



Dairy farms and cows 50 years in the future

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THE EUROPEAN HOLSTEIN CHAMPIONSHIP

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Our team: Mike Hutjens, IL; Gordie Jones, WI; Jeff Stevenson, KS; Pam Ruegg, MI; Chad Dechow, PA; George Seidel, CO; Bob Cushman, NB; Tony McNeel, MI; Louise Holt, VT; Hilary Dobson, UK; Martin Sheldon, UK; Patrice Humblot; SE

Dairy Farms

- *Livestock are mostly in Asia and Africa.*
- *Population density and land affect farm locations.*
- *Climate change will push dairy farms **northward**.*
- *Is methane really a problem? It depends.*
- *Herd sizes will diverge*
 - ✓ *Affordable technologies and shared resources*
 - ✓ *Collaborate to improve environmental impacts*
 - ✓ *Multiple models worldwide*

World Livestock FAOSTAT 2017

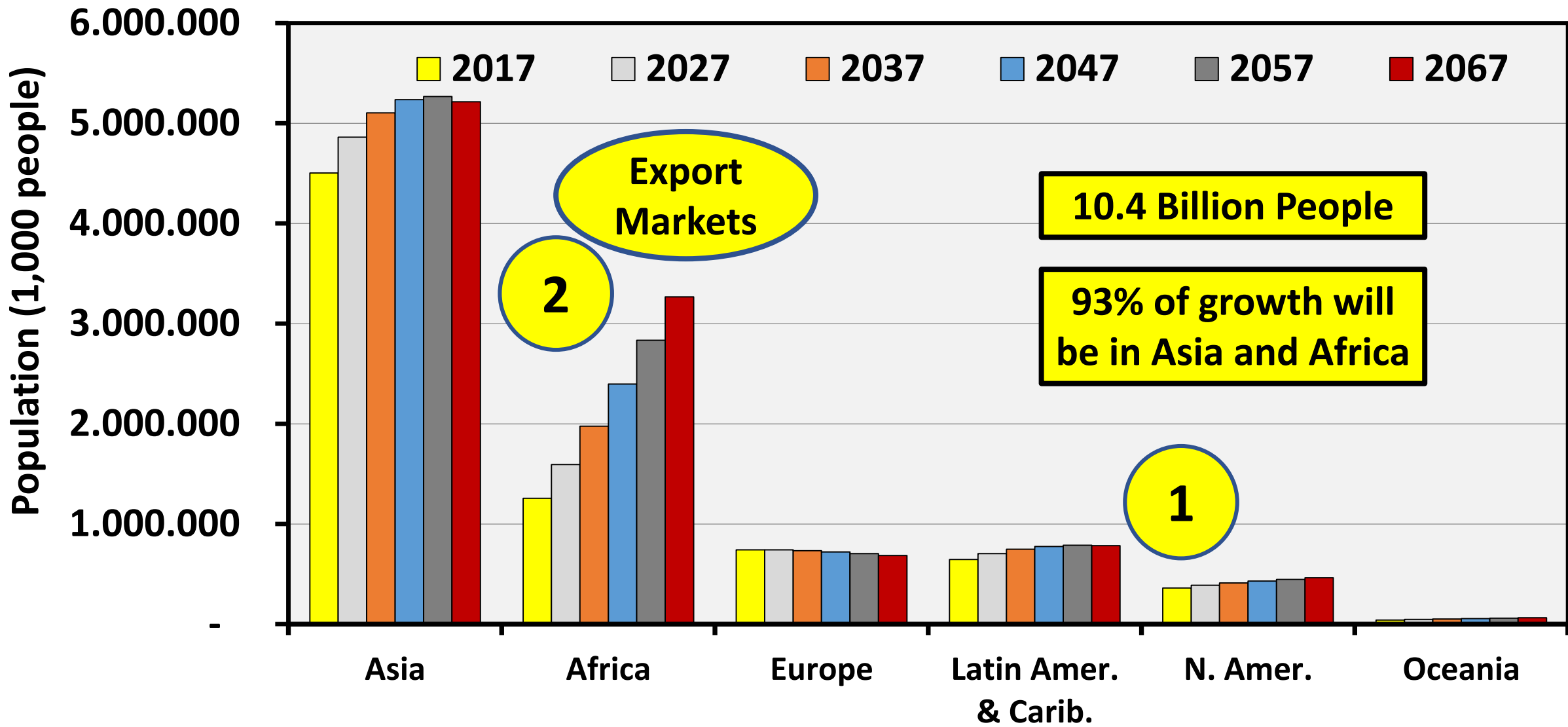
Type	World Estimate	1st	2nd	3rd
Chickens	22,208,179,000	China	USA	Indonesia
Cattle <small>274 million milk cows</small>	1,452,465,485	Brazil	India	USA
Ducks	1,236,588,000	China	Viet Nam	Bangladesh
Sheep	1,160,315,382	China	Australia	India
Pigs	987,400,659	China	USA	Brazil
Goats	979,405,438	China	India	Nigeria
Rabbits	539,159,000	China	N. Korea	Italy
Turkeys	449,365,000	USA	Chile	Brazil
Geese & guinea fowls	377,635,000	China	Russia	Mozambique
Buffaloes	196,144,518	India	Pakistan	China
Camels	28,304,990	Somalia	Sudan	Kenya
Total	29,614,962,472	FAOSTAT	2017	Accessed 2019
Others, millions:		Asia (17)	USA (4)	Other (3)
Asses 33, Horses 66, Mules 12, Dogs 900, Cats 600		Africa (5)	S. America (4)	

1

2

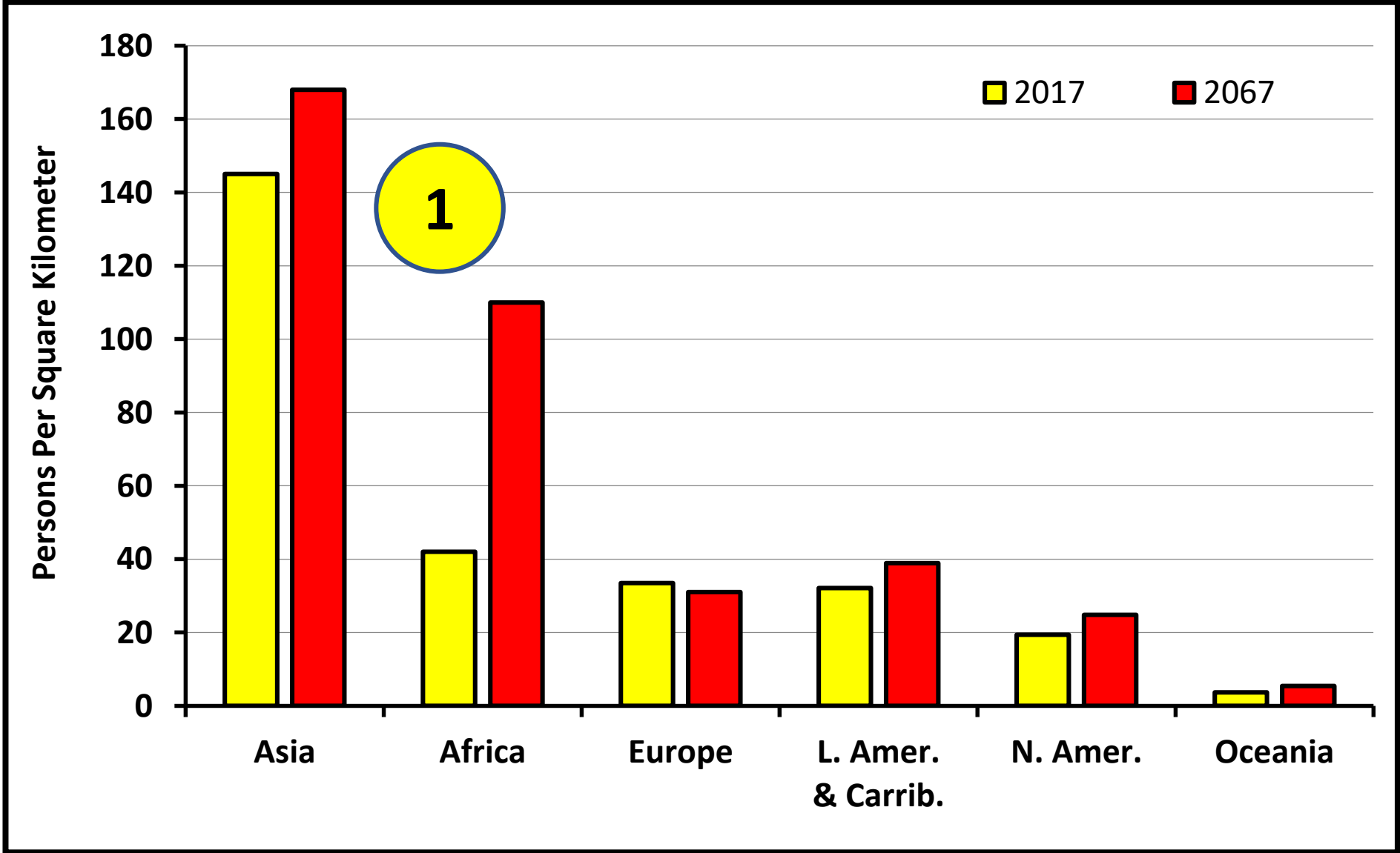
Of the 33 colored categories in the large table, 22 are in Asia or Africa. Highlighted species type produce more methane.

Forecasts. **Growth of population will be in Africa and Asia**



Britt et al. 2018. J. Dairy Sc. 101 (5): 3722-3741. Data source: FAOSTAT 2017.

