an obligatory function*)
 - Then to non-obligatory productive (*lactation, reproduction, growth*)

Nutrient Pathway Schematic



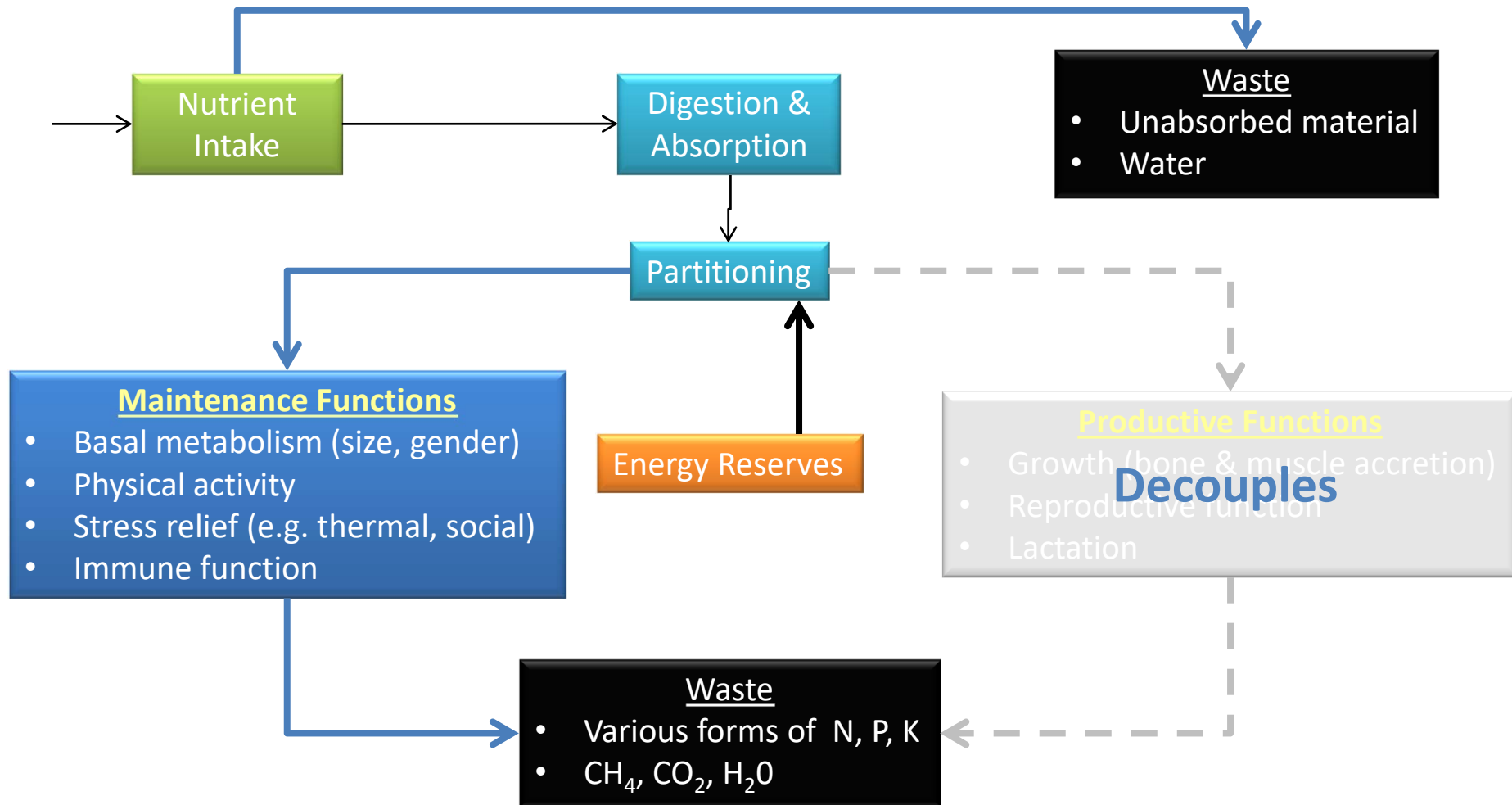
Positive Energy Balance

(Dietary intake meets all metabolic demands – excess leads to fat accretion)



Negative Energy Balance

(Dietary intake insufficient to meet all metabolic demands – energy reserves mobilized)



