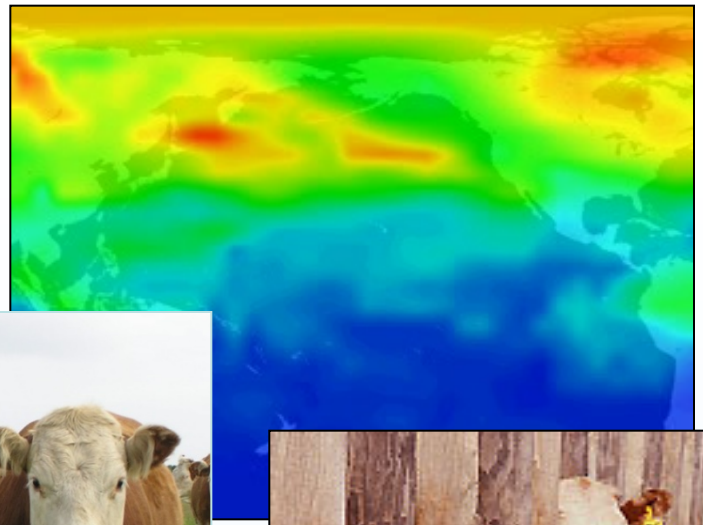
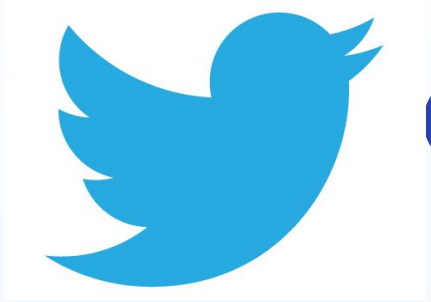
Livestock and Climate



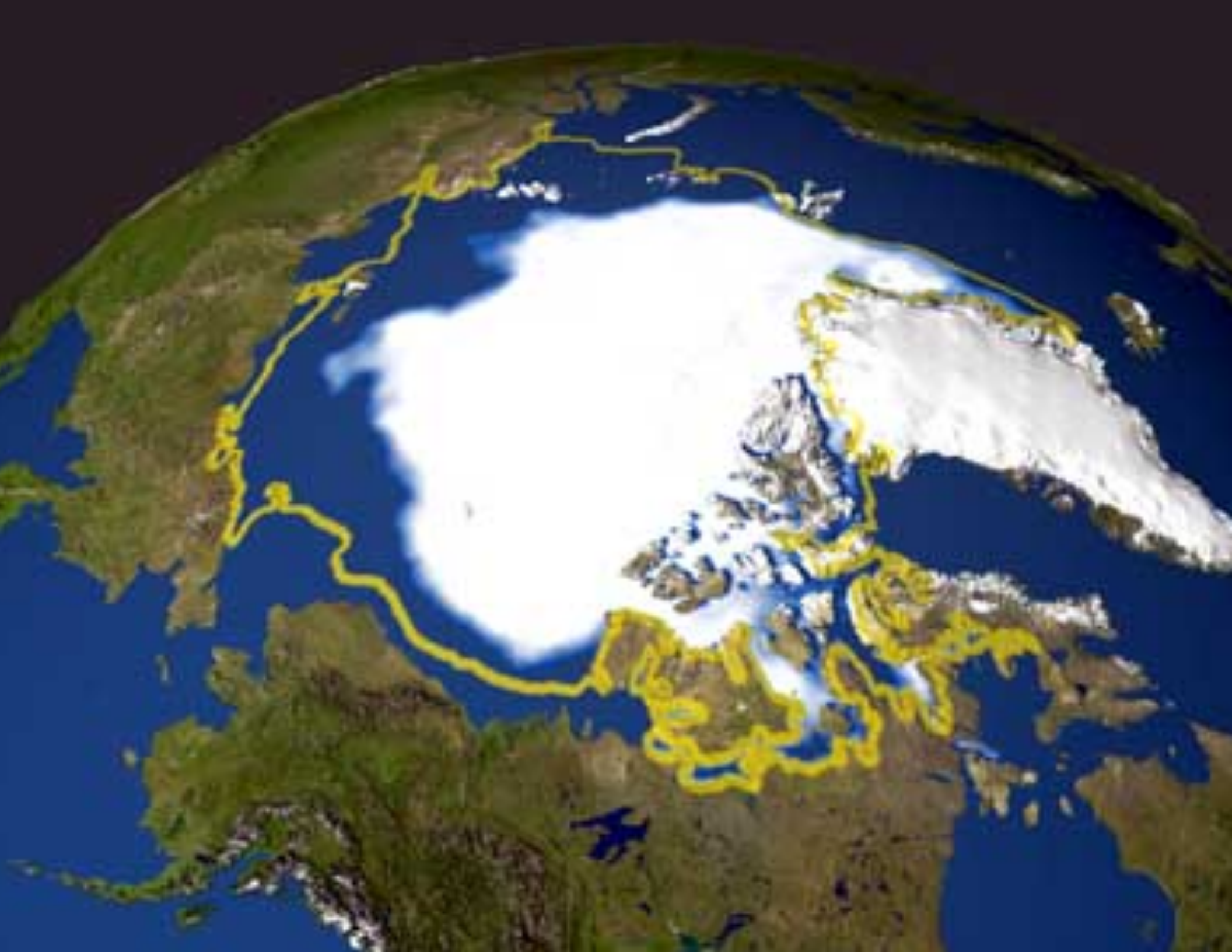
Frank Mitloehner, PhD
Professor & Air Quality Specialist
Dept Animal Science
University of California, Davis

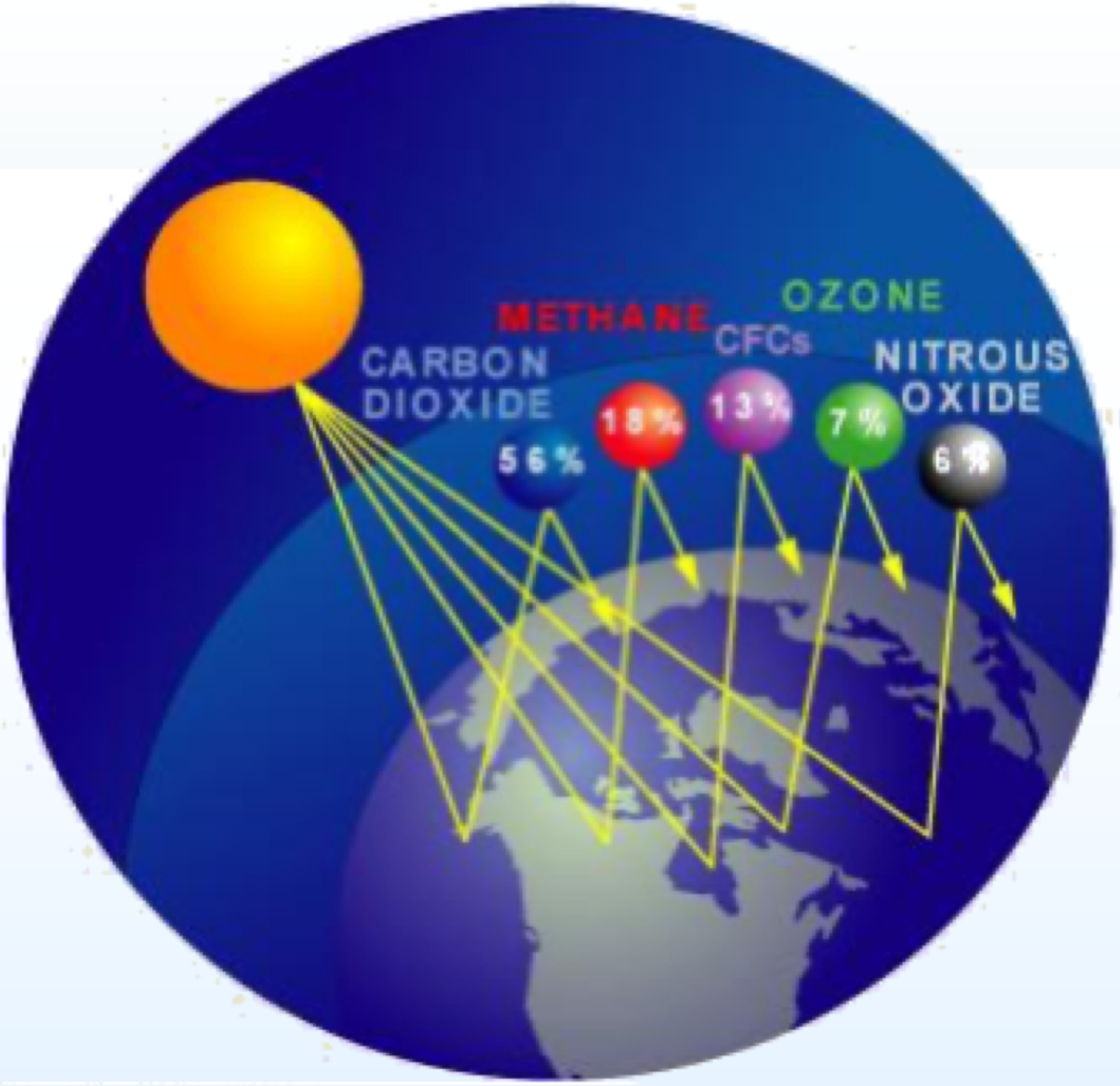
Follow me on Twitter



@GHGGuru

Climate change and GHG

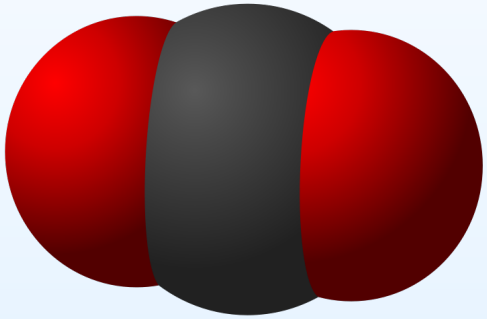



METHANE
OZONE
CFCs
CARBON DIOXIDE
NITROUS OXIDE
56%
18%
13%
7%
6%

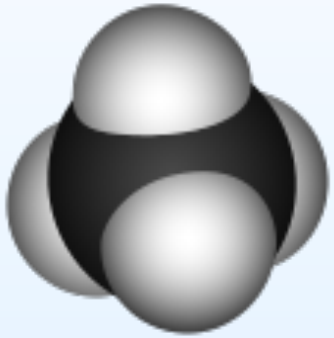
GHG & GWP

Global Warming Potential (GWP_{100}) of Main GHG

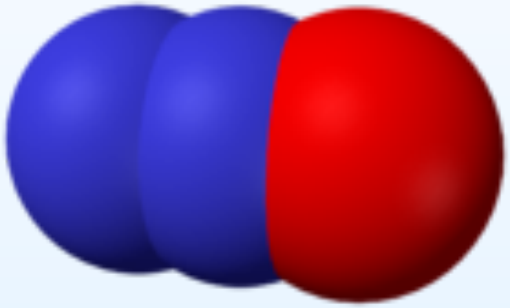
- Carbon Dioxide, CO_2 1
- Methane, CH_4 28
- Nitrous Oxide, N_2O 298