Population density: Limits livestock growth in Africa and Asia



Climate: Canada, Russia and Northern China benefit from climate change

1

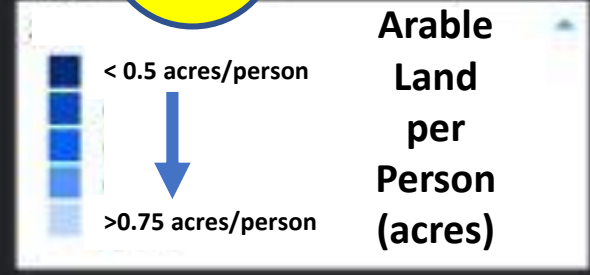
82% of people
81% of food
N. hemisphere

5-8 wk longer
growing season

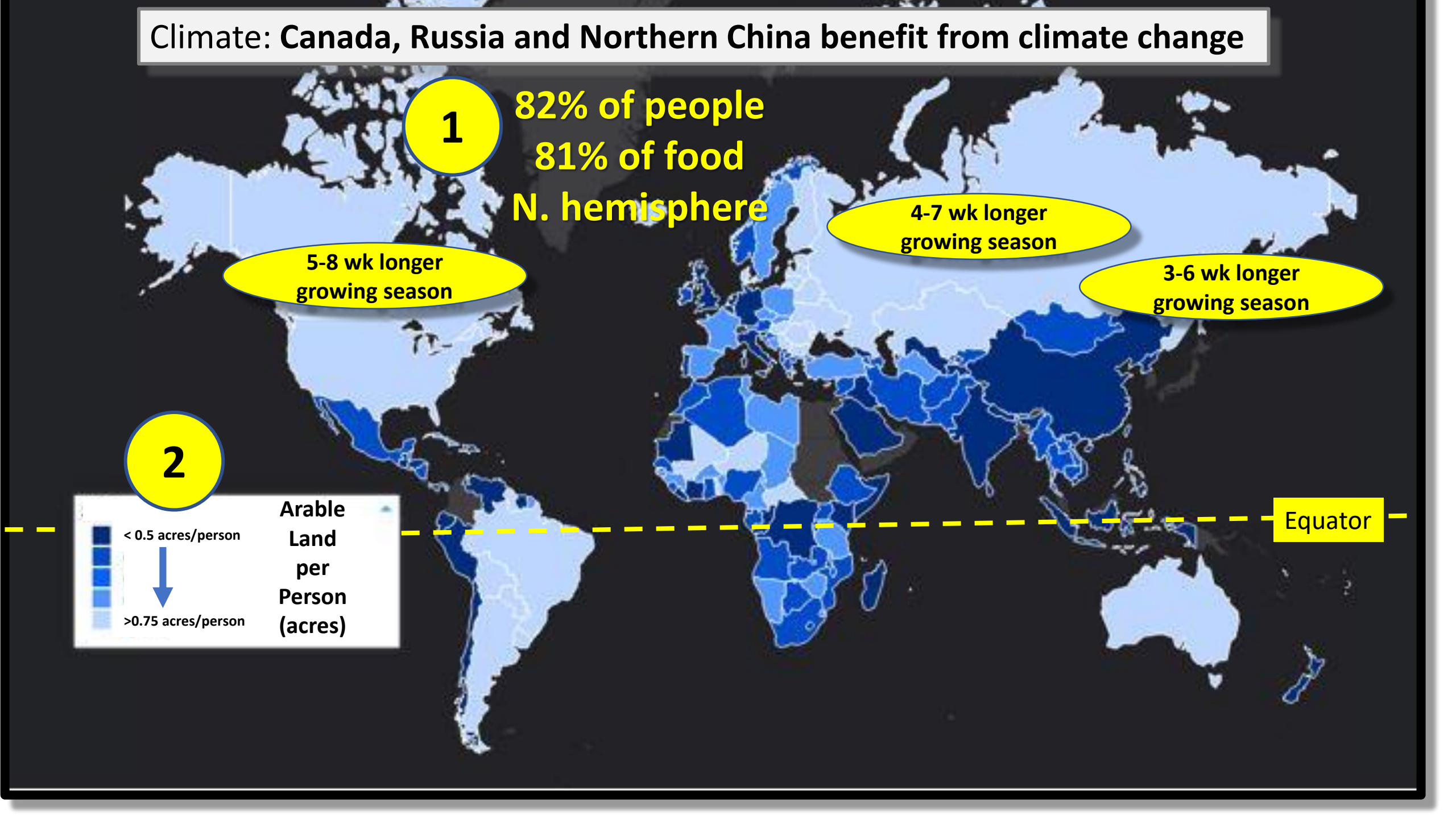
4-7 wk longer
growing season

3-6 wk longer
growing season

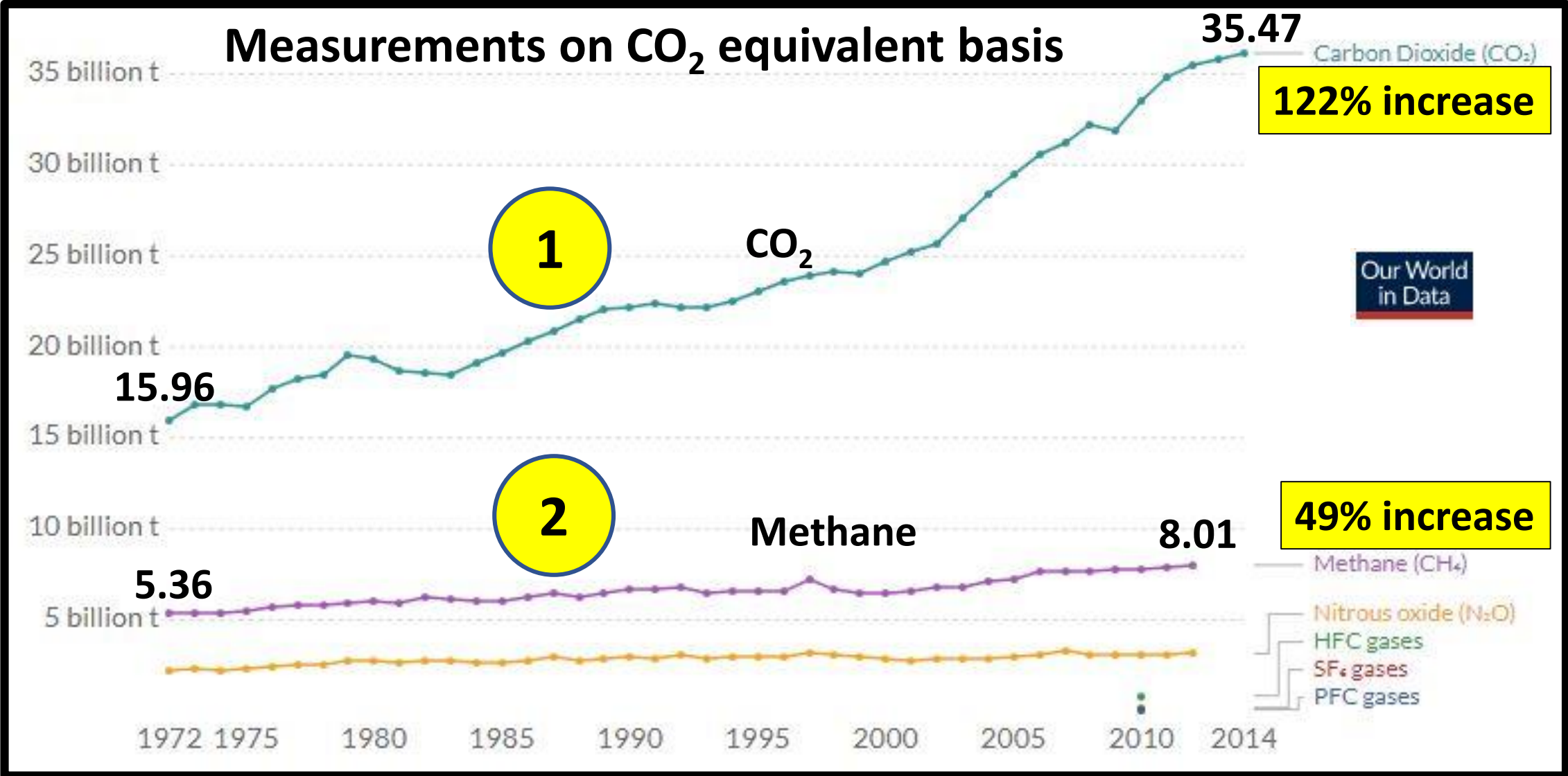
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Equator

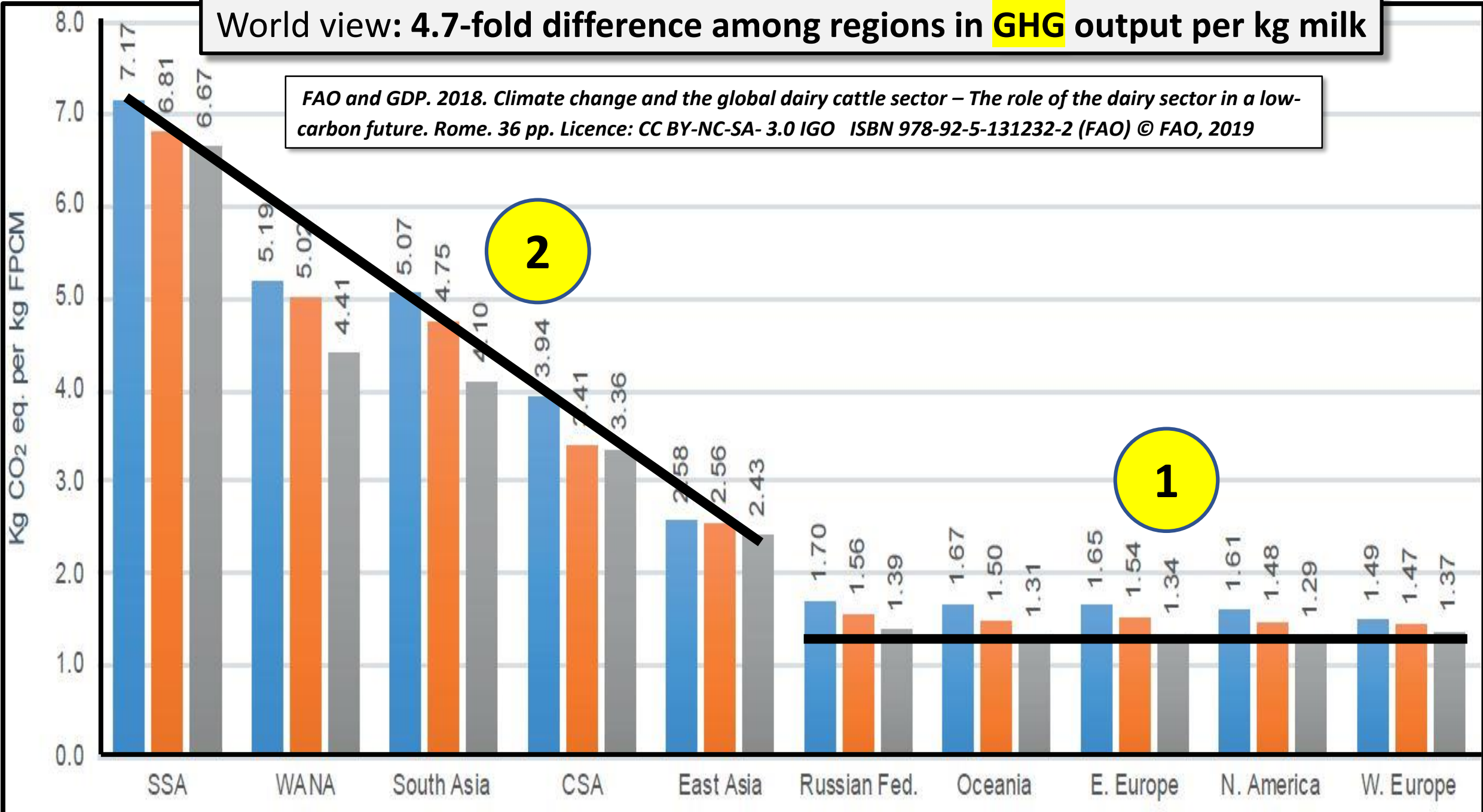


Methane? Is methane a problem, or is it methane intensity?