Dilution of Maintenance

- **Definition:** a reduction in the percentage of dietary intake required to meet maintenance energy requirements for healthy survival.
 - Corollary in financial world is the ability to spread fixed costs over more units of production
 - **Not** a reduction in feed intake
- **History**
 - Not a new concept
 - Discussed as early as 1917 in a nutrition physiology textbook by H. P. Armsby
 - Unable to attribute who originally coined the term but term was in common use by the 1970s

Three Biological Pathways to Reduce Environmental Impact of Animal Production

- **Direct:** Increase metabolic feed efficiency
- **Indirect I:** Dilution of animal maintenance
- **Indirect II:** Reduction of animal maintenance

Note: A specific technology may affect the environment through more than one pathway.

Dairy herd performance factors that affect environmental impact

| Metabolic Efficiency | Dilution of Maintenance | Reduction of Maintenance |
|-------------------------|------------------------------------|---------------------------|
| Feed digestibility | Milk yield | Physical activity level |
| Feed quality | Heifer growth rate | Animal size |
| Rumen biom (microflora) | Artificial insemination (genetics) | Cooling/ventilation |
| | Milk components | Morbidity |
| | Reproductive performance | Mortality |
| | Replacement program | System feed loss (shrink) |
| | | No. dry days |
| | | A.I. (No. bulls) |

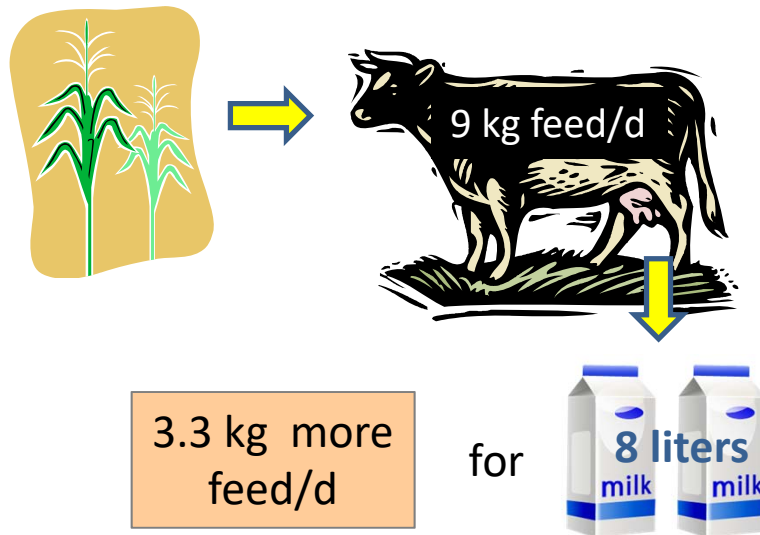
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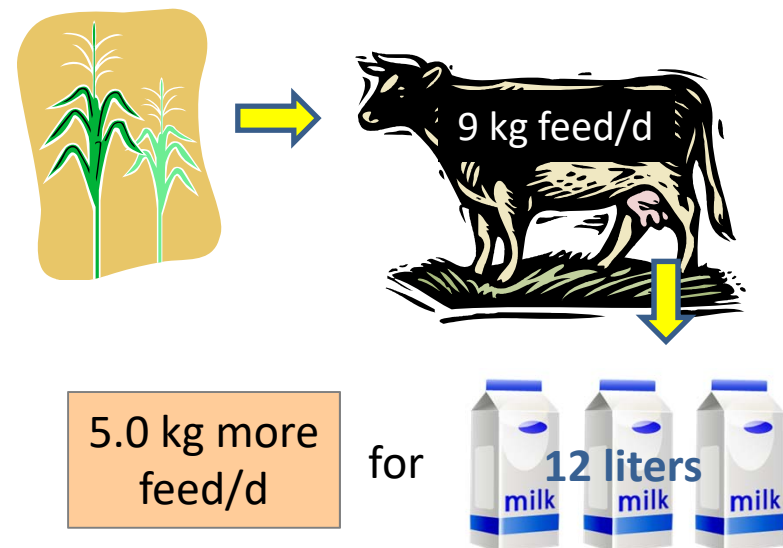
Dilution of Animal Maintenance:

Ability to consume and partition additional nutrients towards productive functions