CO2 – Carbon Dioxide

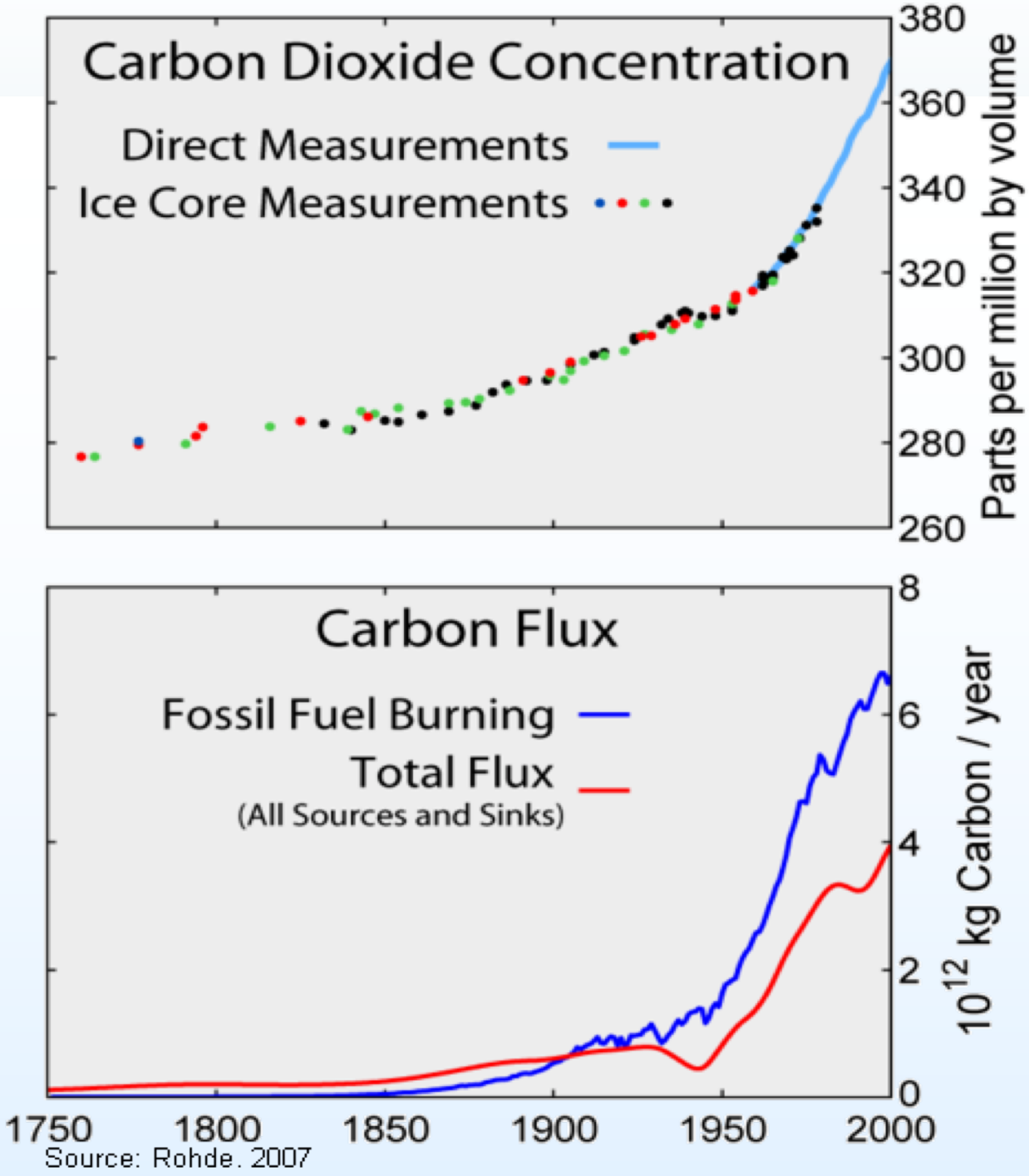


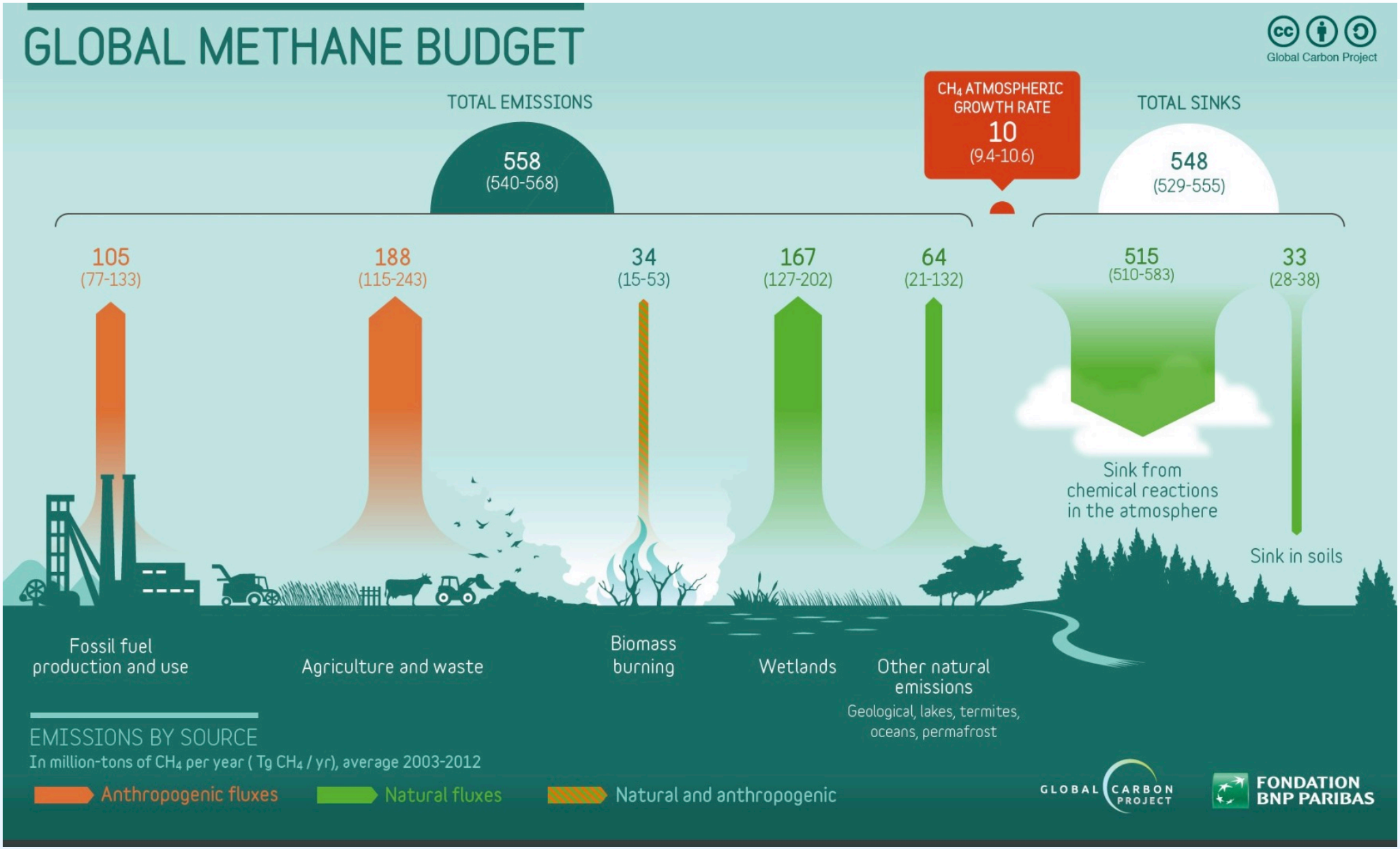
CH4 – Methane

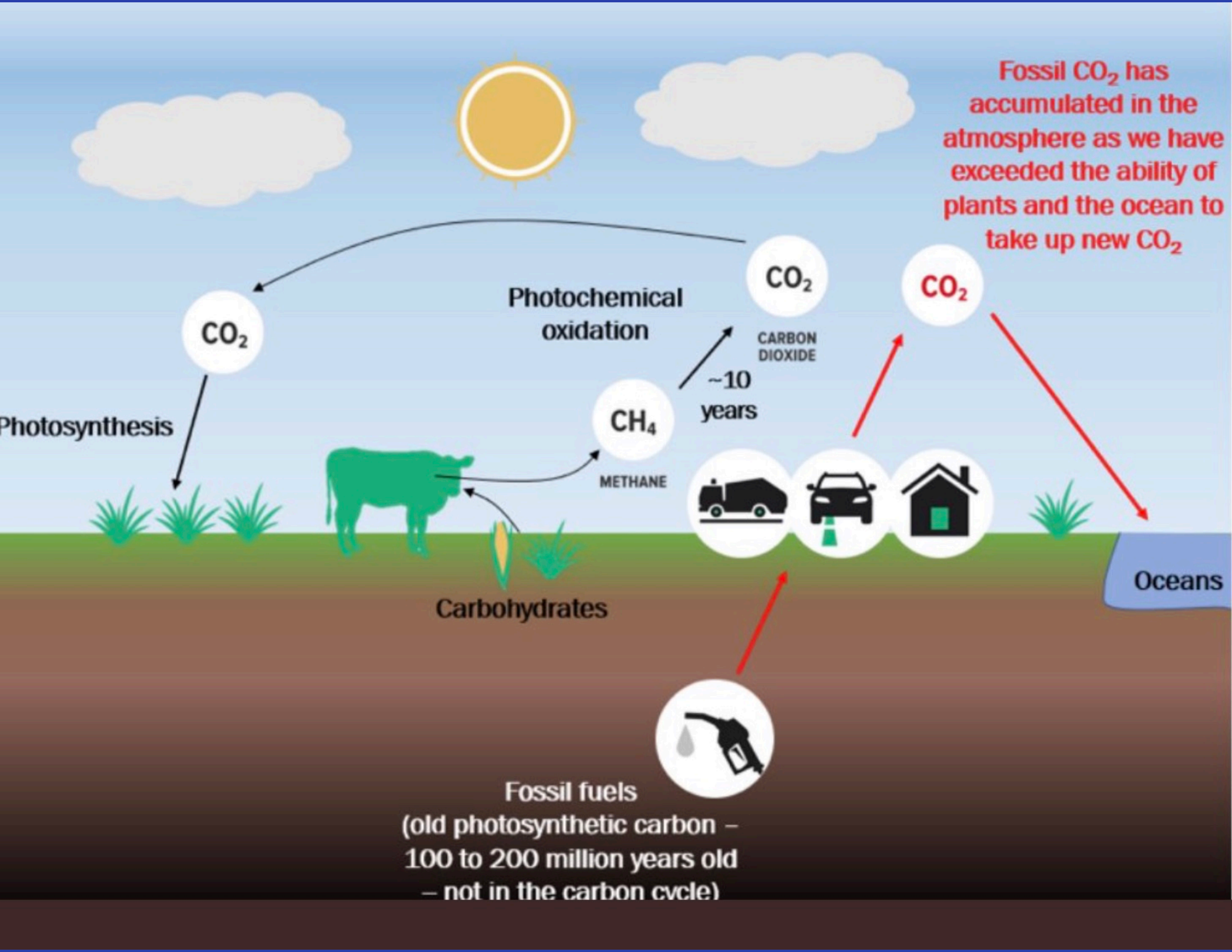


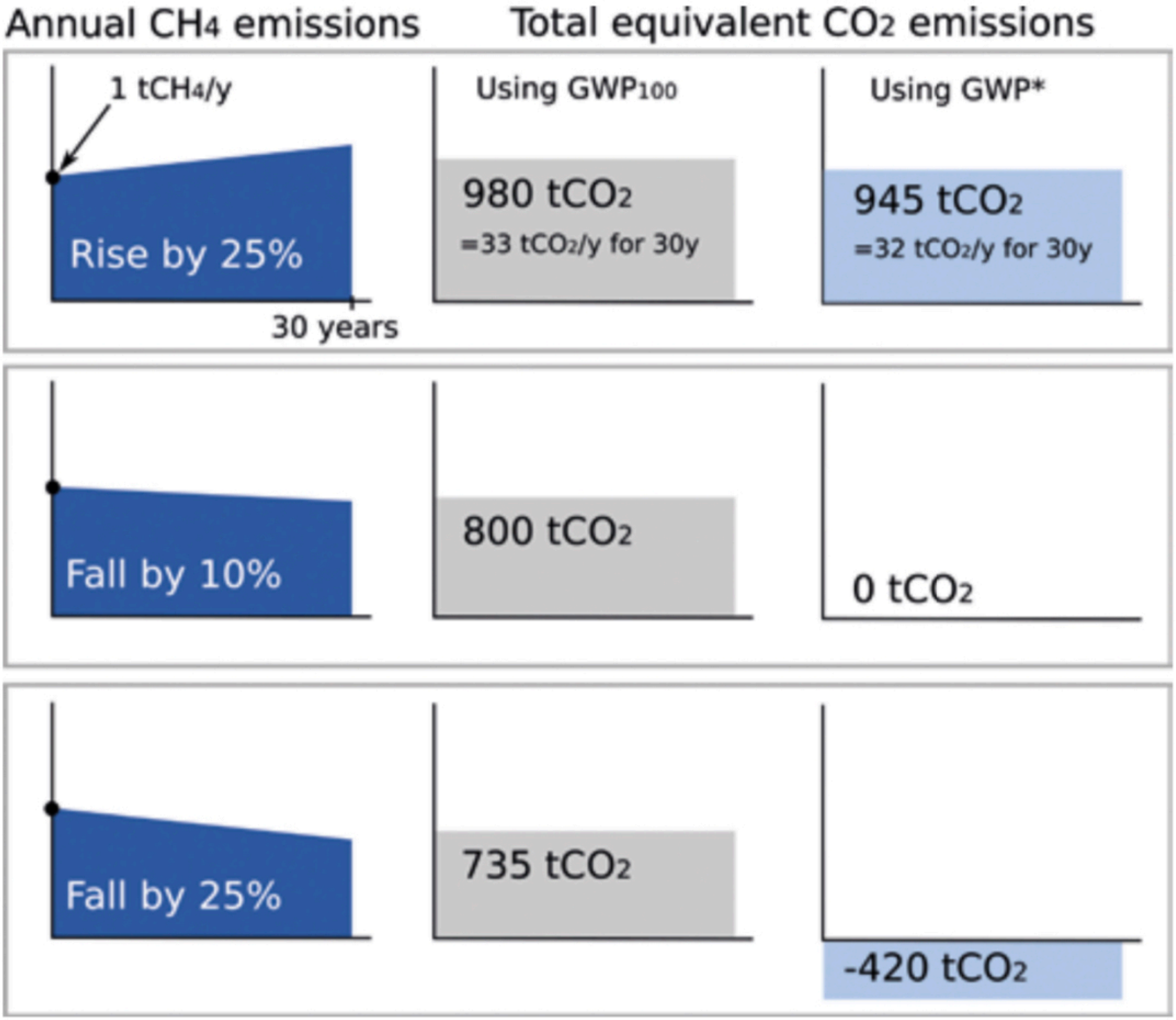
N2O – Nitrous Oxide

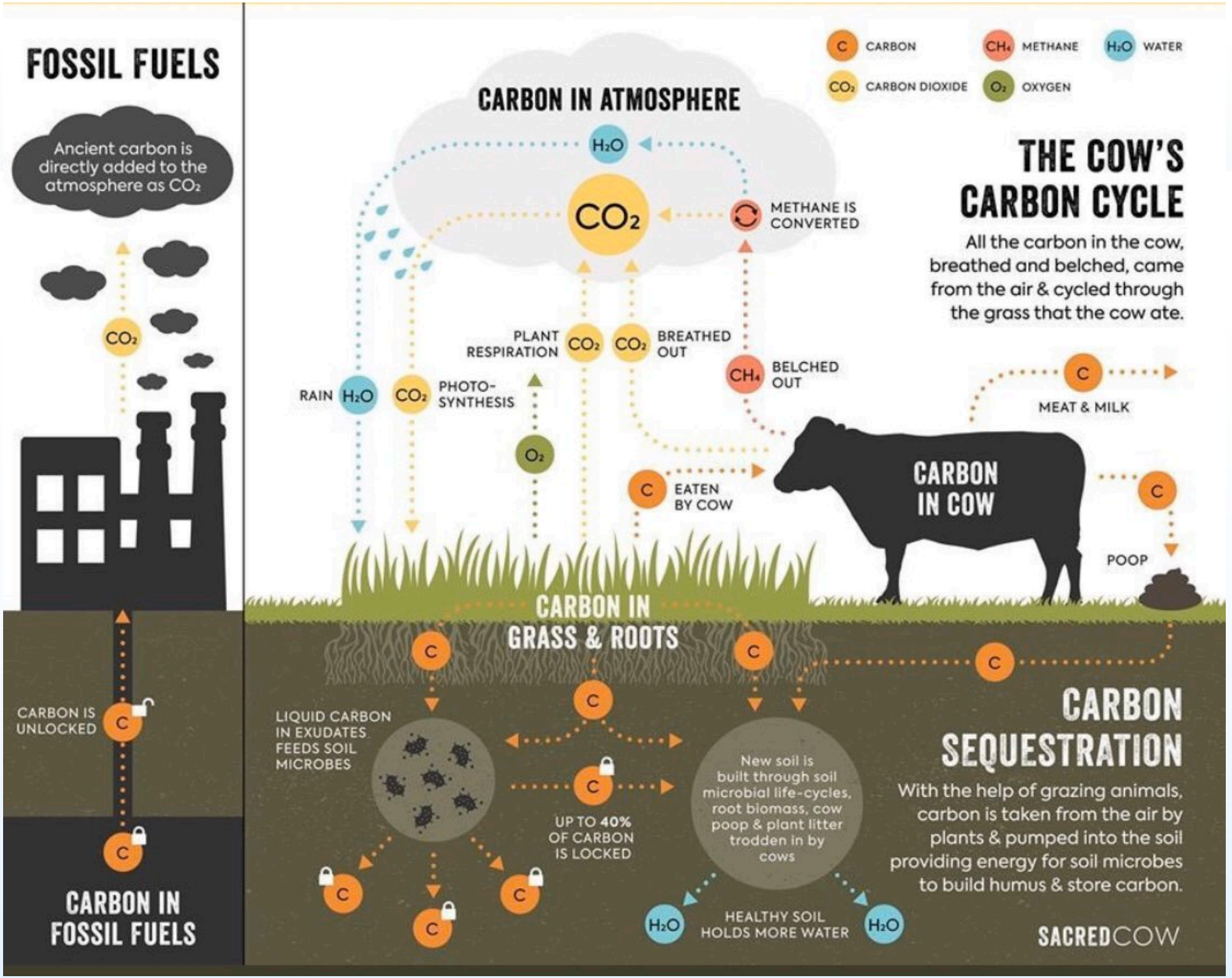
Carbon Dioxide and Carbon Flux



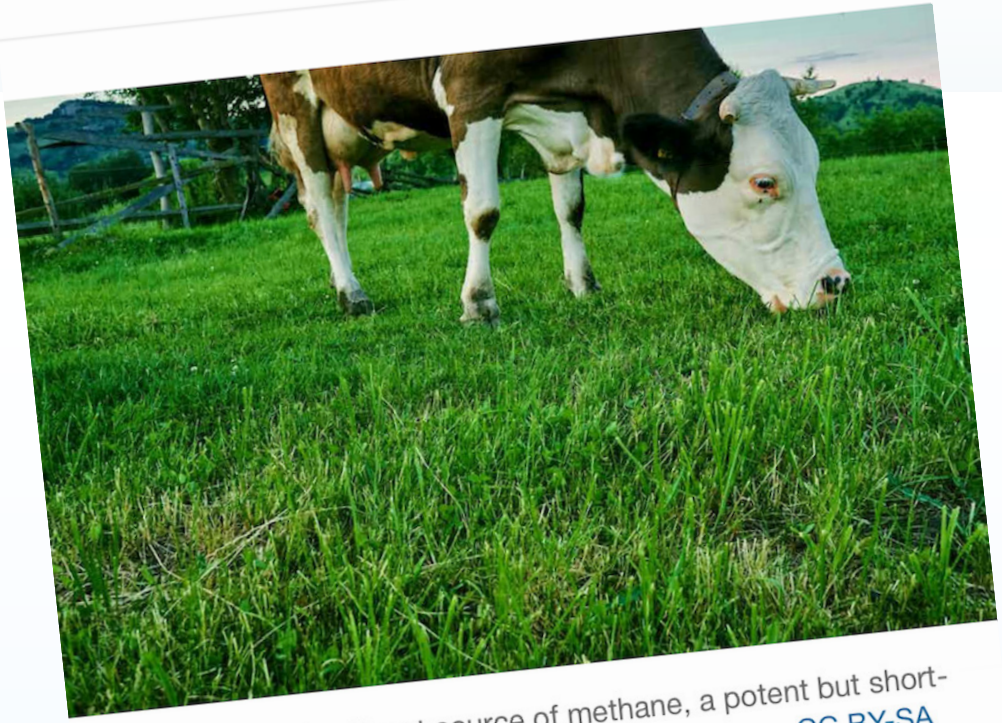

GLOBAL METHANE BUDGET
Global Carbon Project
TOTAL EMISSIONS
558
(540-568)
CH4 ATMOSPHERIC GROWTH RATE
10
(9.4-10.6)
TOTAL SINKS
548
(529-555)
105
(77-133)
188
(115-243)
34
(15-53)
167
(127-202)
64
(21-132)
515
(510-583)
33
(28-38)
Sink from chemical reactions in the atmosphere
Sink in soils
Fossil fuel production and use
Agriculture and waste
Biomass burning
Wetlands
Other natural emissions
Geological, lakes, termites, oceans, permafrost
EMISSIONS BY SOURCE
In million-tons of CH4 per year (Tg CH4 / yr), average 2003-2012
Anthropogenic fluxes
Natural fluxes
Natural and anthropogenic
GLOBAL CARBON PROJECT
FONDATION BNP PARIBAS


Fossil CO_2 has accumulated in the atmosphere as we have exceeded the ability of plants and the ocean to take up new CO_2
CO_2
Photochemical oxidation
CO_2
CARBON DIOXIDE
CO_2
Photosynthesis
~10 years
CH_4
METHANE
Oceans
Carbohydrates
Fossil fuels
(old photosynthetic carbon – 100 to 200 million years old – not in the carbon cycle)


Annual CH4 emissions
Total equivalent CO2 emissions
1 tCH4/y
Rise by 25%
30 years