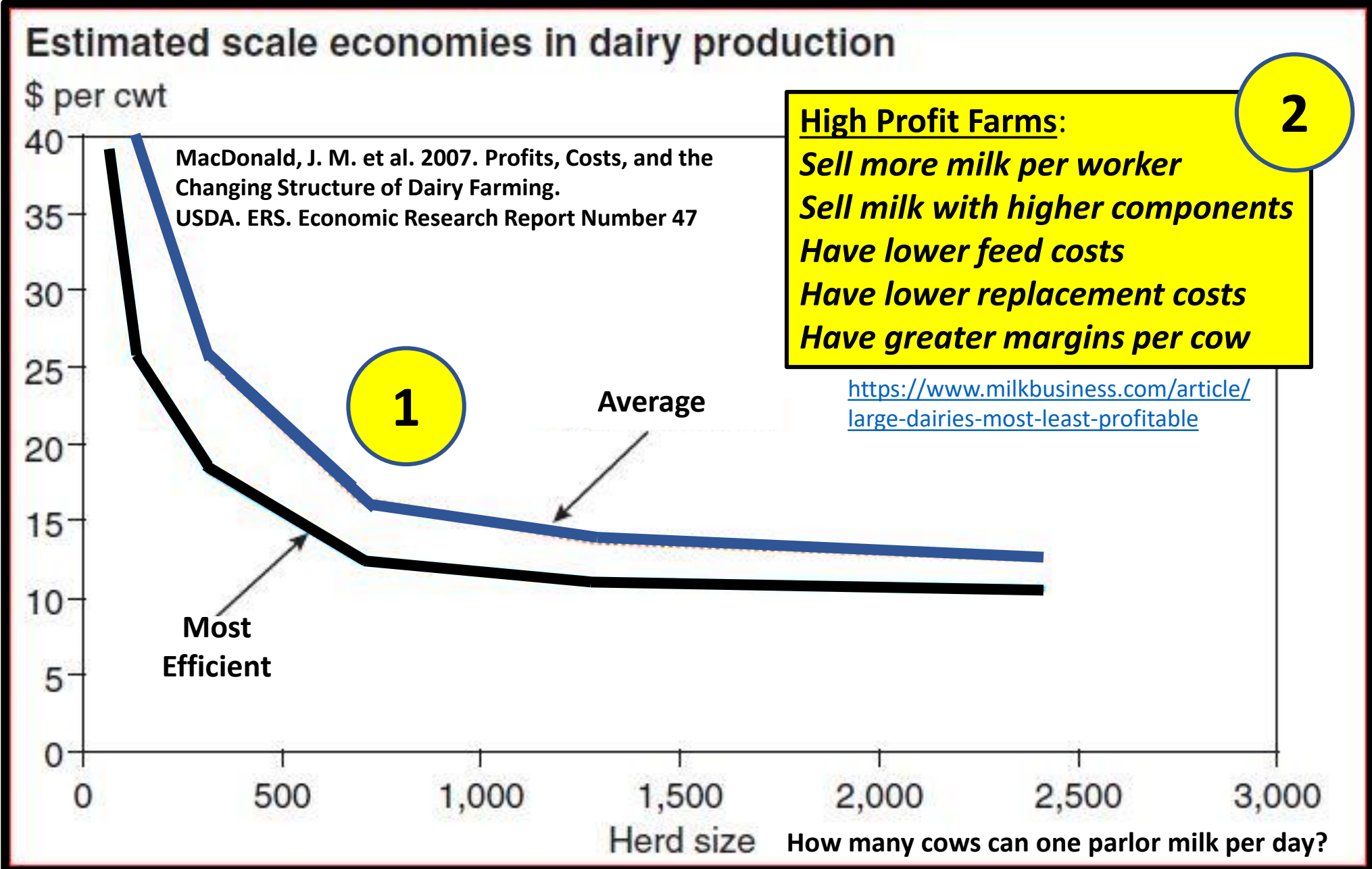


World view: 4.7-fold difference among regions in **GHG** output per kg milk

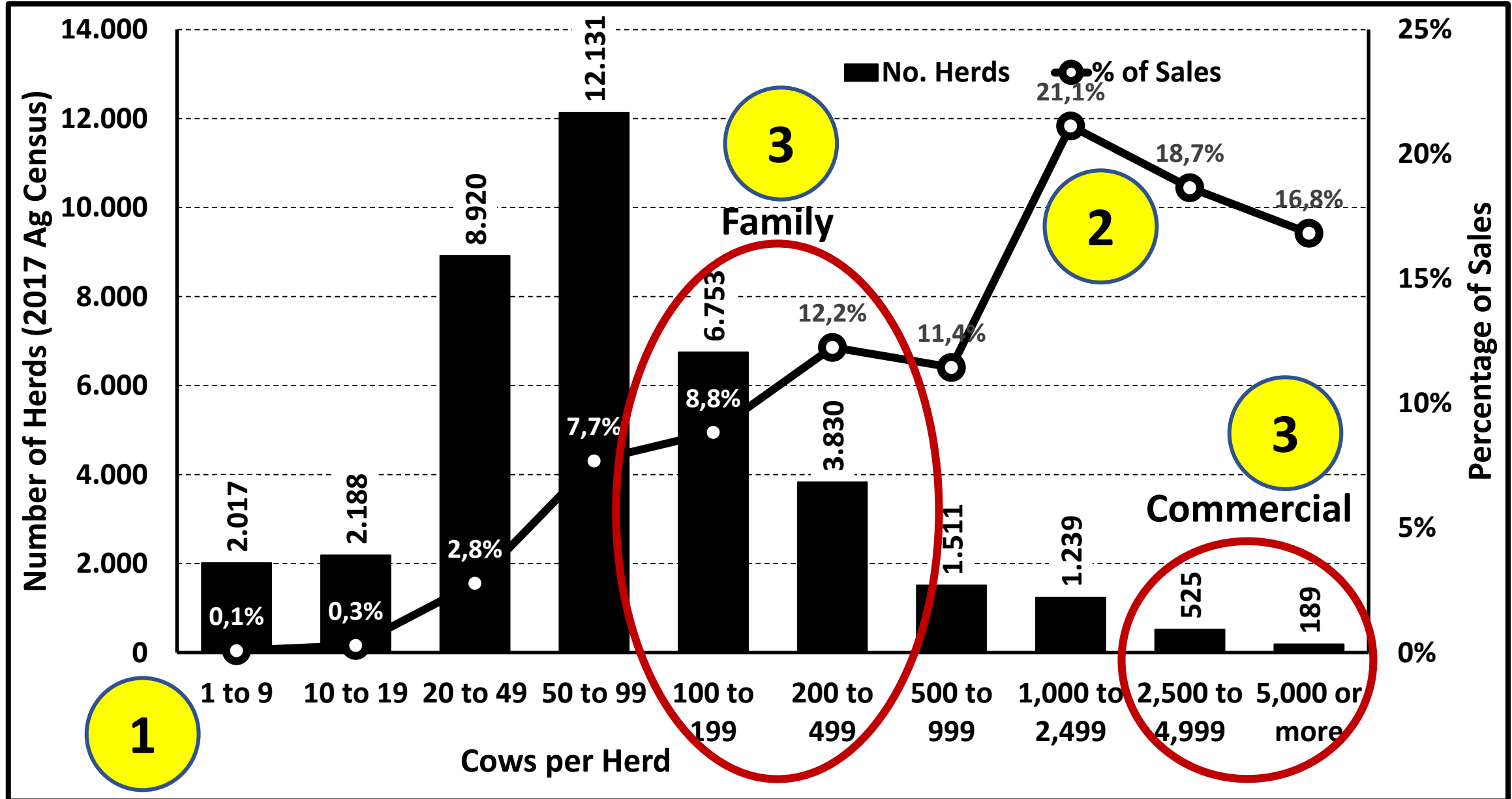
FAO and GDP. 2018. *Climate change and the global dairy cattle sector – The role of the dairy sector in a low-carbon future*. Rome. 36 pp. Licence: CC BY-NC-SA- 3.0 IGO ISBN 978-92-5-131232-2 (FAO) © FAO, 2019



Dairy herd sizes: Scale can benefit sustainability and profitability.



USA dairying 2017: Herd sizes and % of total milk sales.



Looking ahead: **Small or large.....not many between**

1

200 cows (77 hectares)
1 double-3 parlor
2X milking
High population density, low farmland hectares

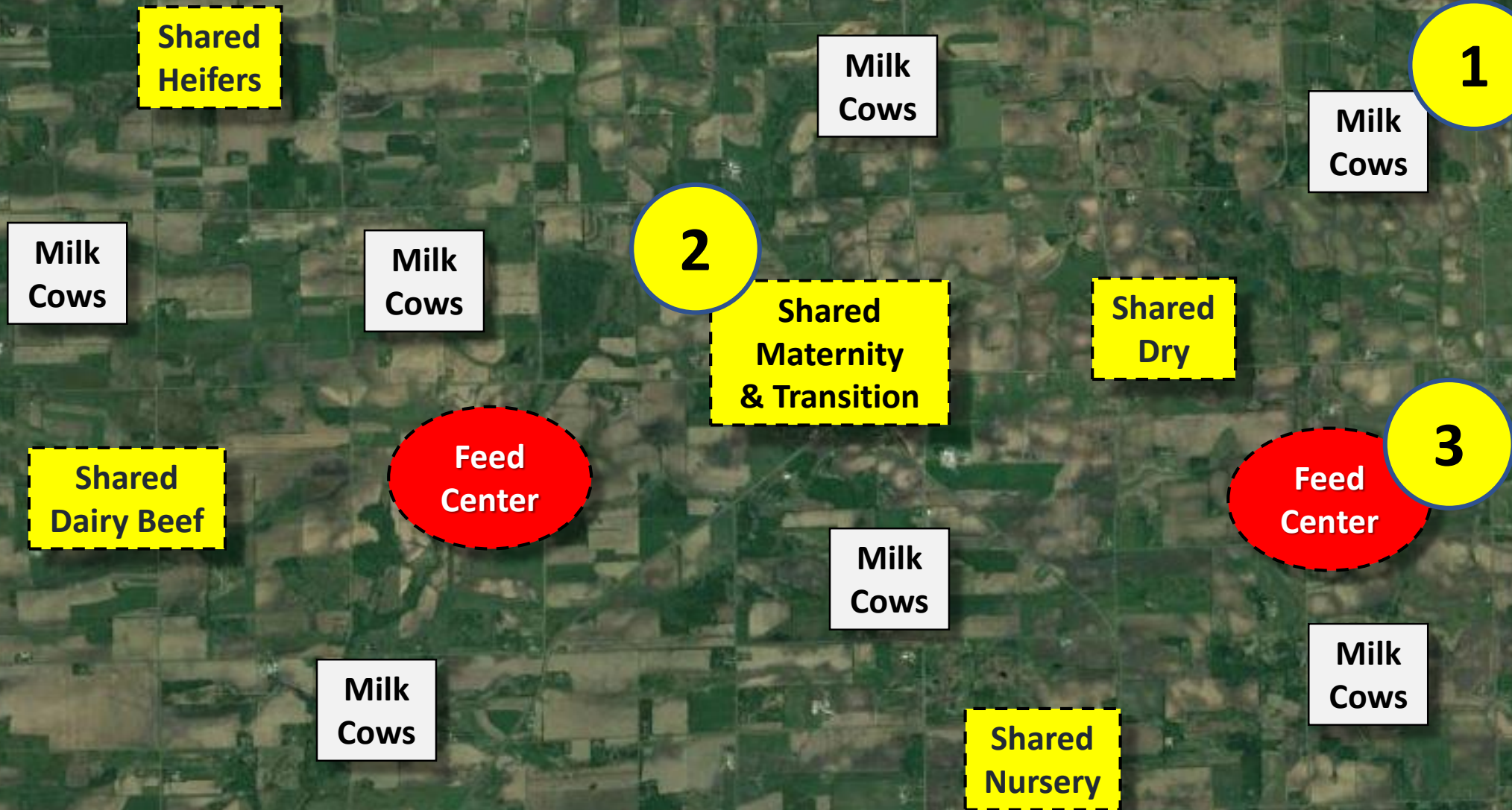
2

25,000 cows (1570 hectares)
3 Rotary Parlors (60. 110. 130)
3X milking
Very low population density, high farmland hectares

Largest milking parlor complex?

Nelson Faria dairy in Texas plans to have 5 106-cow rotary parlors in one building and can milk 30,870 cows 3X daily.

Looking ahead: Dairy farmers will share specialized facilities (**Lateral Integration**)



Reduce fixed costs/cow

Adopt common protocols

Volume discounts

Common design of facilities

Collaboration among large-scale dairy farms

Organization

- Family-owned large dairy farms
- 35,000 cows
- 19,000 acres
- 7,700 hectares

1

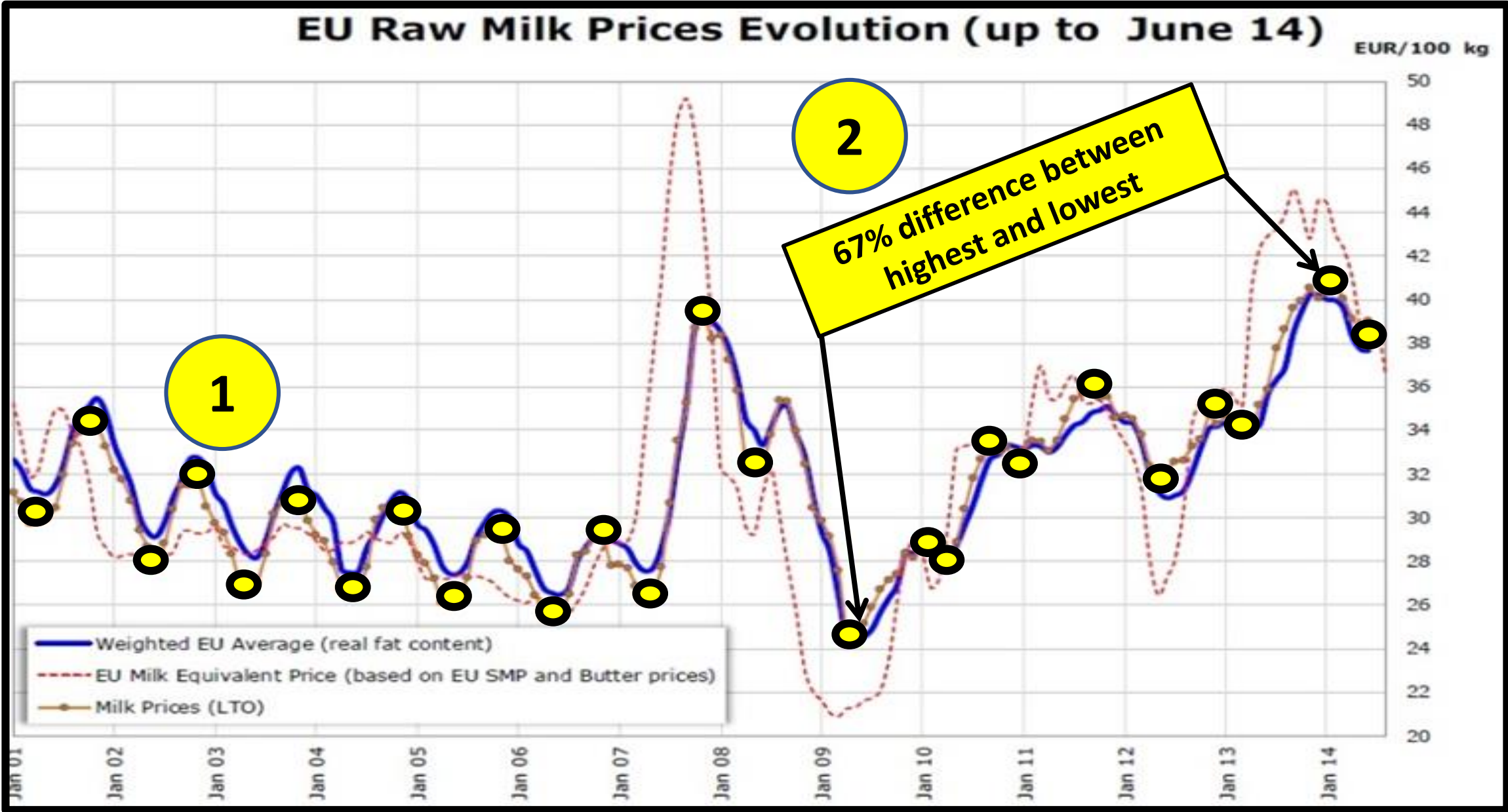


Shared

- Purchasing
- Marketing
- Payroll mgt
- Trucking
- Cropping
- Methane digester
- Phosphorus recycle
- Water recovery
- Habitat mgt

2

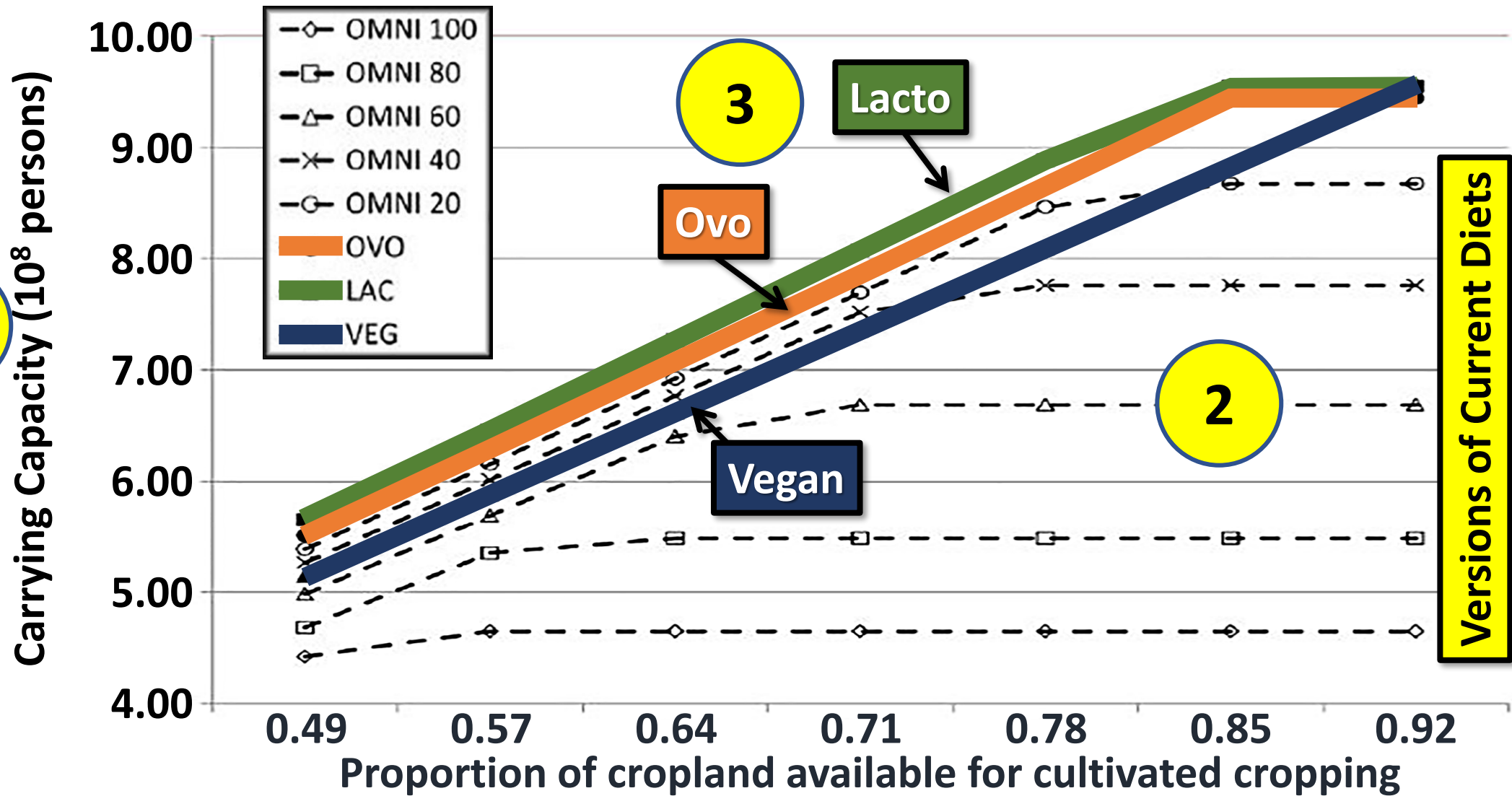
View ahead: Milk prices will continue to be VOLATILE!



