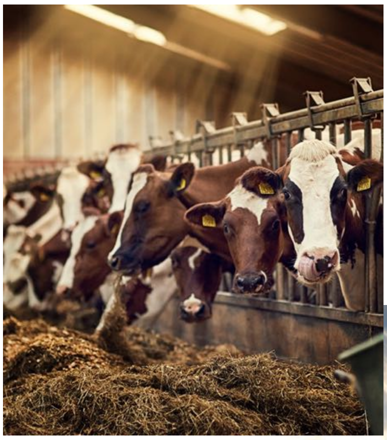


Der Weg zur Klimaneutralität in der Milch- und Rindfleischproduktion

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Professor & Air Quality Specialist
Department of Animal Science
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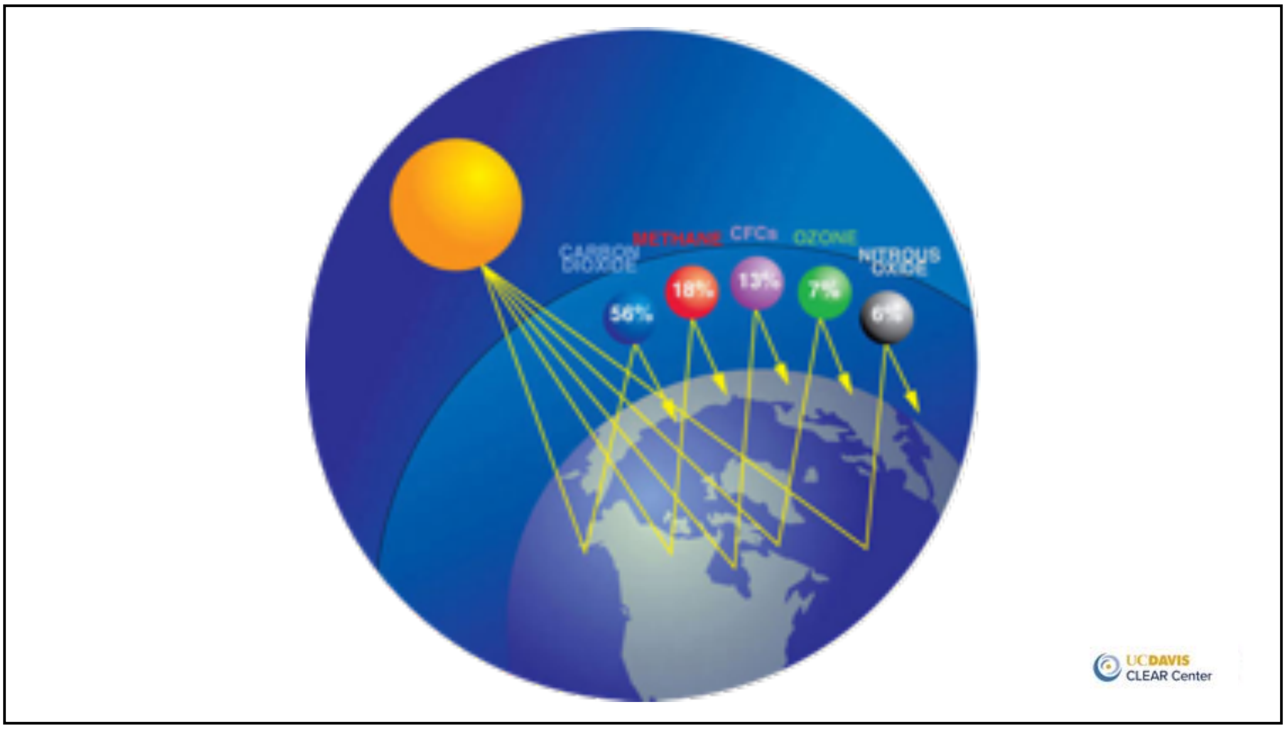
CARBON DIOXIDE
METHANE
CFCs
OZONE
NITROUS OXIDE
56%
18%
13%
7%
6%
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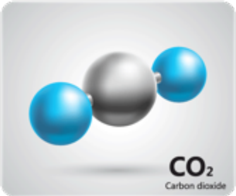
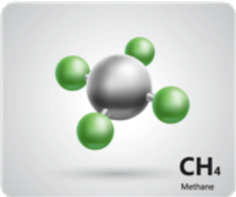
4