Using GWP100
980 tCO2
=33 tCO2/y for 30y
Using GWP*
945 tCO2
=32 tCO2/y for 30y
Fall by 10%
800 tCO2
0 tCO2
Fall by 25%
735 tCO2
-420 tCO2


FOSSIL FUELS
Ancient carbon is directly added to the atmosphere as CO_2
CARBON IS UNLOCKED
CARBON IN FOSSIL FUELS
C CARBON
CH_4 METHANE
H_2O WATER
CO_2 CARBON DIOXIDE
O_2 OXYGEN
CARBON IN ATMOSPHERE
THE COW'S CARBON CYCLE
All the carbon in the cow, breathed and belched, came from the air & cycled through the grass that the cow ate.
METHANE IS CONVERTED
PLANT RESPIRATION
BREATHED OUT
BELCHED OUT
RAIN
PHOTO-SYNTHESIS
EATEN BY COW
MEAT & MILK
CARBON IN COW
POOP
CARBON IN GRASS & ROOTS
LIQUID CARBON IN EXUDATES FEEDS SOIL MICROBES
UP TO 40% OF CARBON IS LOCKED
New soil is built through soil microbial life-cycles, root biomass, cow poop & plant litter trodden in by cows
HEALTHY SOIL HOLDS MORE WATER
CARBON SEQUESTRATION
With the help of grazing animals, carbon is taken from the air by plants & pumped into the soil providing energy for soil microbes to build humus & store carbon.
SACREDCOW

THE CONVERSATION



Livestock is a significant source of methane, a potent but short-lived greenhouse gas. from www.shutterstock.com, CC BY-SA

Why methane should be treated differently compared to long-lived greenhouse gases

CarbonBrief
CLEAR ON CLIMATE

Cattle round-up before shipping on a West Texas ranch. Credit: Luc Novovitch / Alamy Stock Photo.