Part 2. Dairy Cows

- *Dairy demand will increase?*
- *How much milk will cows produce?*
- *Are we approaching biological limits for yields?*
- *How will cows differ in the future?*
- *Genetic lines of cows to serve world's regions?*

Why dairy: It feeds more people from available cropland.

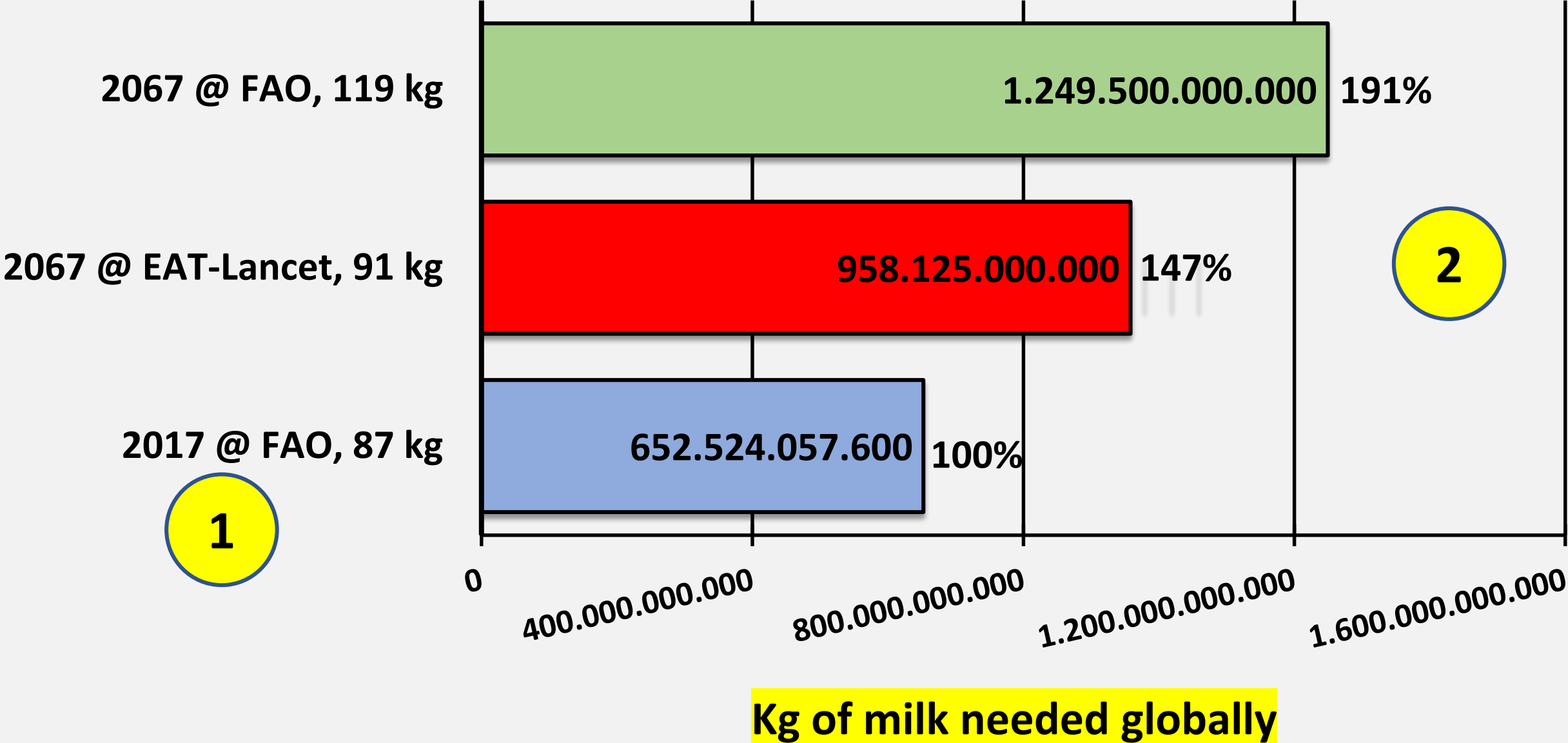


Peters, Christian J., Jamie Picardy, Amelia F. Darrouzet-Nardi, Jennifer L. Wilkins, Timothy S. Griffin, Gary W. Fick. 2016.

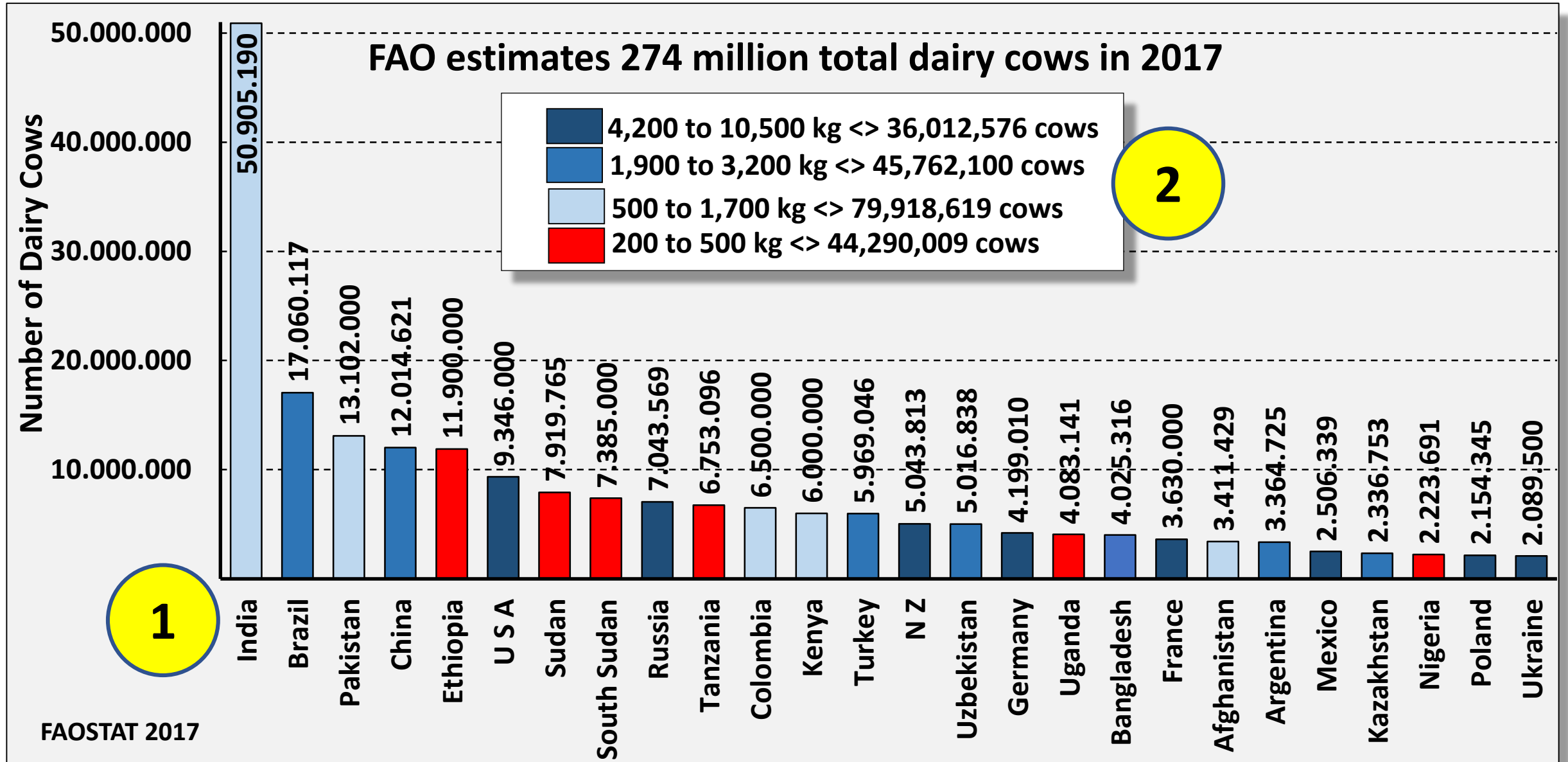
Carrying capacity of U.S. agricultural land: Ten diet scenarios. *Elementa: Science of the Anthropocene* • 4: 000116 • doi: 10.12952/journal.elementa.000116

World view: Demand for dairy will be strong

Estimated Global Milk Consumption in 2017 and 2067, kg



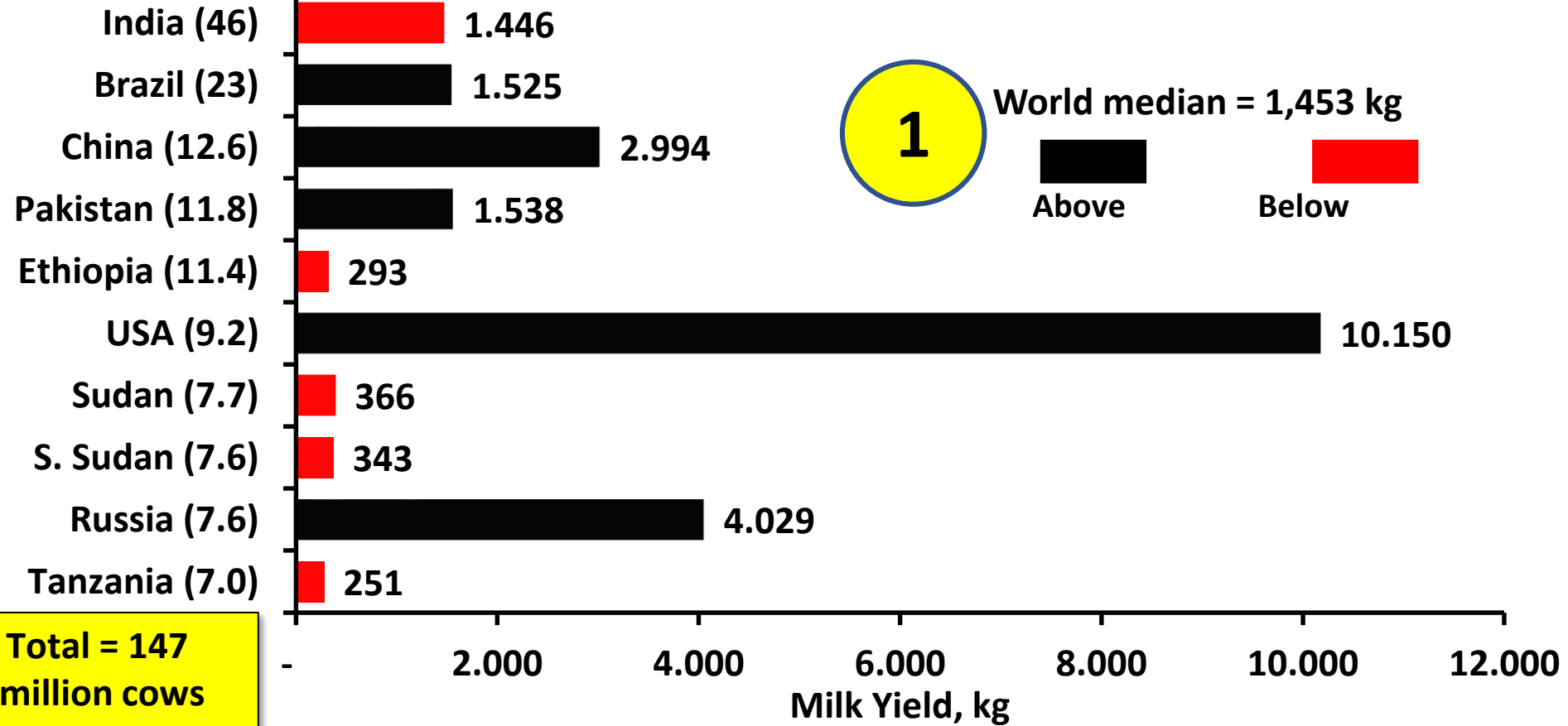
World view: 26 countries have 75% of dairy cows in world today