Total 12.3 kg feed/d → 1.54 kg/l

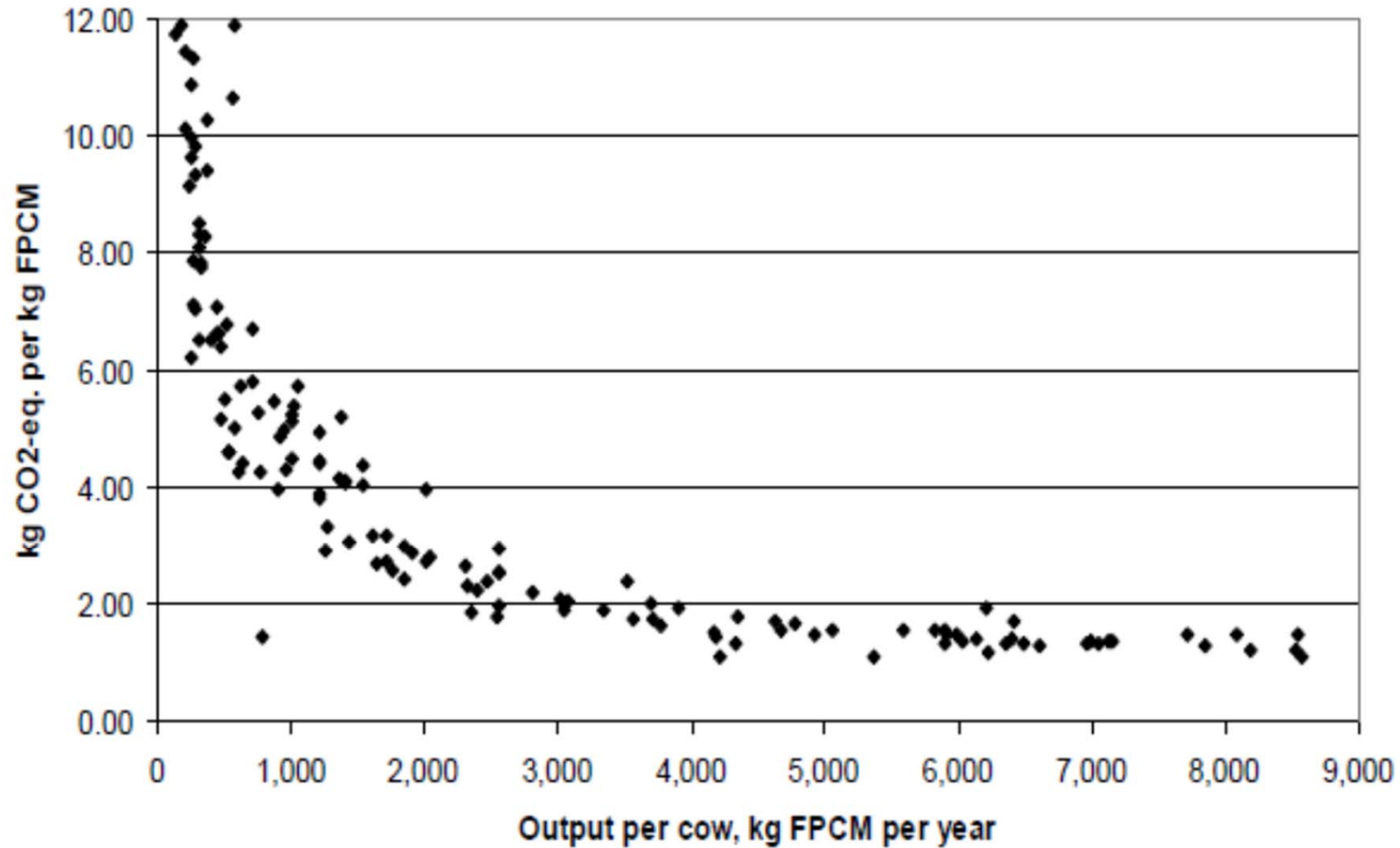
**$1\frac{1}{8}$ kg maintenance feed/liter milk
73% of feed for animal maintenance**