GUEST POSTS 7 June 2018 10:08

Guest post: A new way to assess 'global warming potential' of short-lived pollutants

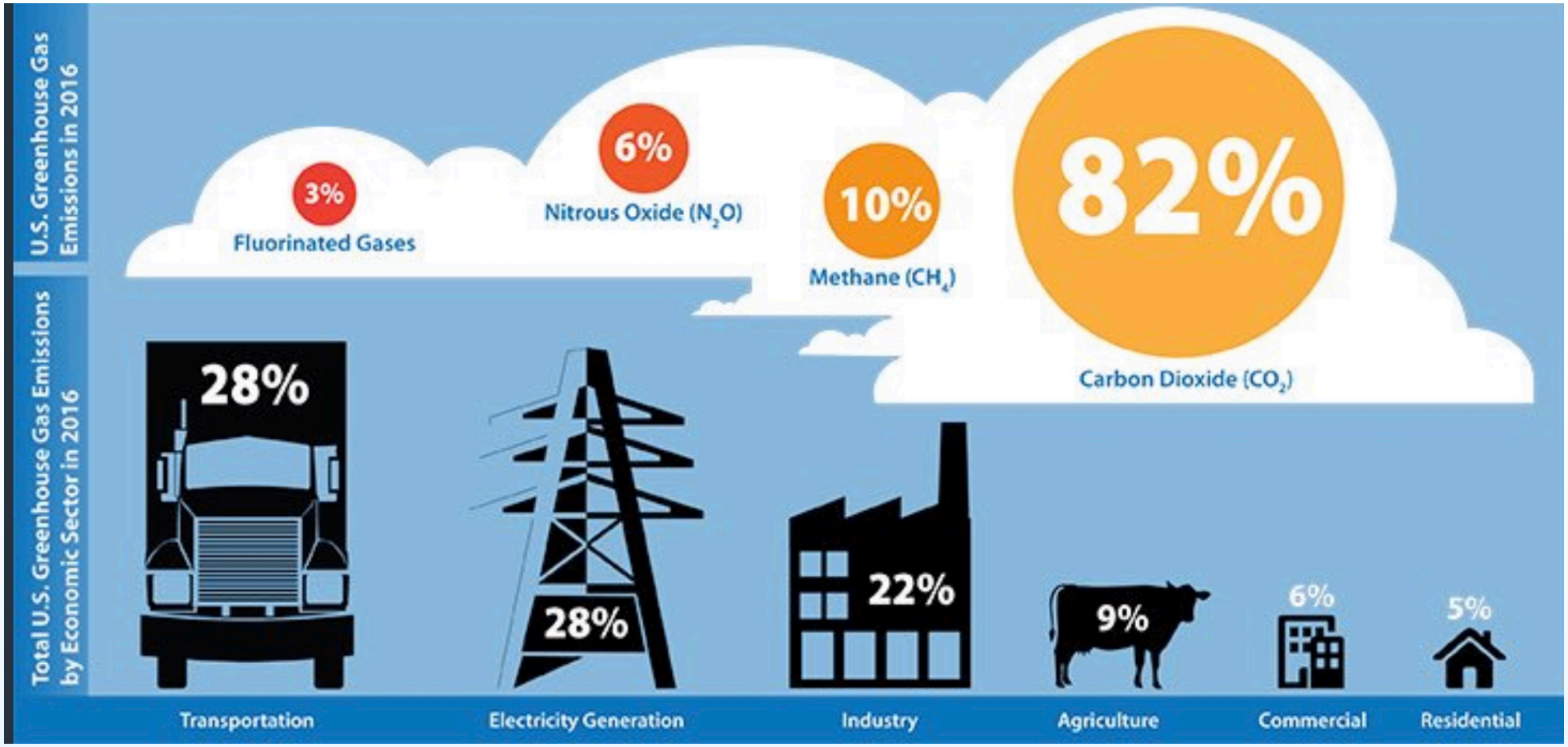
CB DR MICHELLE CAIN
06.07.18

GUEST POSTS Guest post: A new way to assess 'global warming potential' of short-lived pollutants

Dr Michelle Cain in a science and policy research associate on the Oxford Martin School's

Progress to Date

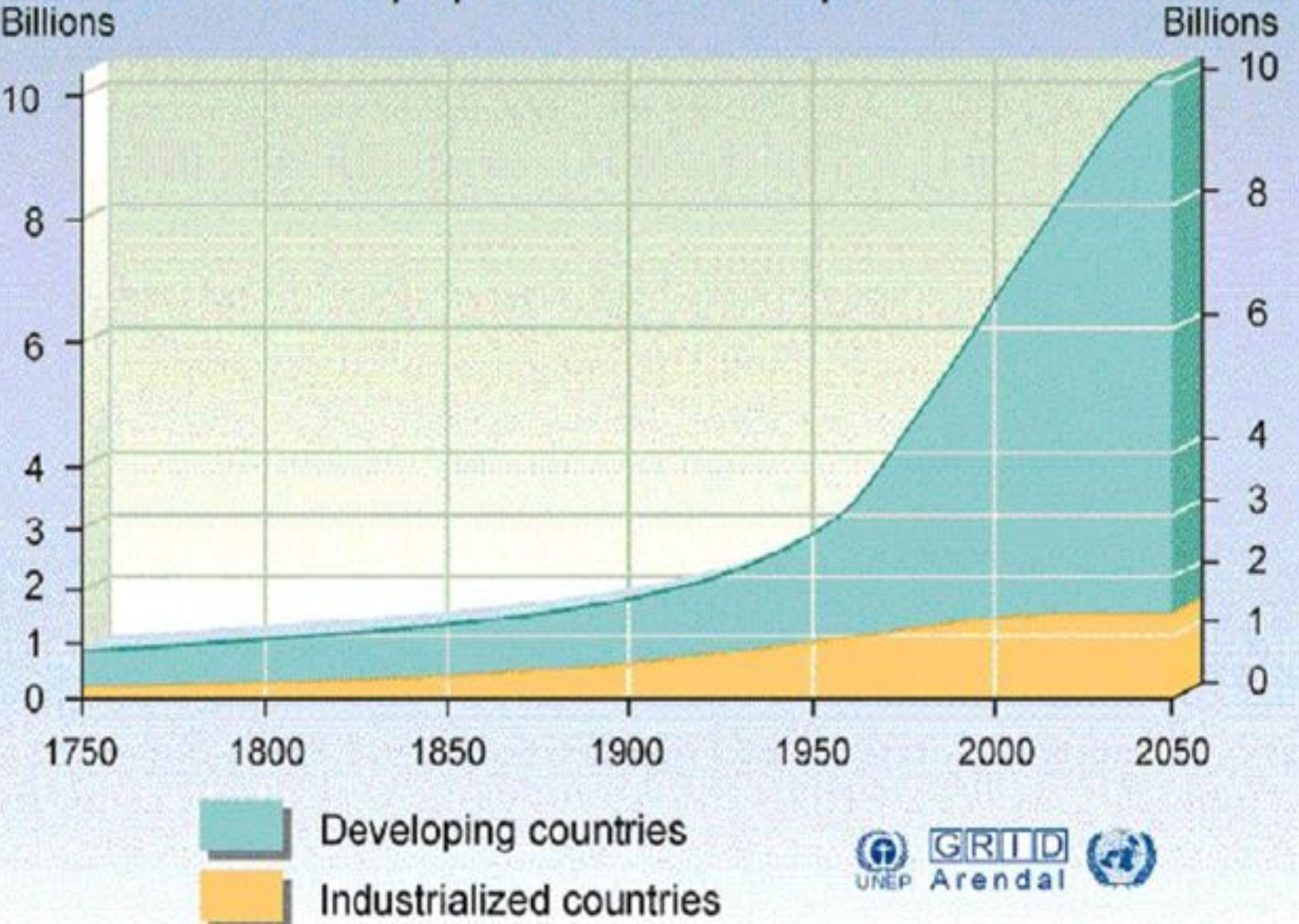
National-Level U.S. GHG Inventory



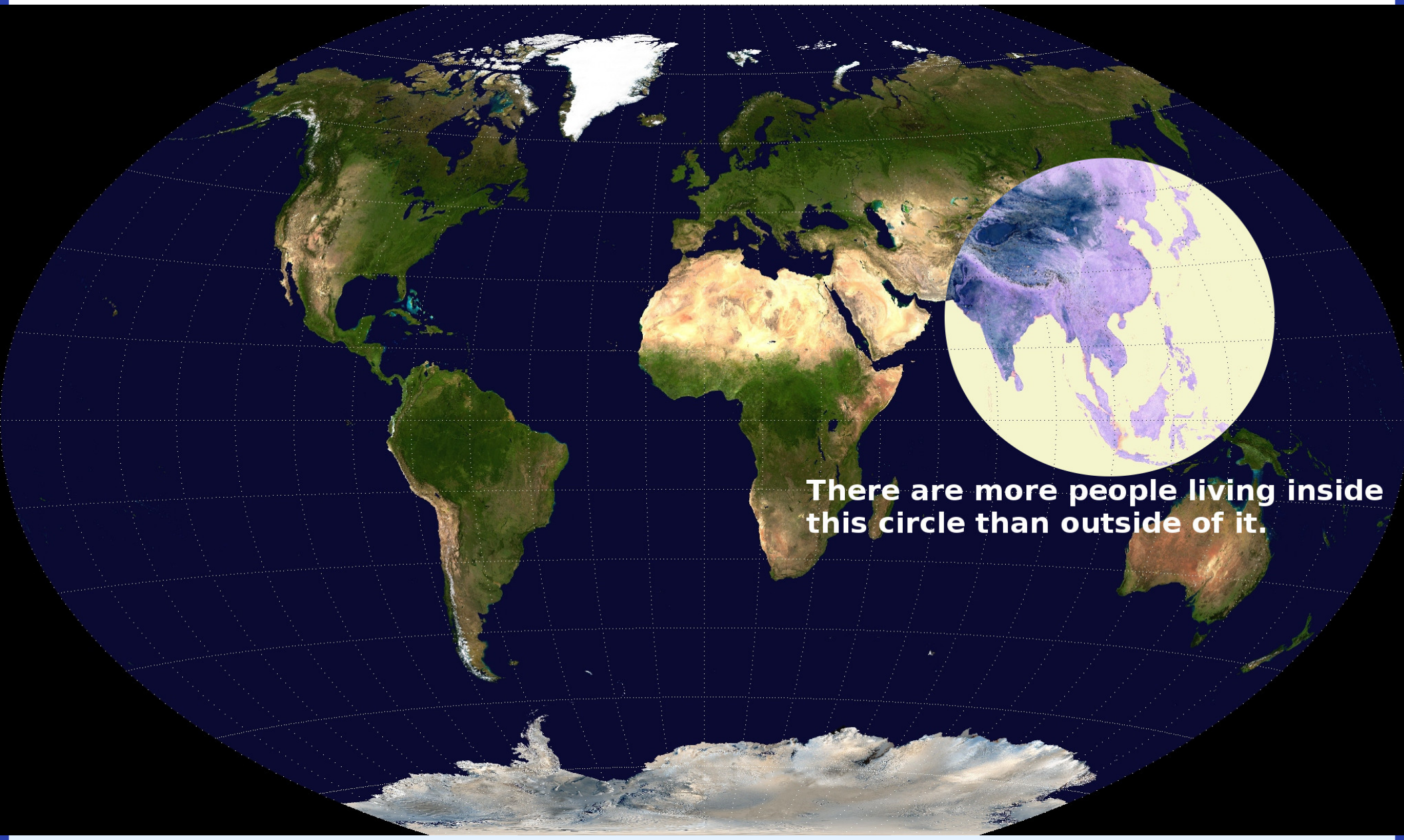
Source: EPA (2017)