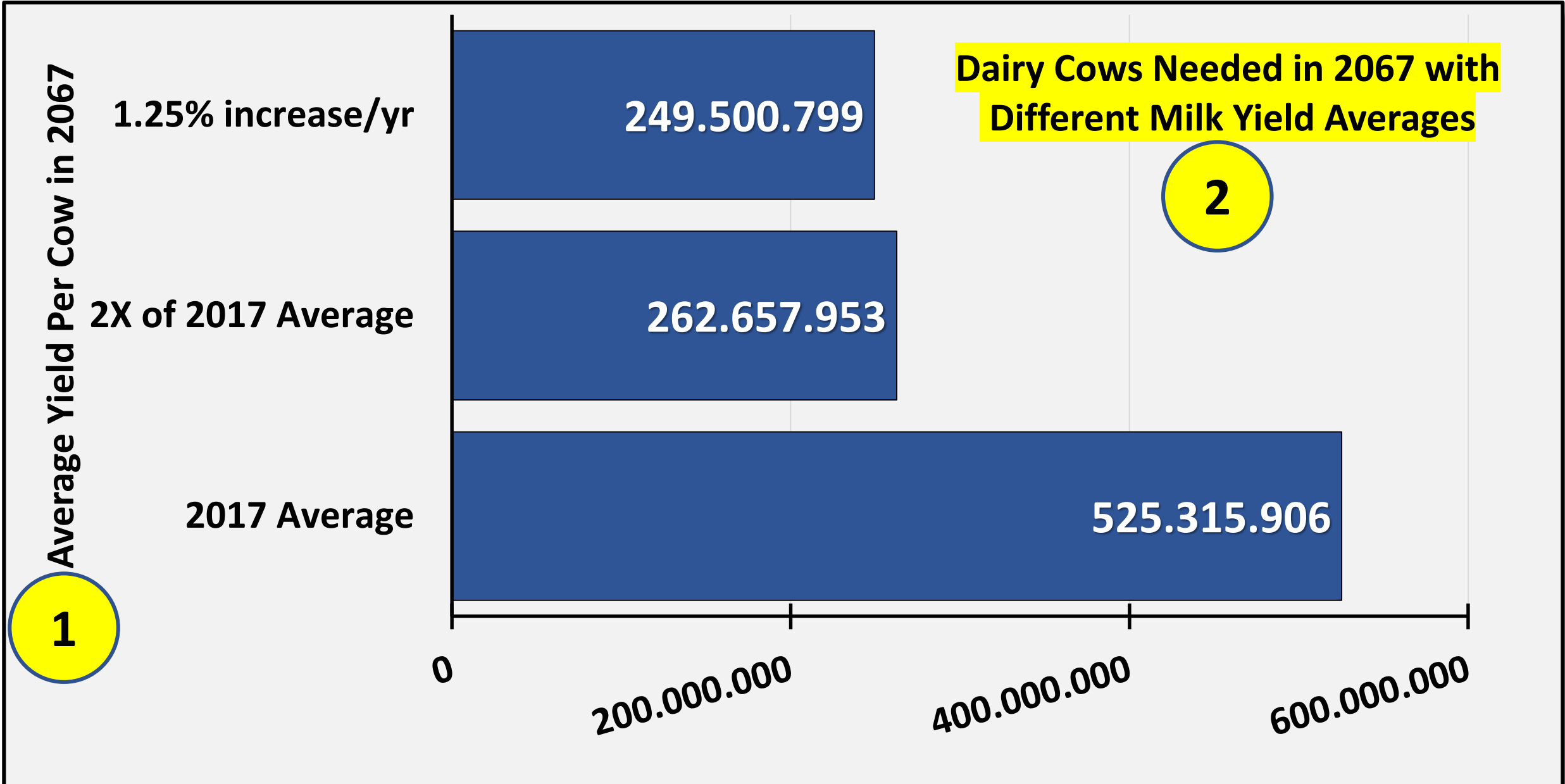
Currently: 40–fold difference in yield per cow is the greatest challenge

Country (cows, M)

FAO STAT 2014 Data; 12 May 2017



World view: How many dairy cows to meet demand



Average Yield Per Cow in 2067

1.25% increase/yr

249.500.799

Dairy Cows Needed in 2067 with Different Milk Yield Averages

2

2X of 2017 Average

262.657.953

2017 Average

525.315.906

1

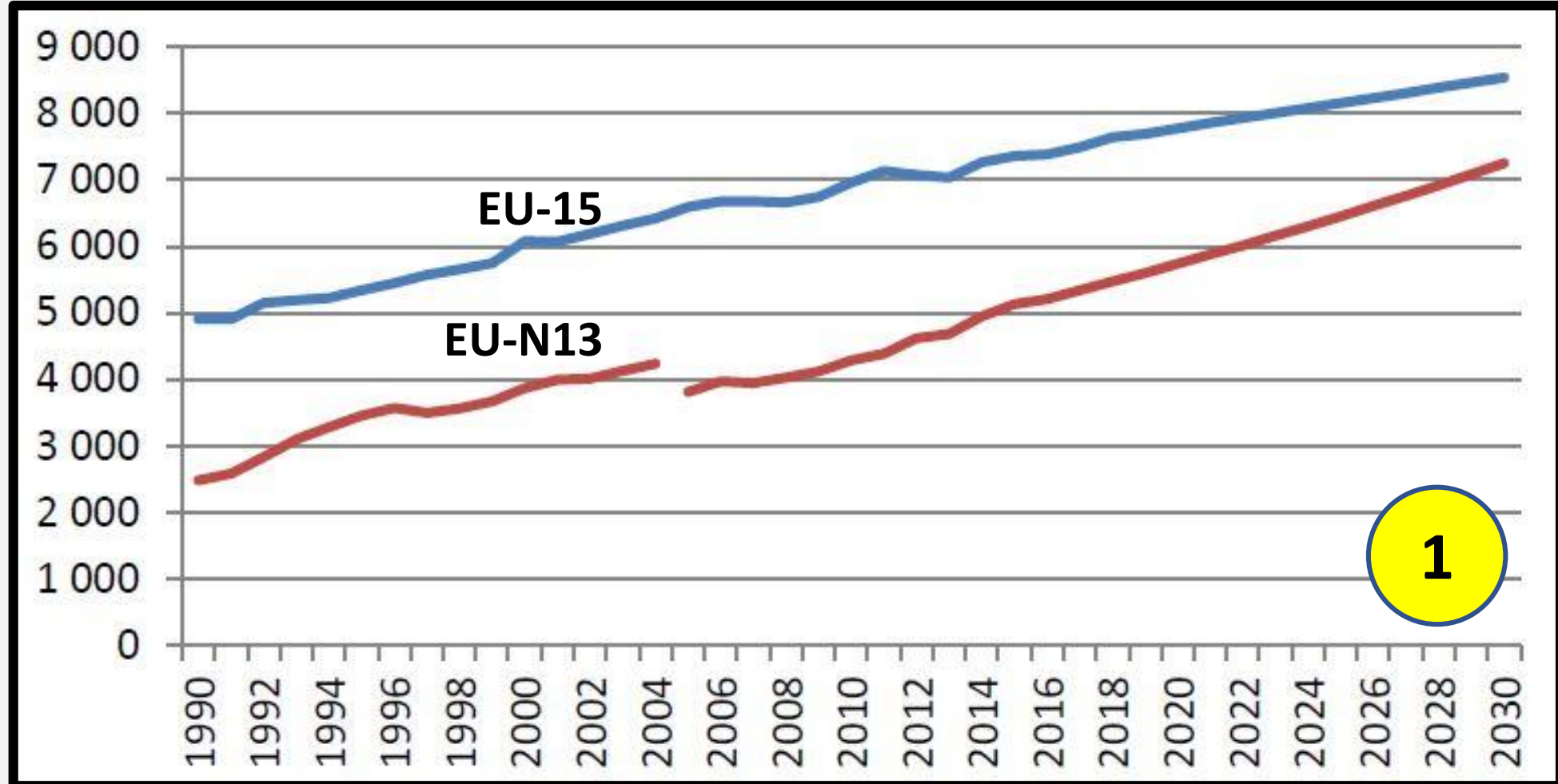
0

200.000.000

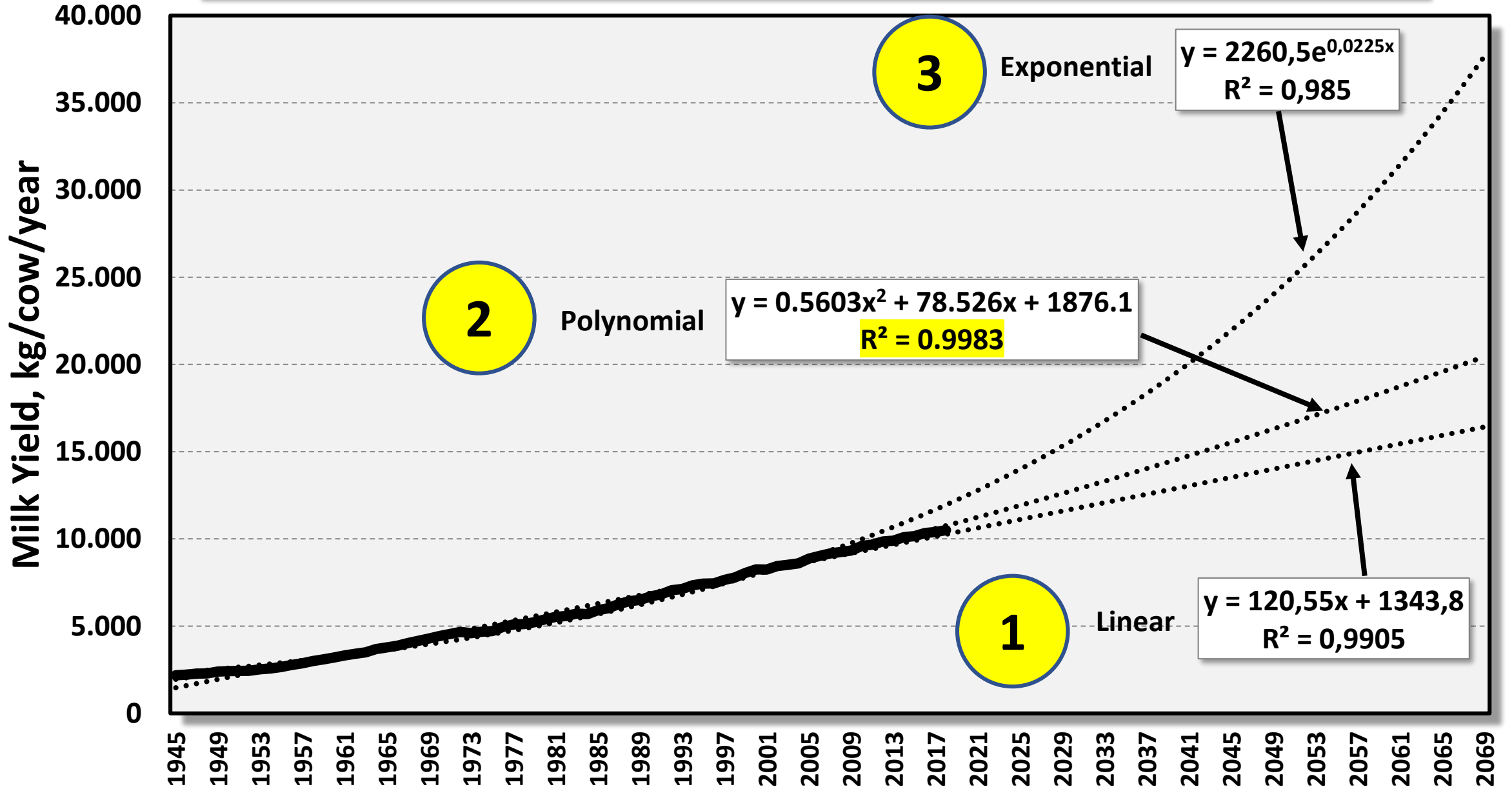
400.000.000

600.000.000

Milk yield: Forecast for EU (kg per cow per year)



Projected (July 2019): USA yield per cow will exceed 20,000 kg in 2069



Top yields. Potential is far beyond our averages.

- 1
- 2
- 3

	Maize ^{1,2} t/ha	Soybeans ^{1,2} t/ha	Milk ^{1,2} Kg/cow
<u>Record</u> ²	36.4	11.5	35,532
<u>Average</u> ¹	11.5	3.2	10,226
<u>Std. Dev.</u>	3.2	0.9	2,045
$\frac{(R - A)}{(SD \text{ units})} =$	7.7	9.5	12.2

¹ Yield averages are for 2014 in USA. ²Records are for 2016 or 2017 (updated 12.21.2017).

Biological capacity is clearly far beyond than average yield.