Total 14.0 kg feed/d → 1.17 kg/l

**$\frac{3}{4}$ kg maintenance feed/liter milk
64% of feed for animal maintenance**

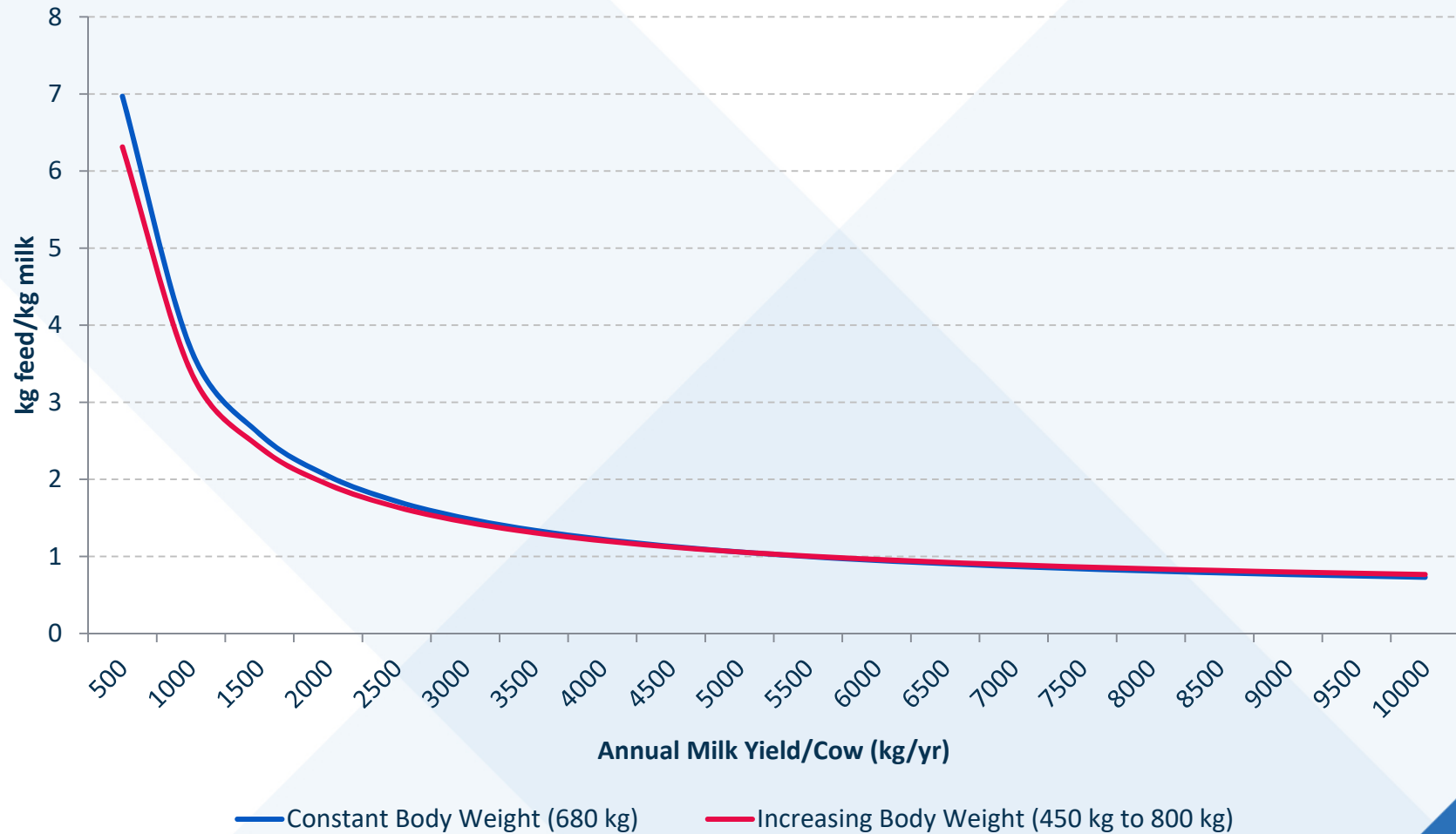
Relationship between total greenhouse gas emissions and milk output per cow [*country basis*]