The 2050 Challenge

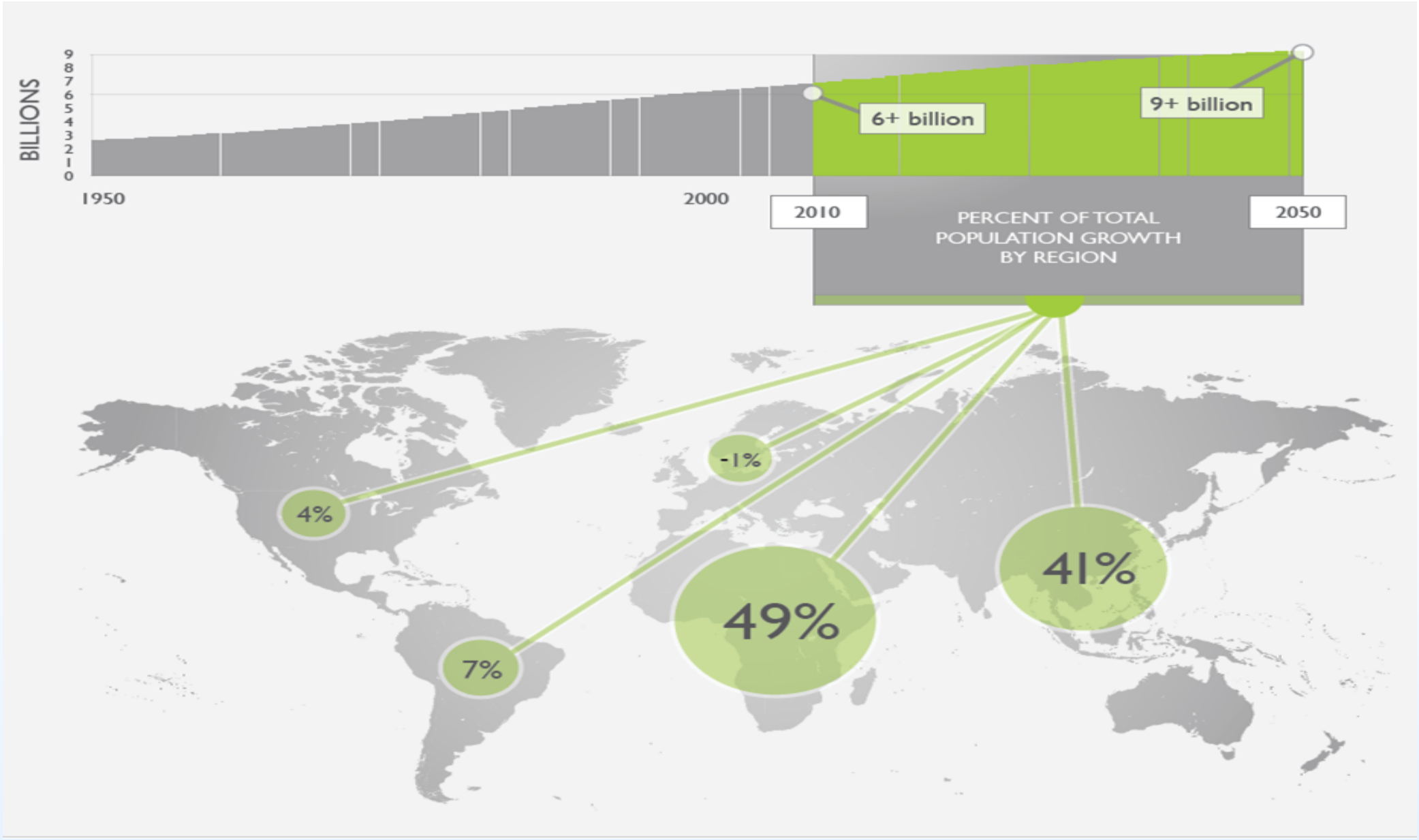
World population development

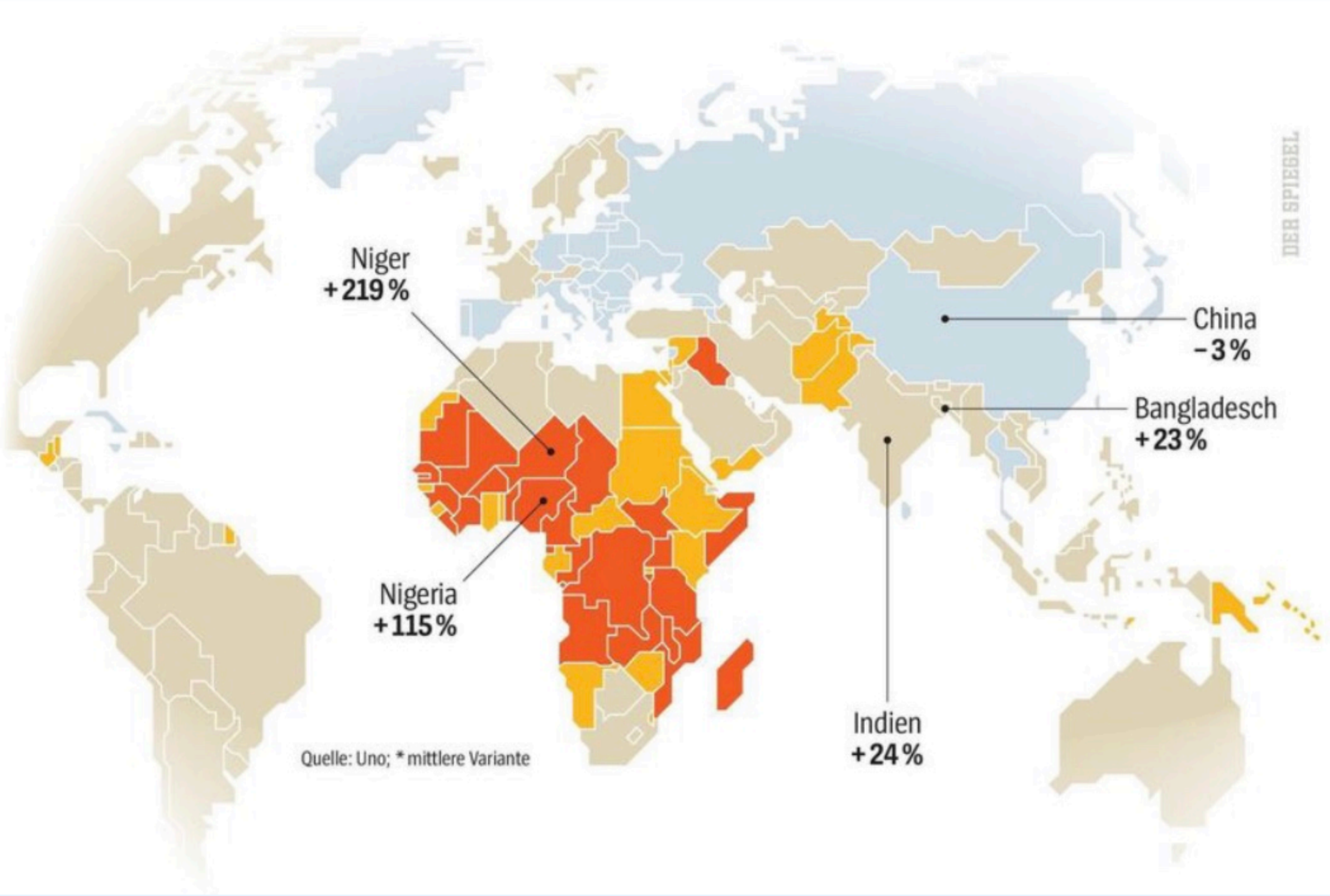


4.5 Billion + population of USA in 10 years

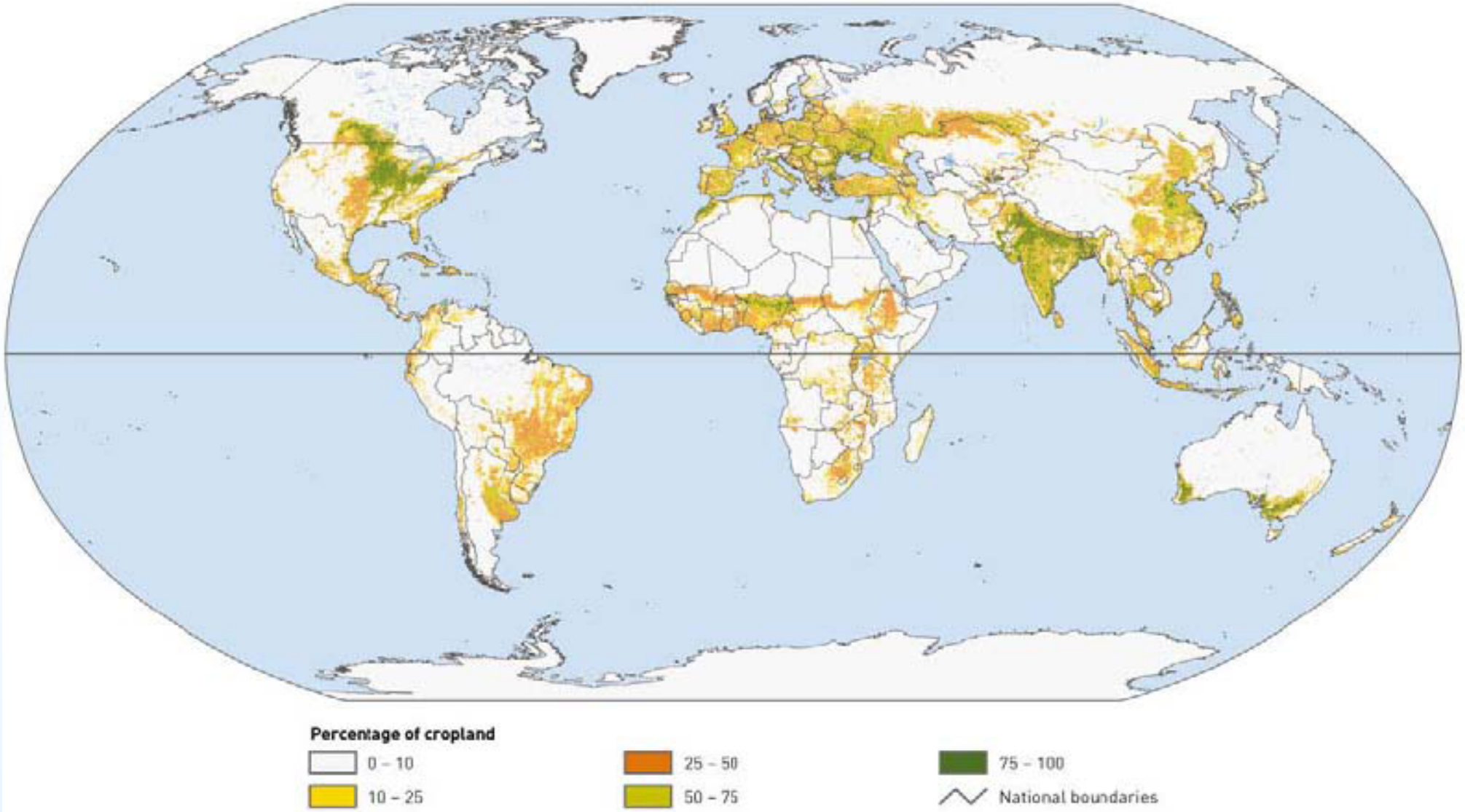


Today and Tomorrow's Markets




Niger
+219 %
China
–3 %
Bangladesch
+23 %
Nigeria
+115 %
Indien
+24 %
Quelle: Uno; * mittlere Variante
DER SPIEGEL

Global cropland



Source: FAO, 2006f.