Biological limits? Top producing Holstein single lactation in North America



<u>Traits</u>	<u>Values</u>
ECM milk, kg	40,599
Fat, kg	1,664
Fat, %	5.33%
Protein, kg	1,156
Protein, %	3.70%
Days in milk	365
ECM milk, kg/day	111.2

Looking ahead. **Genetics of cows of the future**

**Efficient, smaller
environmental
footprint**

**Genomics of
microbiomes**

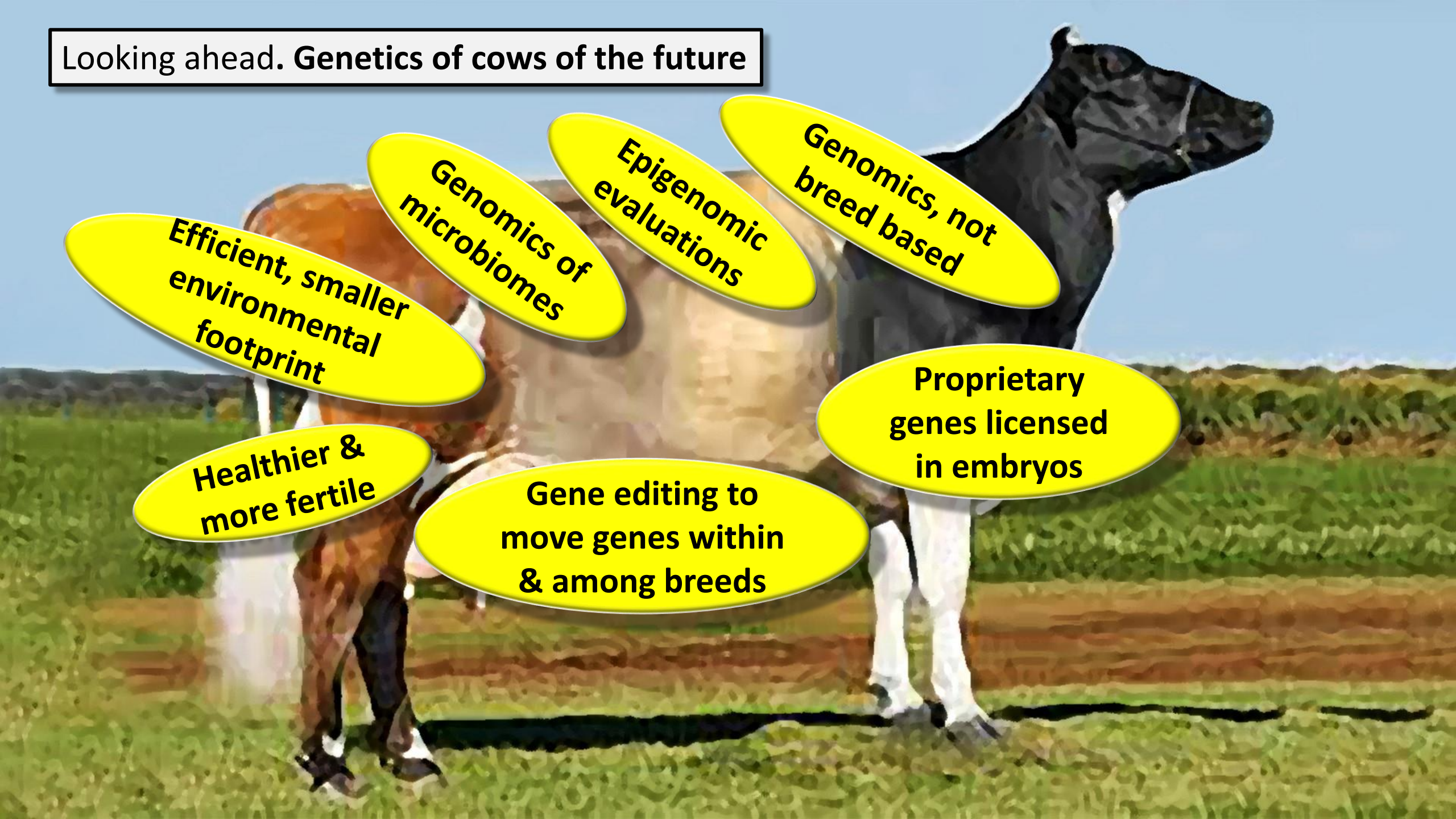
**Epigenomic
evaluations**

**Genomics, not
breed based**

**Healthier &
more fertile**

**Gene editing to
move genes within
& among breeds**

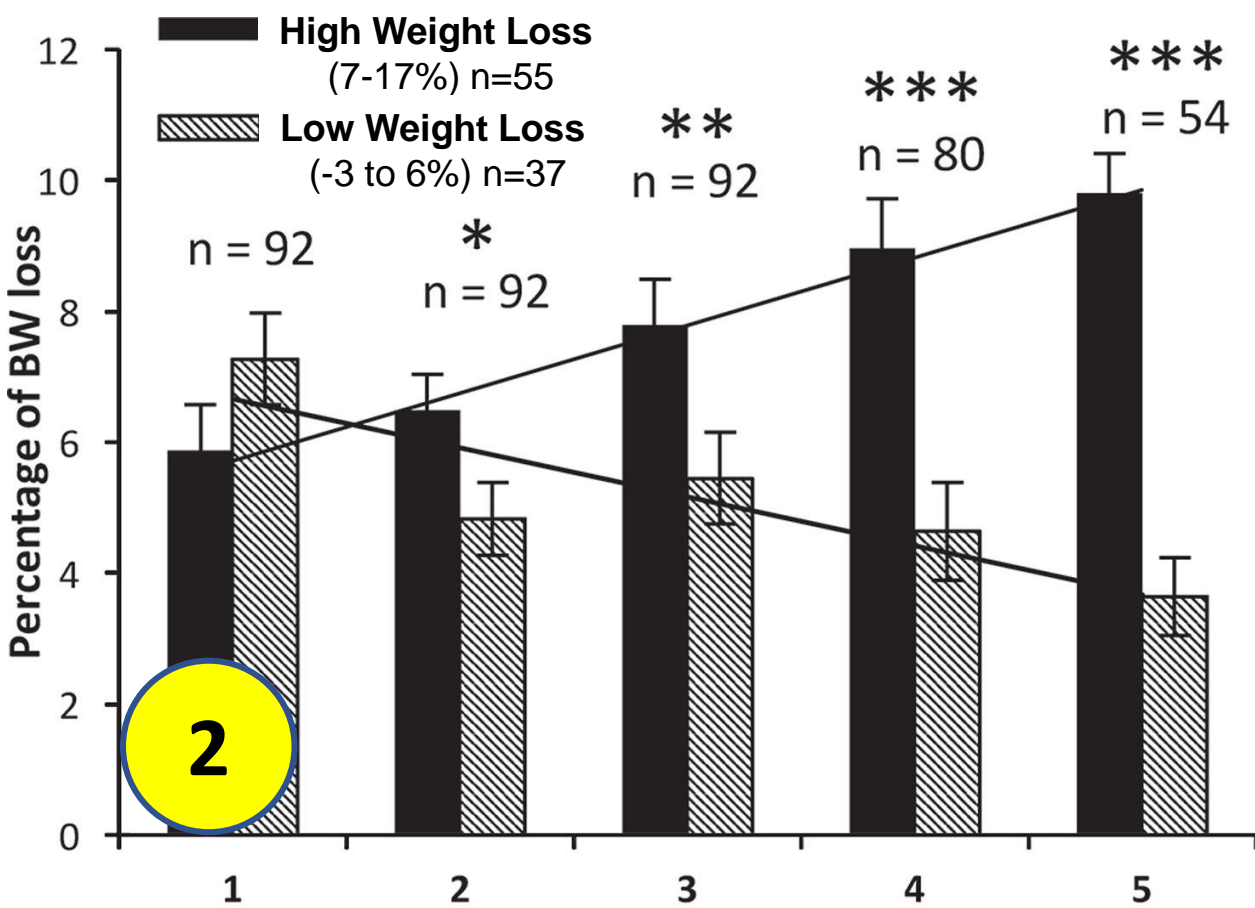
**Proprietary
genes licensed
in embryos**



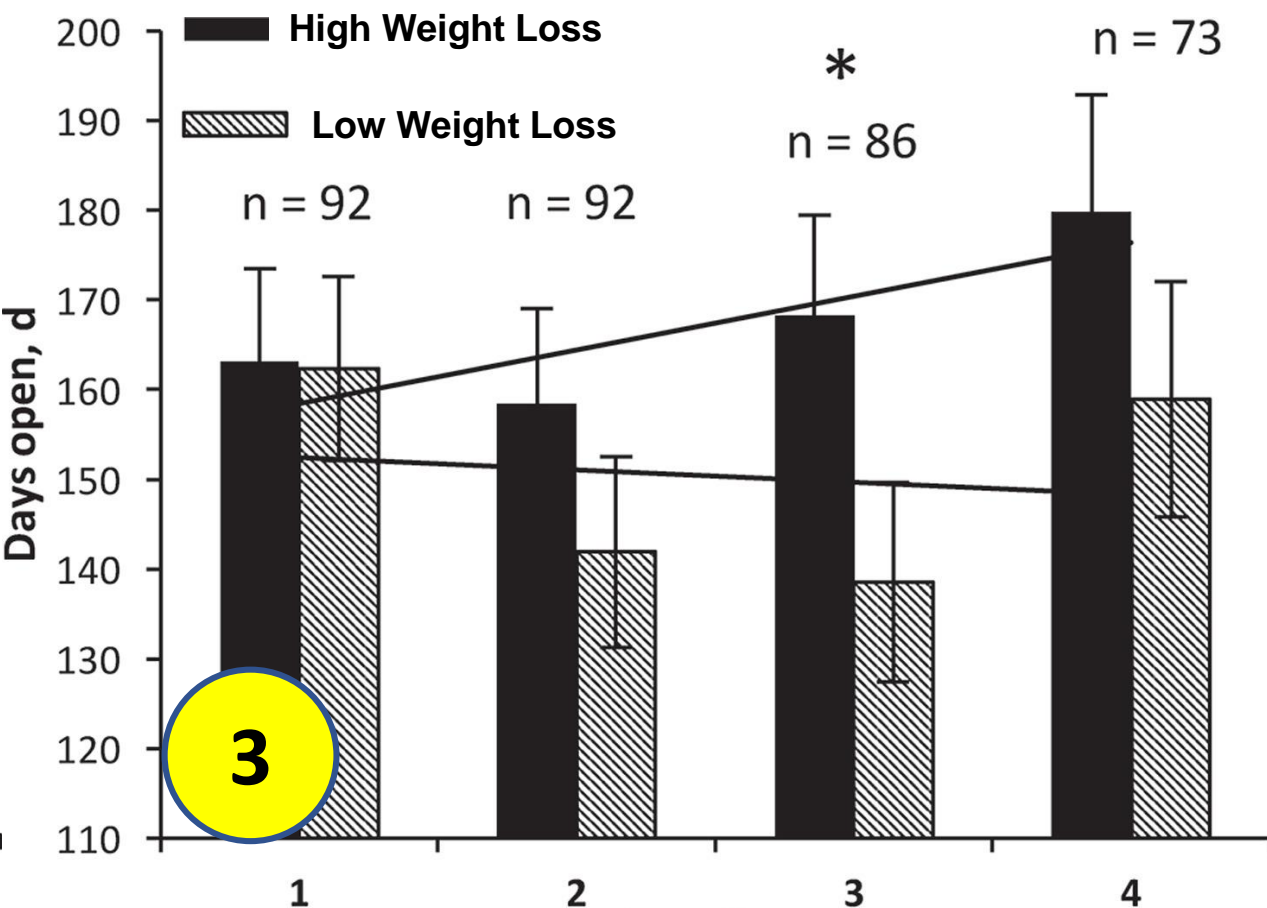
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Do cows have to lose more weight naturally to have high yields?

M. Zachut and U. Moallem. 2017. J. Dairy Sci. 100 (4) 3143–3154



	High	Low
Avg 305 yield/d, kg	39.4	39.0
Milk fat, %	3.40	3.46
Milk protein, %	3.09	3.15