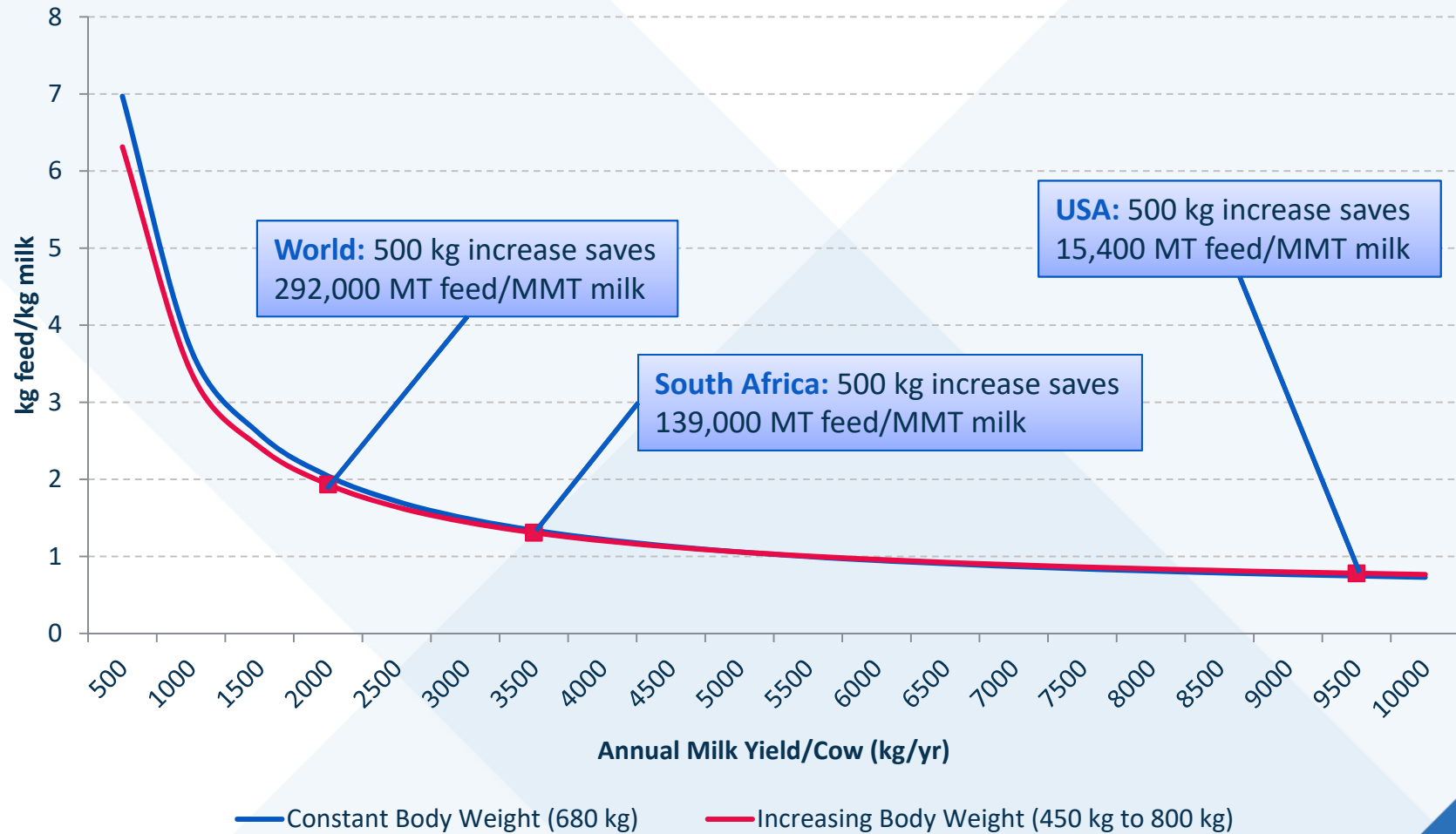
Source: Gerber, P. et al, 2011, Productivity gains and greenhouse gas emissions intensity in dairy systems. *Livestock Science*, 139(1), 100-108.
<http://www.sciencedirect.com/science/article/pii/S1871141311000953>

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Approximate effect of milk yield on feed efficiency (milking cow only)



Approximate effect of milk yield on feed efficiency (milking cow only)



Summary

- We cannot continue to add animals to meet growing protein demand
- Feed utilization is a key proxy for monitoring environmental impact trends
- Dilution of Maintenance provides a major avenue for reducing environmental footprint of animal source protein
- Does not negate need to:
 - Reduce waste
 - Avoid over-indulgence of animal protein
 - Protect animal health and welfare

Thank you!



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