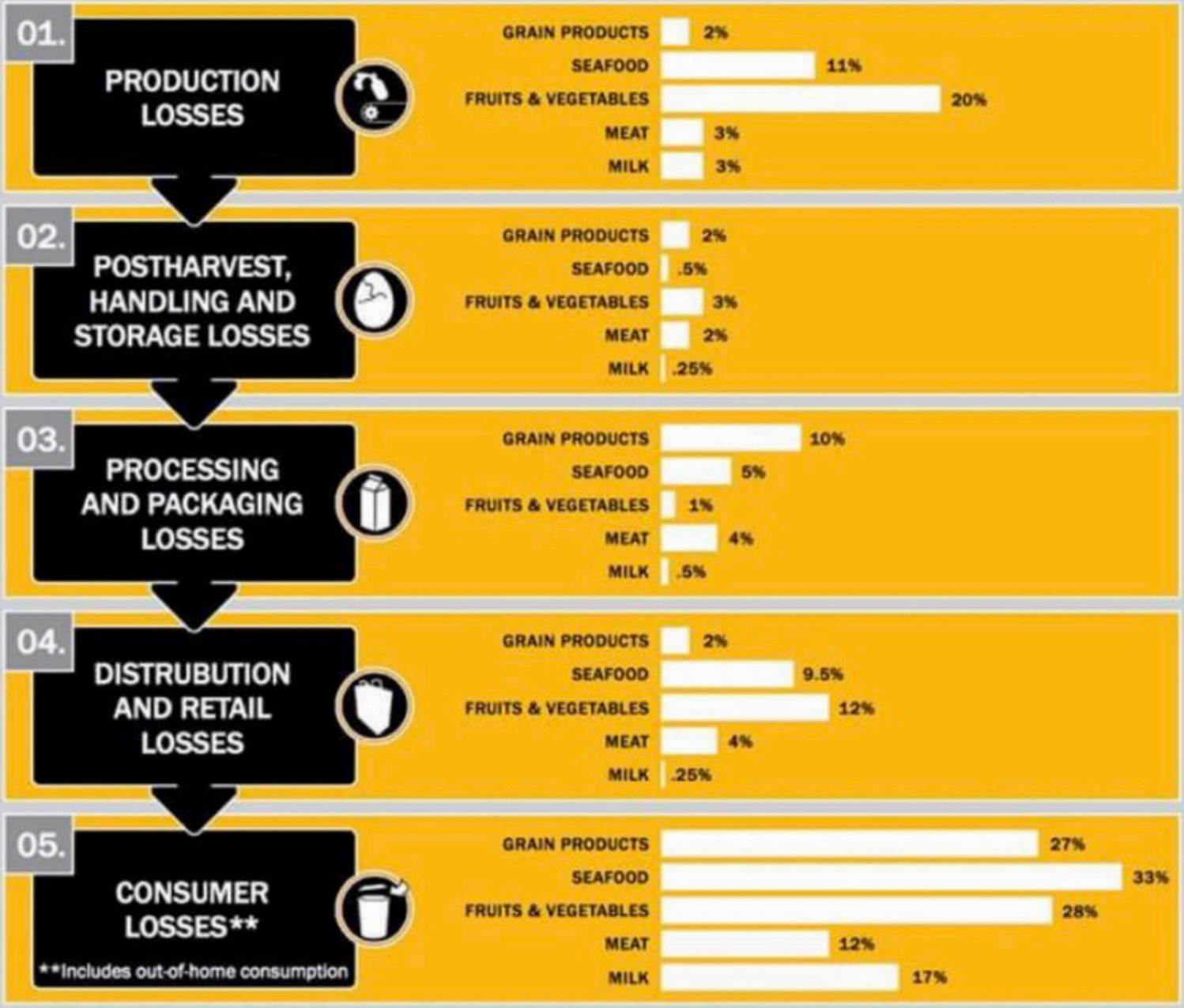
FAO (2006)

Turning Challenges into Solutions

National Geograpic

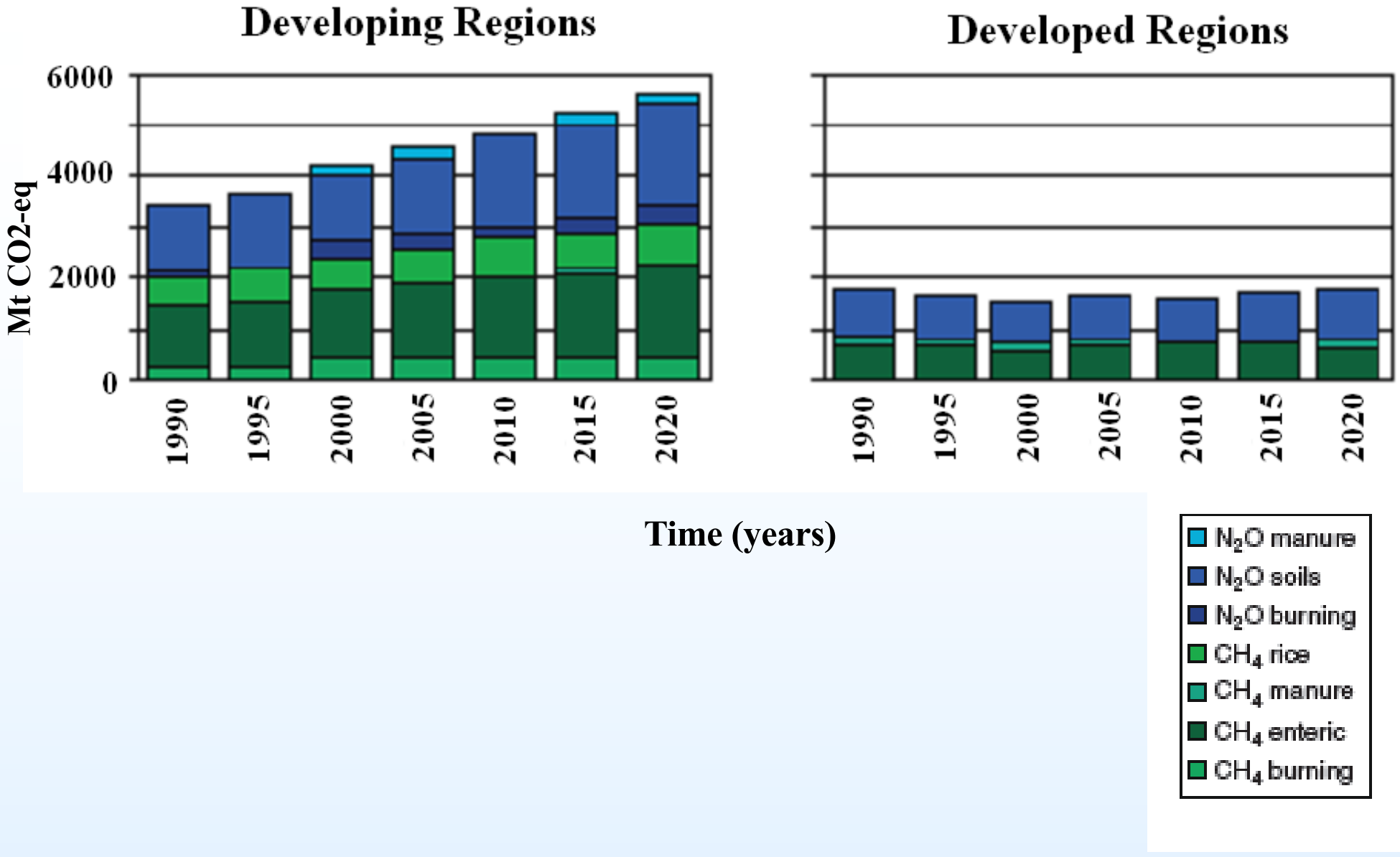
NORTH AMERICAN* FOOD LOSSES AT EACH STEP IN THE SUPPLY CHAIN

*Percentages calculated collectively for USA, Canada, Australia, and New Zealand.



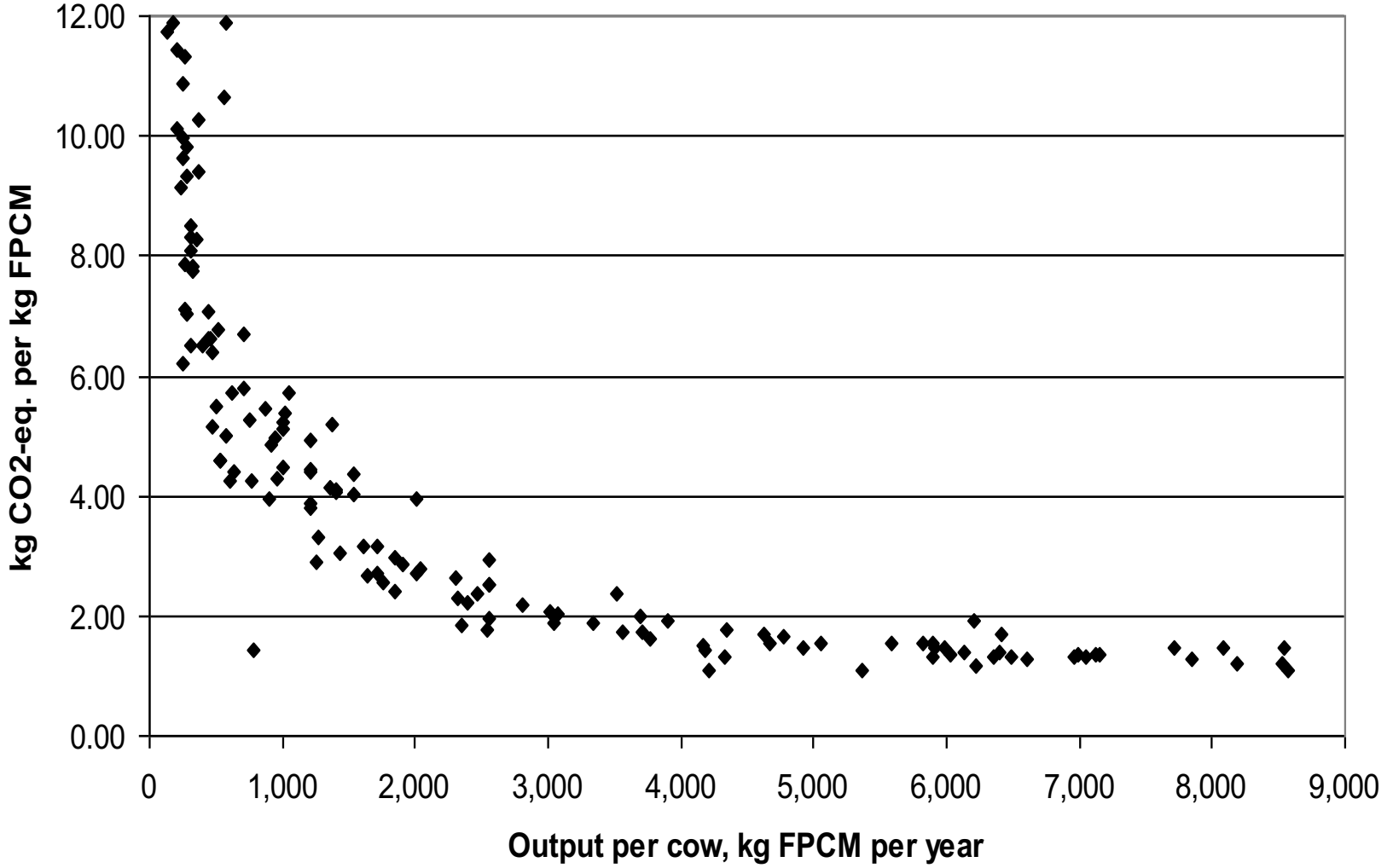
Source: Food and Agriculture Organization 2011