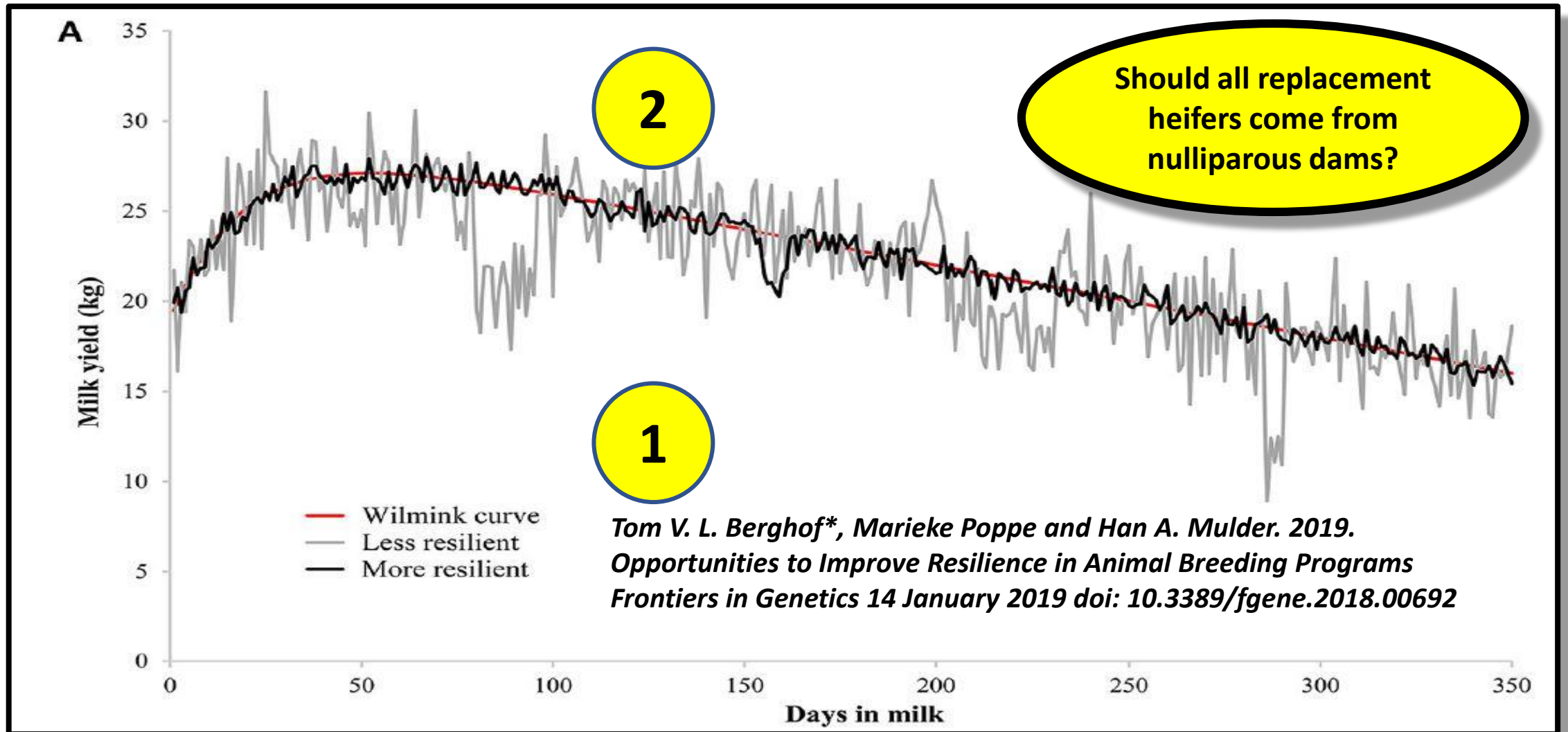


	High	Low
Days open	167	150
Concep rate all, %	32.5	42.1

2

3

Resilience: Genetic resilience will become a new selection trait



Genetics of the future: Four global dairy cattle lines

1

4

Tropical

3

Dry/Desert

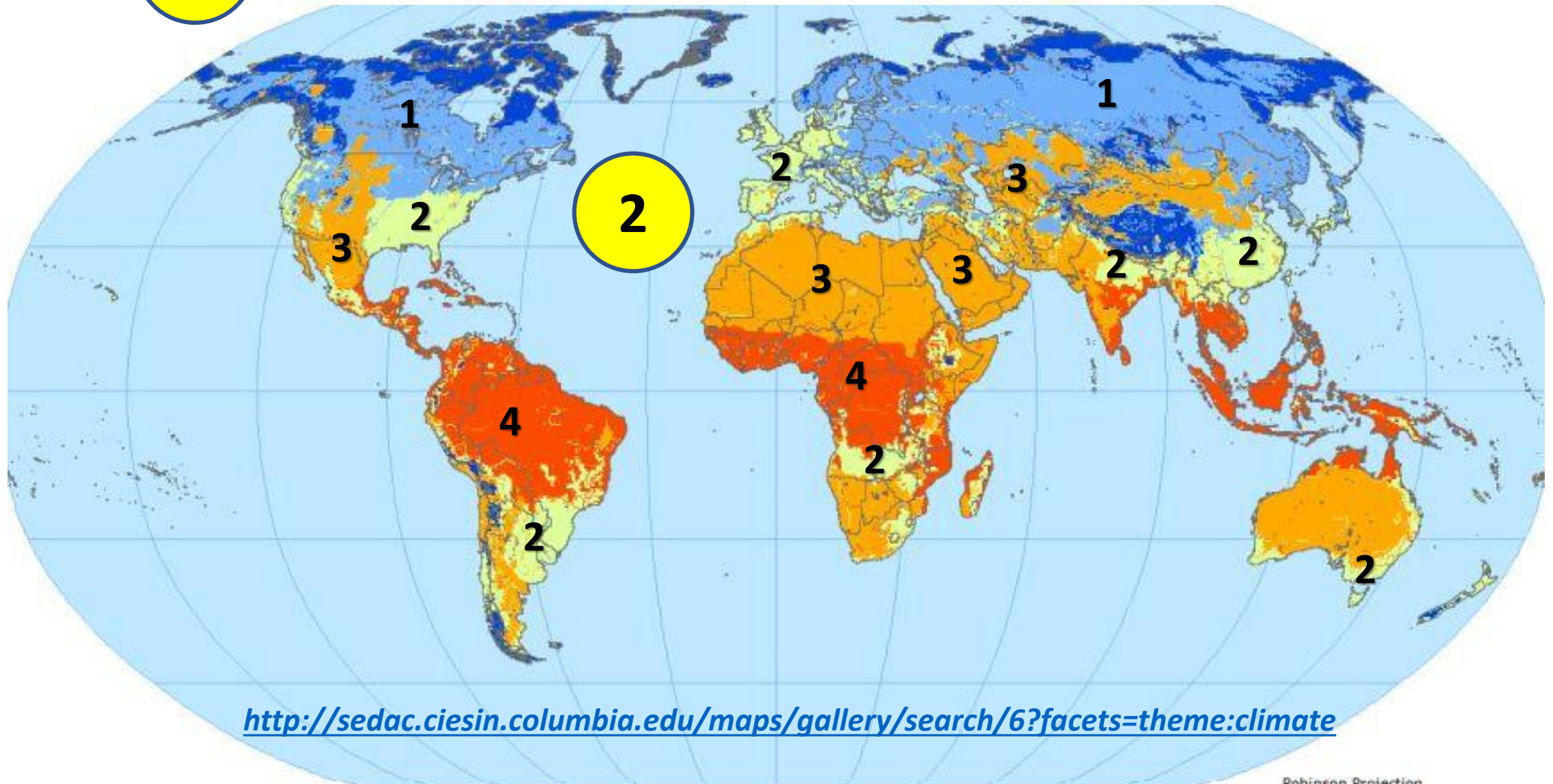
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Temperate

1

Cold

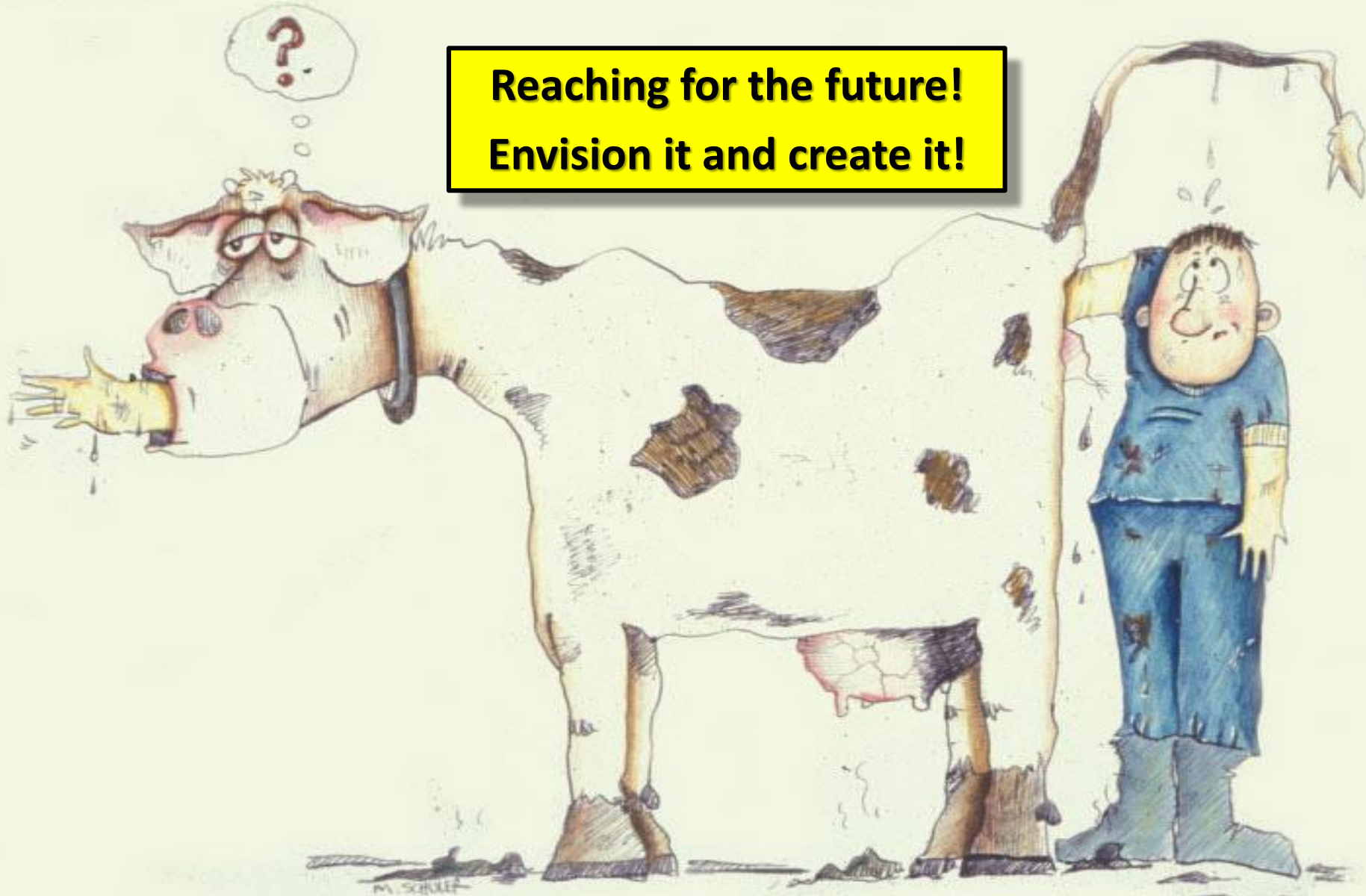
Polar/Tundra



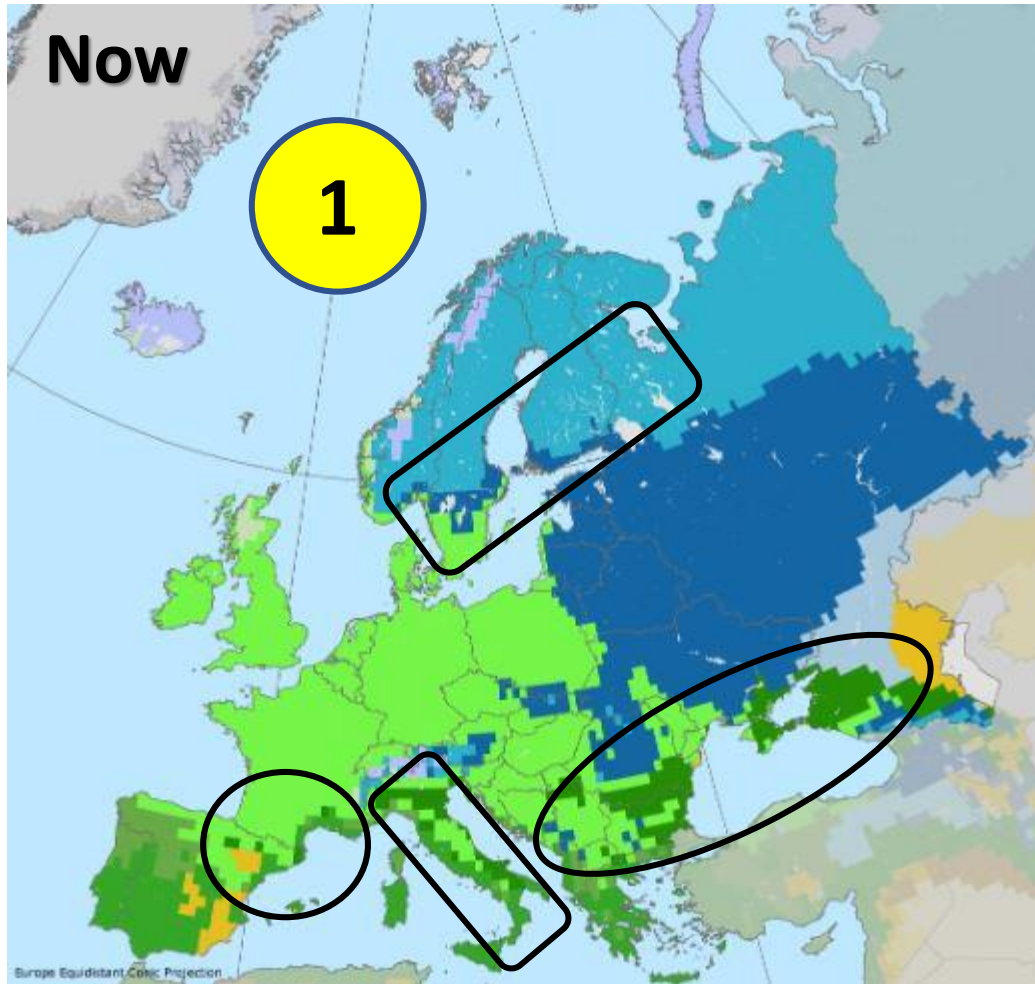
<http://sedac.ciesin.columbia.edu/maps/gallery/search/6?facets=theme:climate>

Thank You for this Opportunity

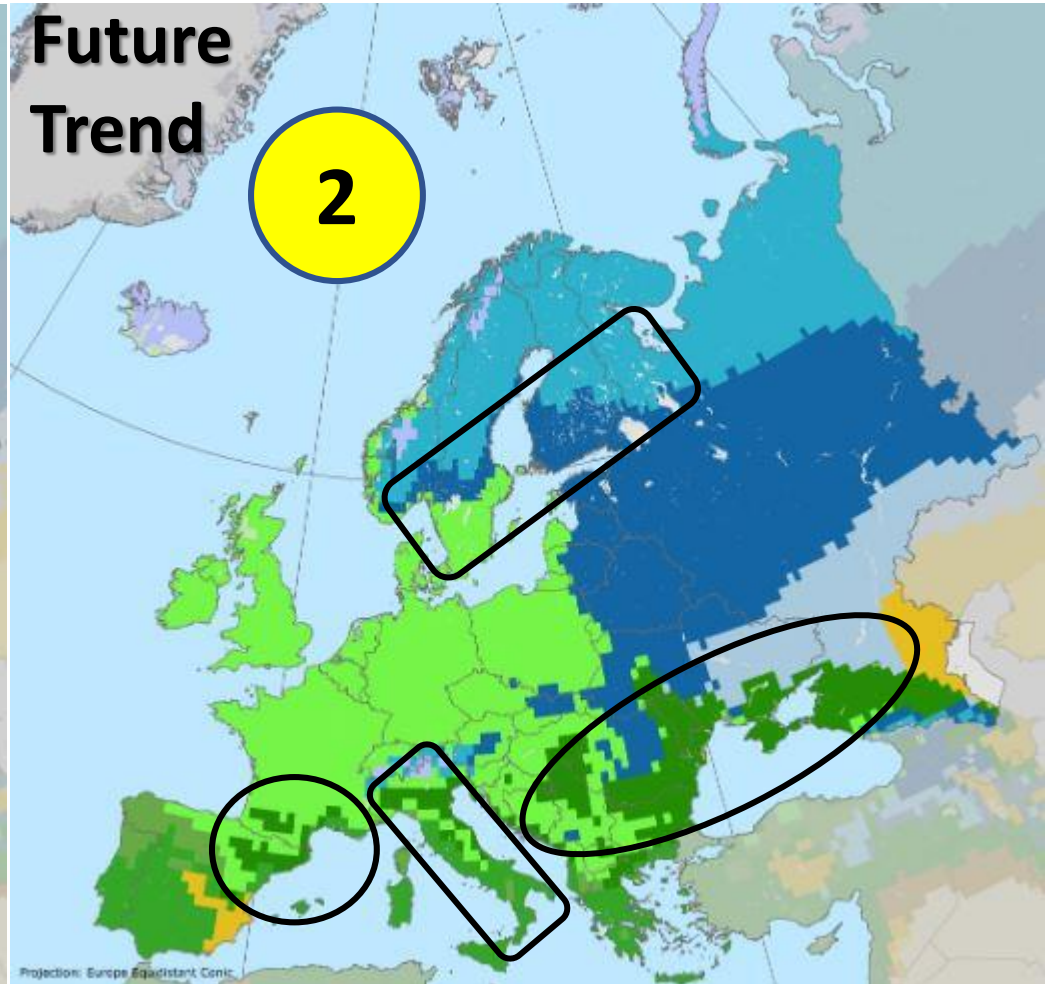
**Reaching for the future!
Envision it and create it!**