GHG in Developing- and Developed Regions

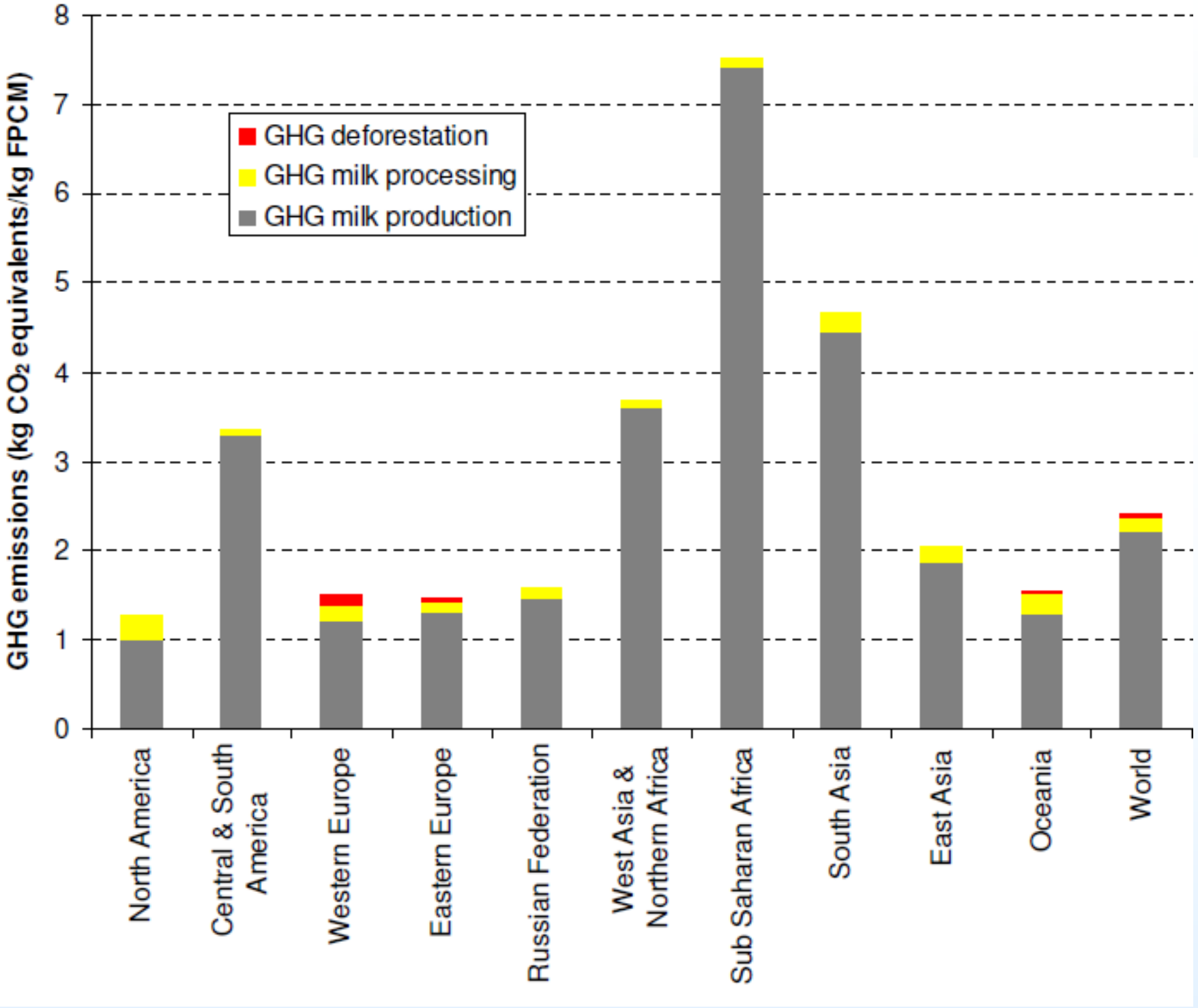


FAO (2006)

Relationship between total greenhouse gas emissions and milk output per cow

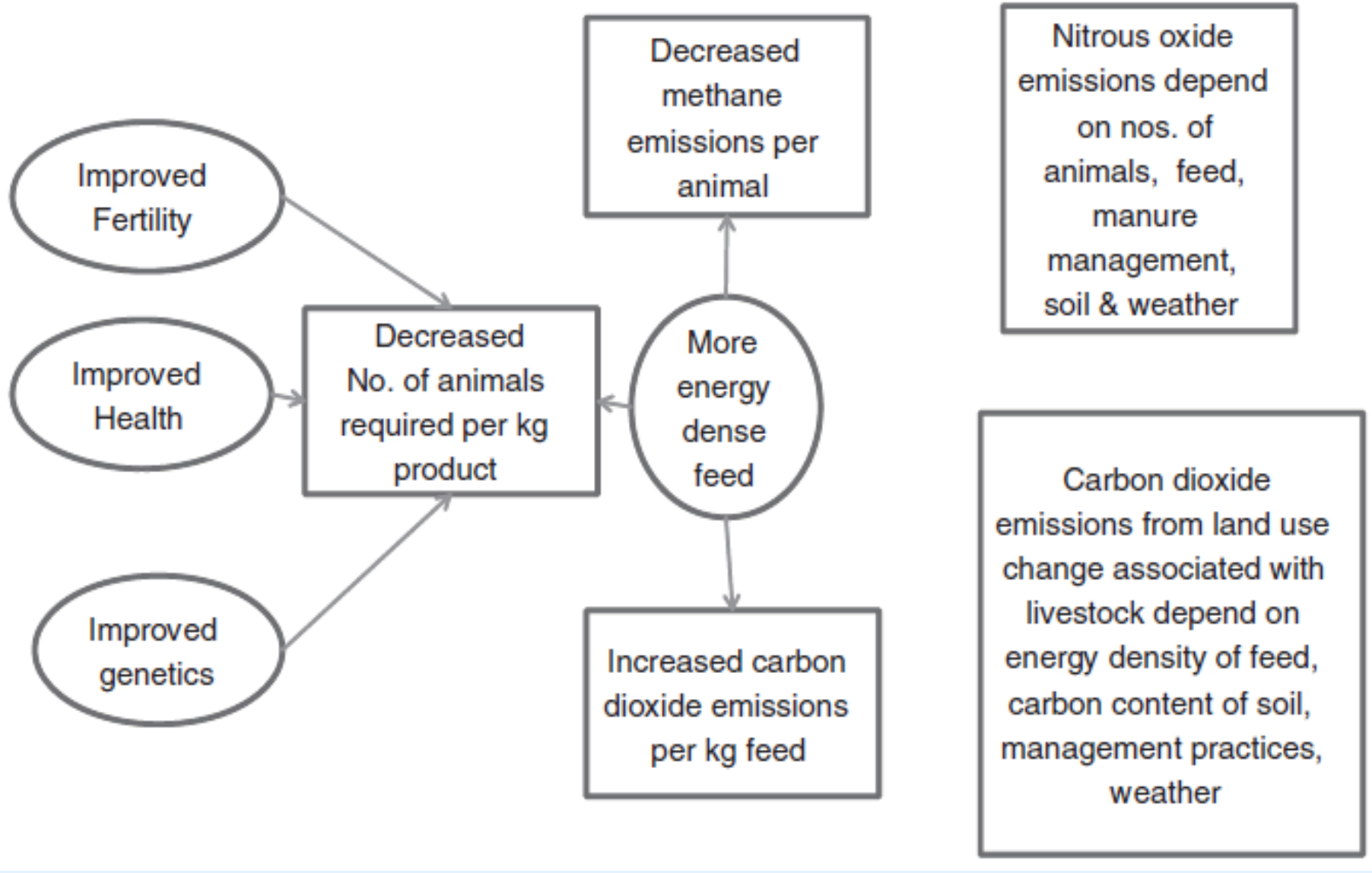


H. Steinfeld, 2015


GHG emissions (kg CO_2 equivalents/kg FPCM)
0
1
2
3
4
5
6
7
8
GHG deforestation
GHG milk processing
GHG milk production
North America
Central & South America
Western Europe
Eastern Europe
Russian Federation
West Asia & Northern Africa
Sub Saharan Africa
South Asia
East Asia
Oceania
World

FAO (2010)

Mitigation: interventions to improve productivity

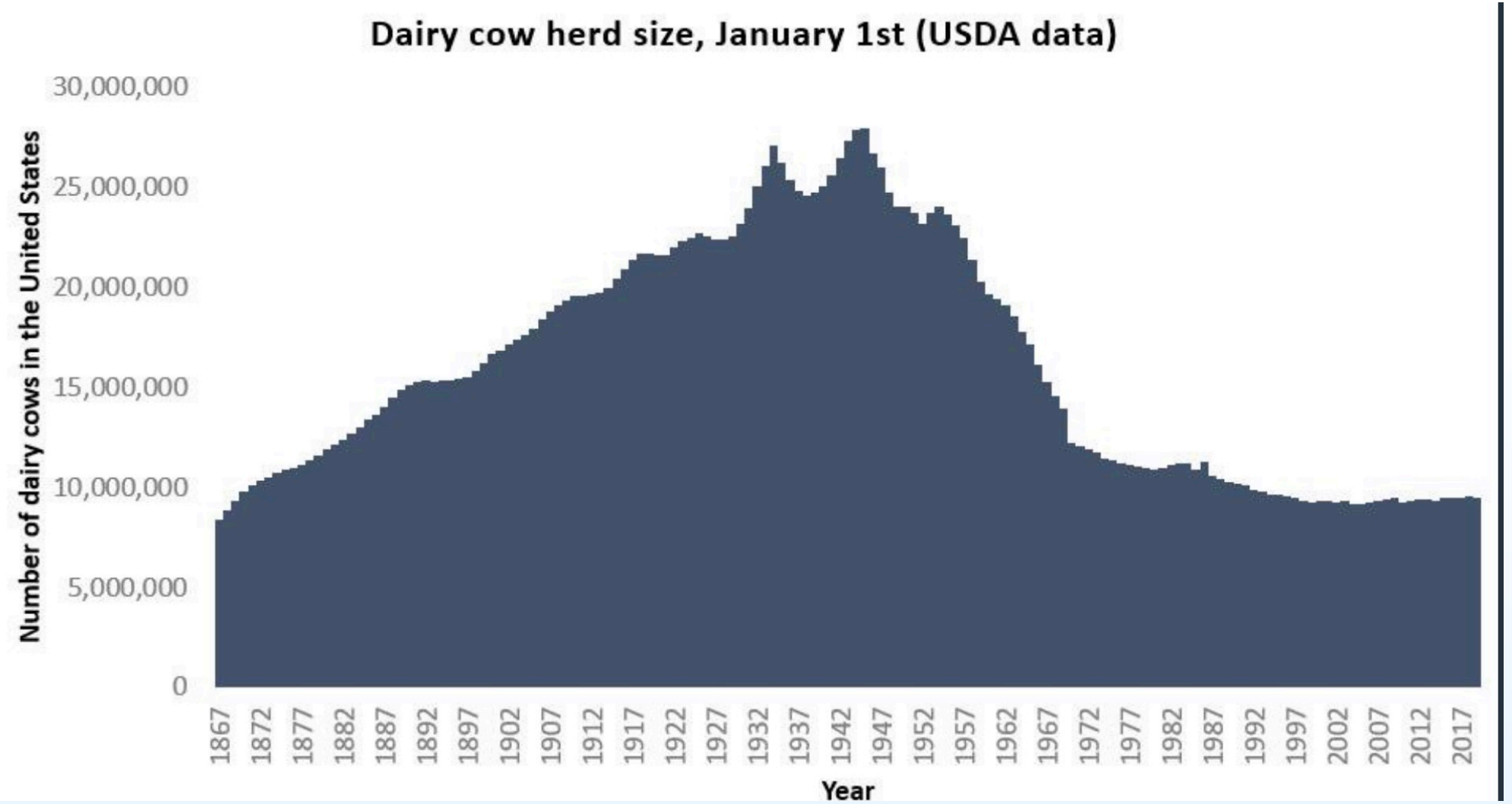


Gill et al. (2010)

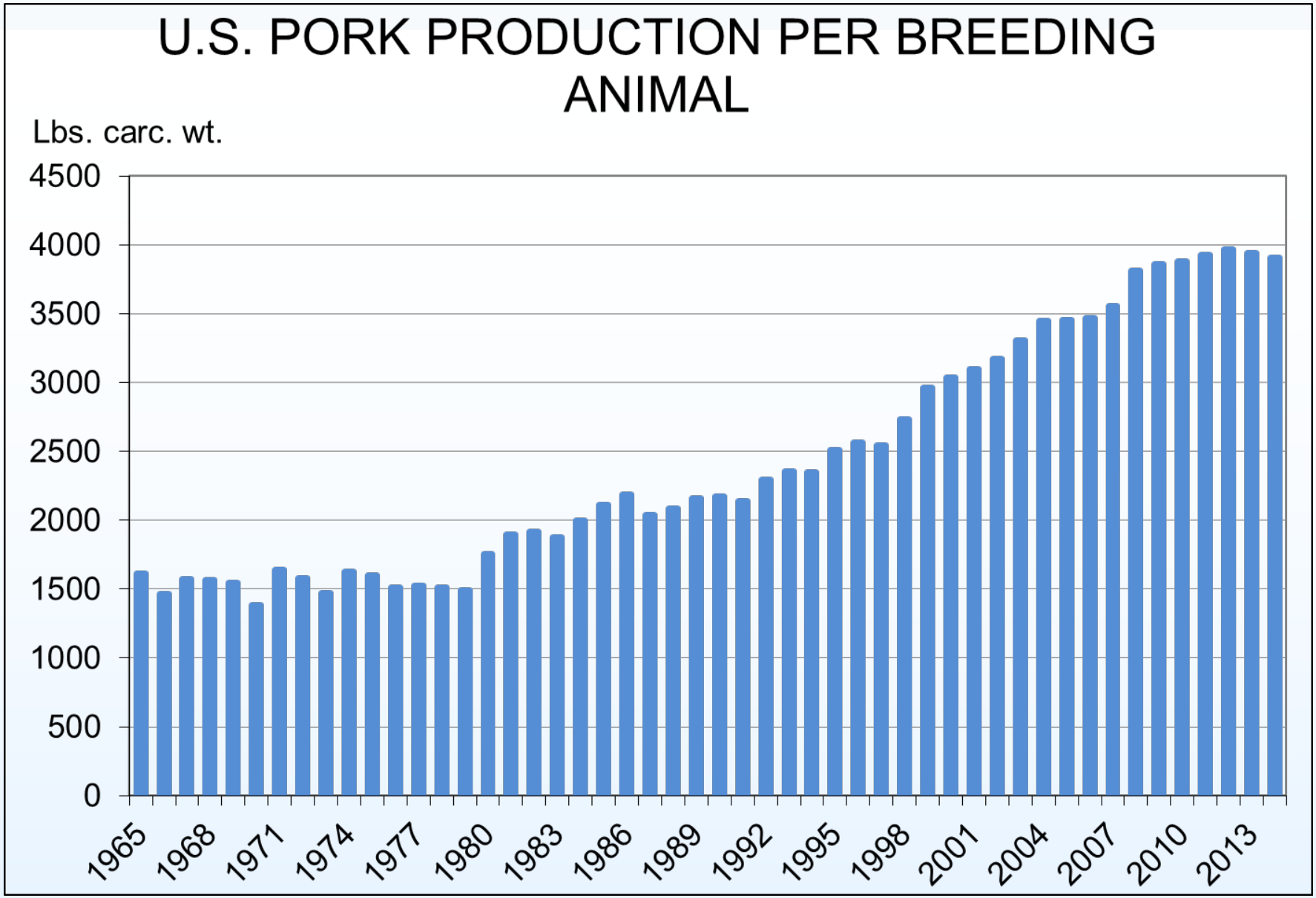
US Dairy trends

- In 1950, there were 25 million dairy cows in the US, vs 9 million today
- With 16 million fewer cows (1950 vs 2018), milk production nationally has increased 60 percent
- The carbon footprint of a glass of milk is 2/3 smaller today than it was 70 years ago

US Dairy Herd from 1867 - 2019

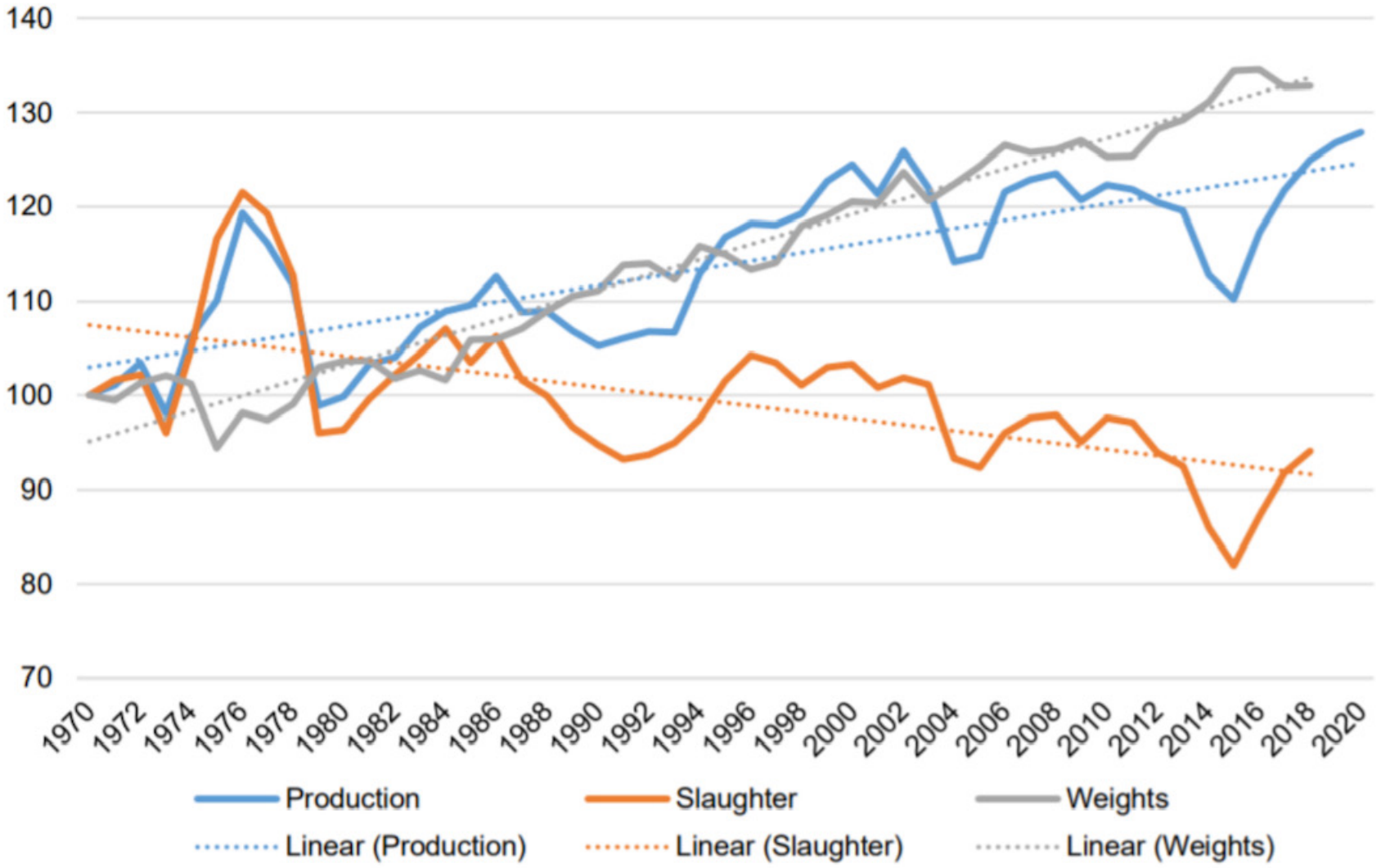


US Pork Trends



For over 50 years, cattle weights have propelled beef production as cattle slaughter decreased

Index 1970=100

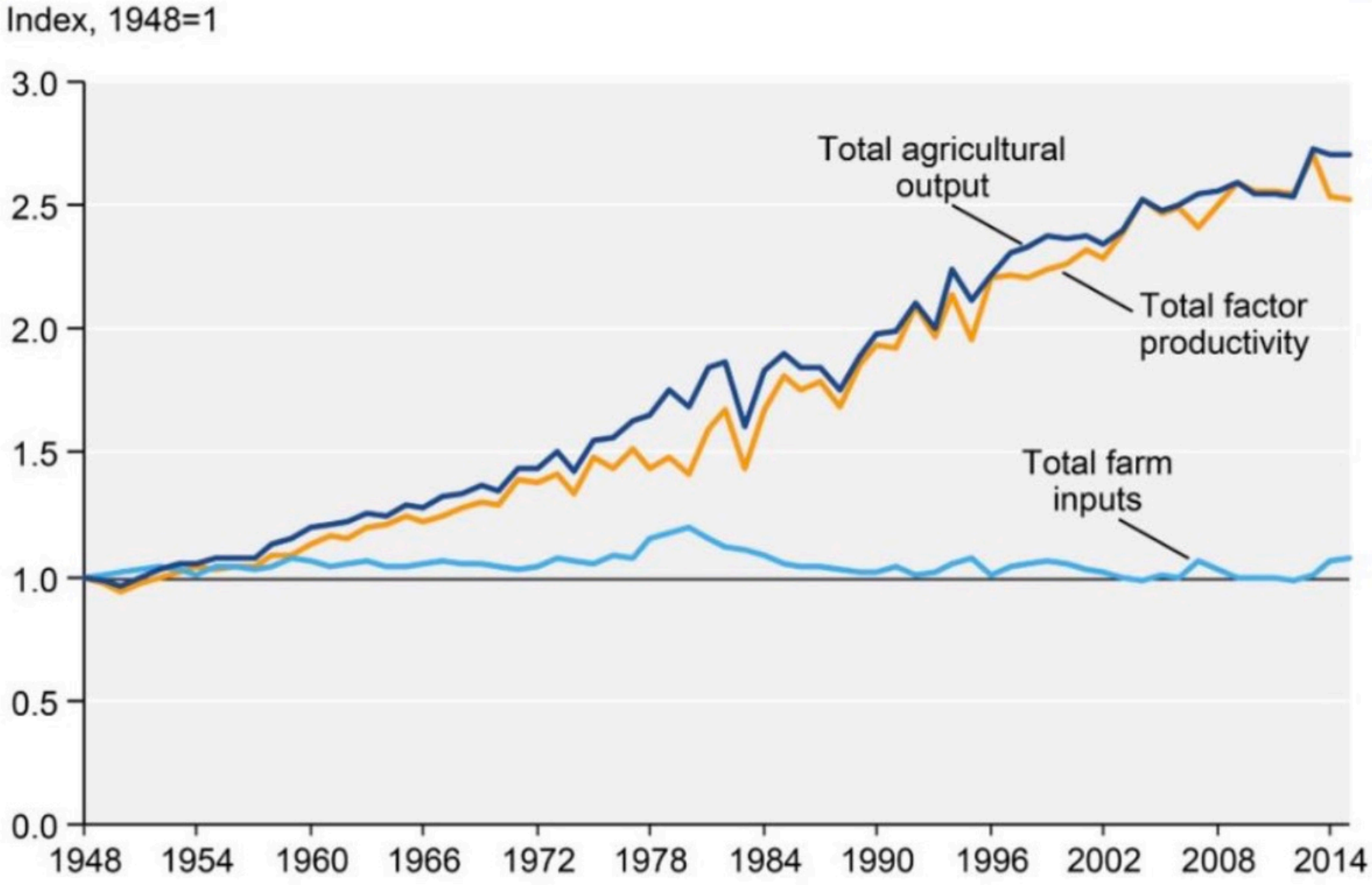


Source: Calculations by USDA, Economic Research Service based on data from USDA, National Agricultural Statistics Service.

China Swine Example

- China’s five year plan focuses on making farms larger and more efficient
- Half of the world’s pigs live in China
- Annual production of 1 Billion pigs
- Pre-weaning mortality causes 400 Million pigs to never make it to the market

U.S. agricultural output, inputs, and total factor productivity, 1948-2015



Source: USDA, Economic Research Service, *Agricultural Productivity in the U.S.* series; data as of October 2017.

Can we eat our way out of climate change?

- Omnivore to vegan (per yr) = 0.8 tons CO2e (Wynes & Nicholas, 2017)
- One trans-atlantic flight (per passenger) = 1.6 tons CO2e (Wynes & Nicholas, 2017)
- Meatless Monday (US) = 0.3% GHG reduction (Hall & White, 2017)
- Vegan US = 2.6% (Hall & White, 2017)


THE · UNIVERSITY · OF · CALIFORNIA ·
A
LET THERE BE
LIGHT
1868