Future: Modest changes in European dairy climate during next decade



<http://sedac.ciesin.columbia.edu/maps/gallery/search?facets=theme:climate&facets=region:europe>



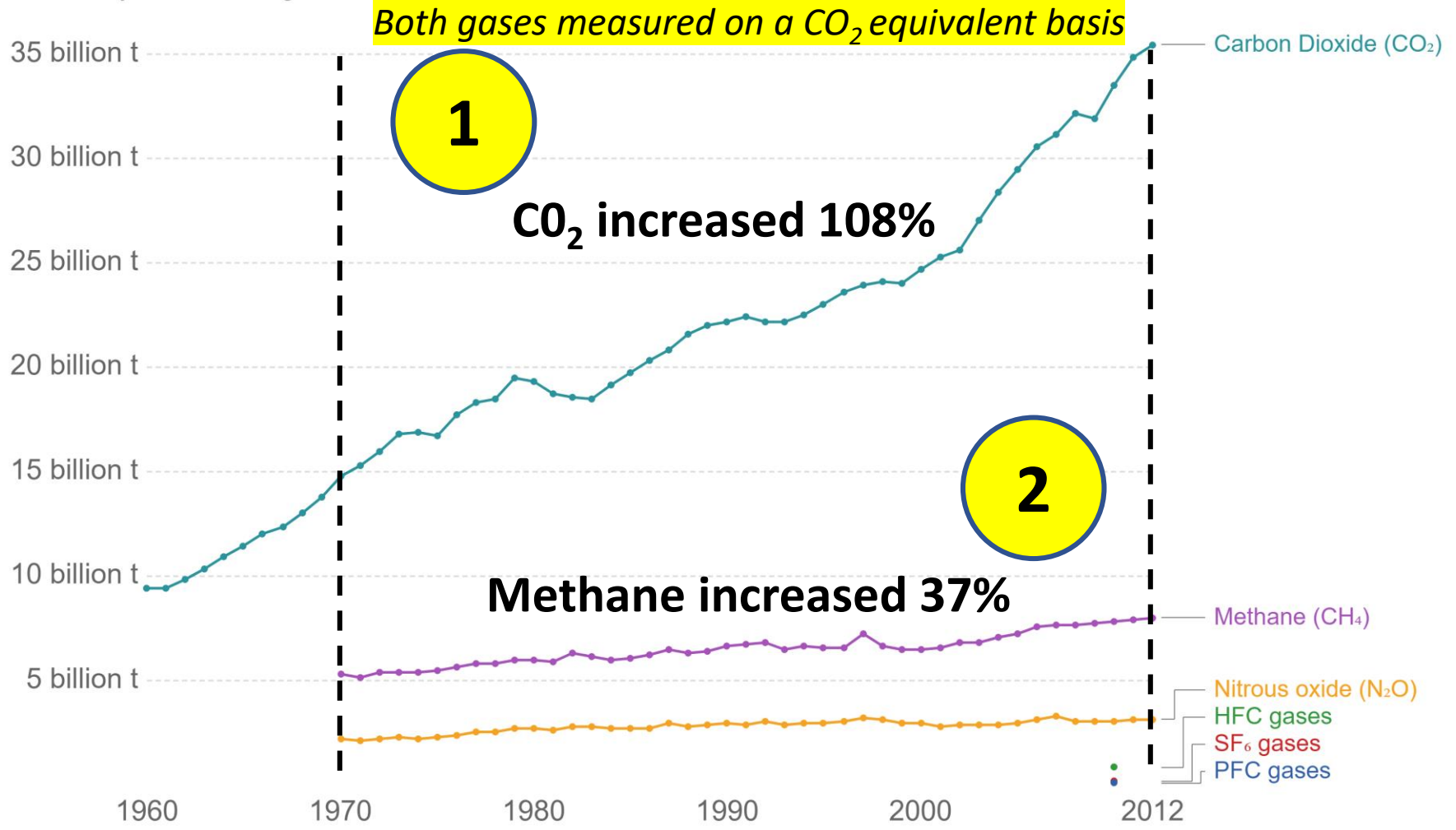
<http://sedac.ciesin.columbia.edu/downloads/maps/nagdc/nagdc-population-landscape-climate-estimates-v3/place3-climatezones-b2-2001-2025-europe.png>

Methane? Is methane a problem, or is it methane intensity?

Greenhouse gas emissions (CO₂e) by gas, World

Our World
in Data

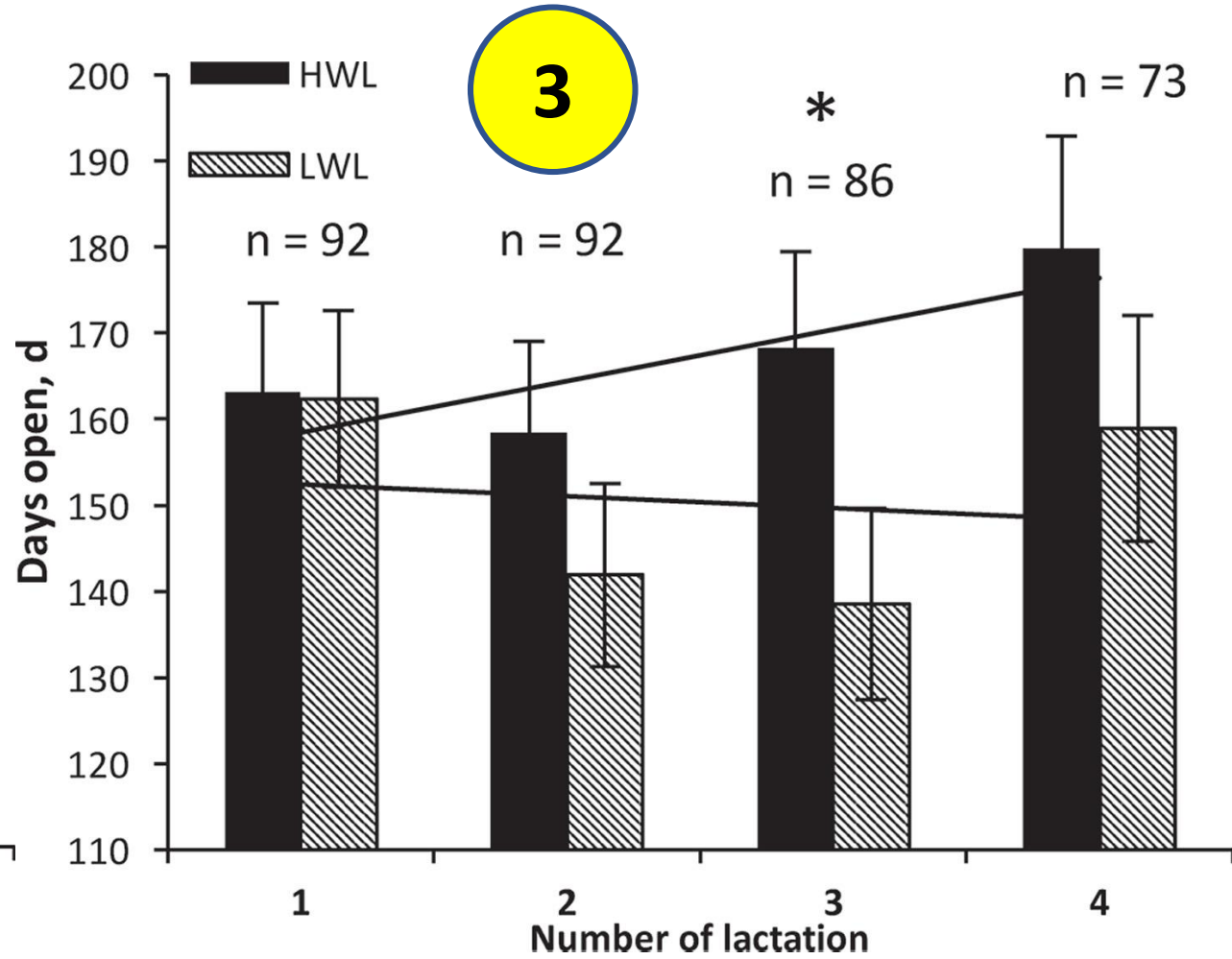
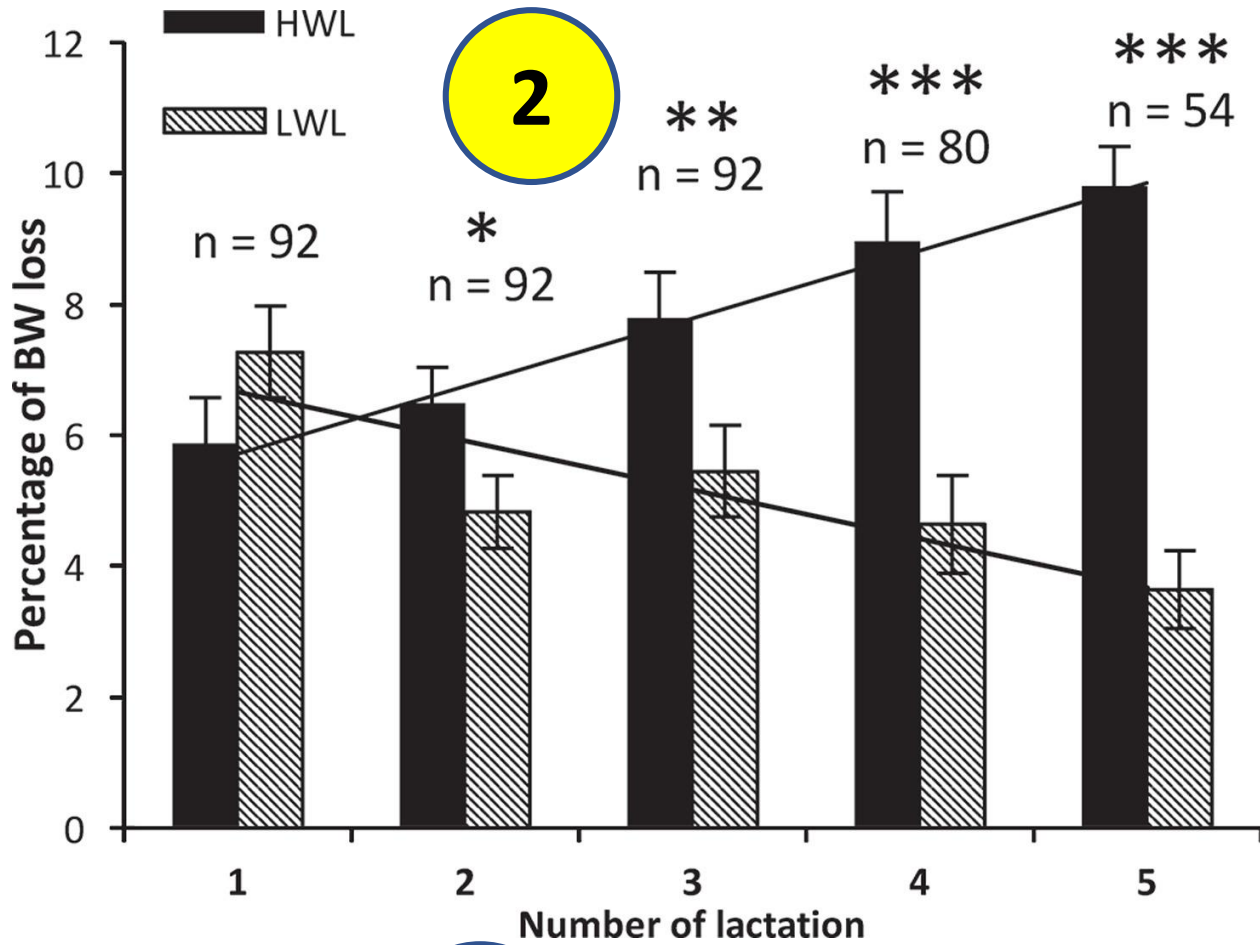
Global greenhouse gas emissions by gas source, measured in tonnes of carbon dioxide equivalents (tCO₂e). Gases are converted to their CO₂e values based on their global warming potential factors. HFC, PFC and SF₆ are collectively known as 'F-gases'.



Source: World Bank - World Development Indicators (WDI)

OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY

Future: Do cows have to lose weight to have high yields?



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M. Zachut and U. Moallem. 2017. J. Dairy Sci. 100 (4) 3143–3154