Global Warming Potential (GWP_{100}) of Main Greenhouse Gases

Carbon Dioxide (CO_2)	1
Methane (CH_4)	28
Nitrous Oxide (N_2O)	265

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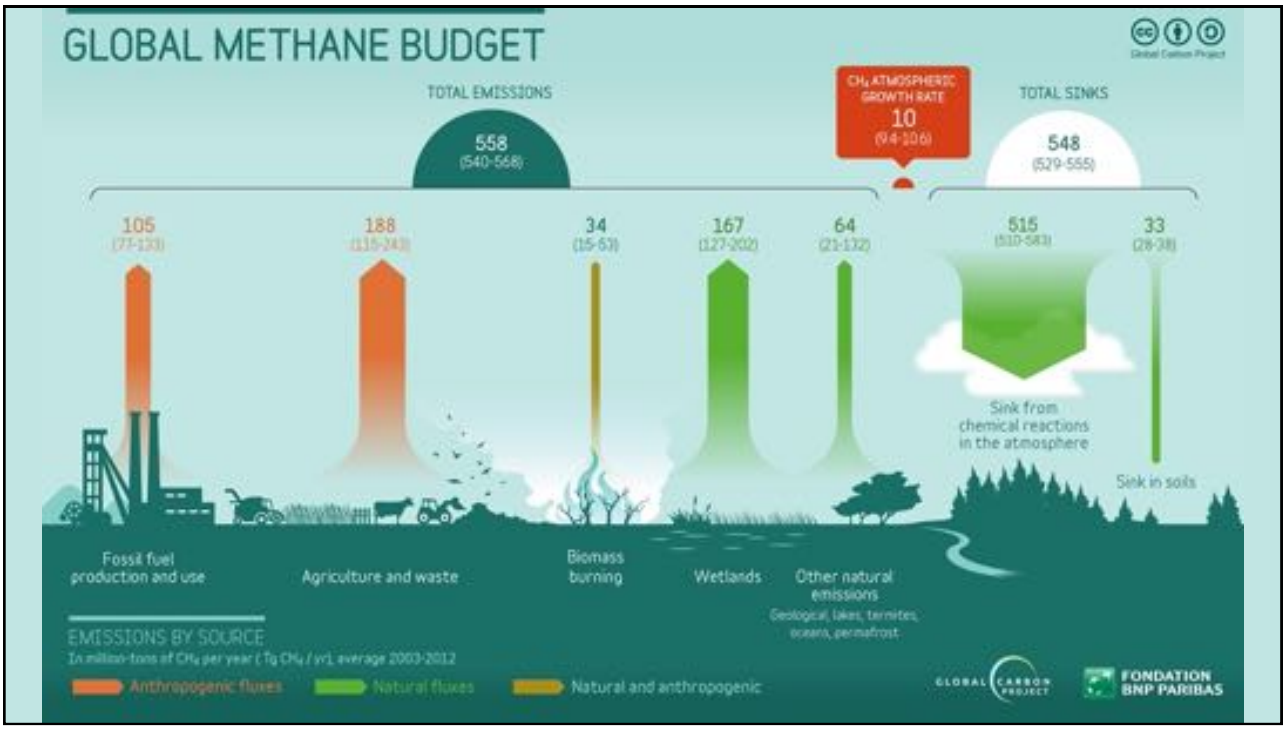

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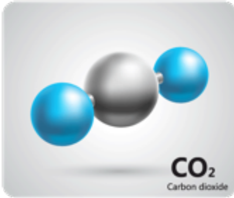
Half-Life of Main Greenhouse Gases in Years

Carbon Dioxide (CO_2)	1,000
Methane (CH_4)	10
Nitrous Oxide (N_2O)	110



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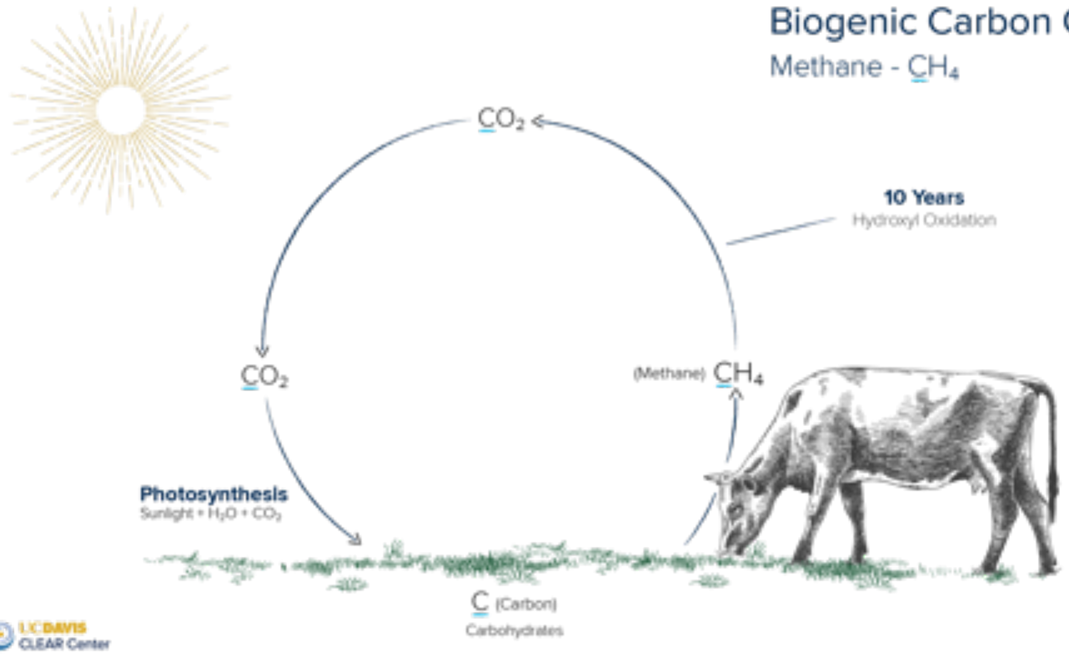
Biogenic Carbon Cycle

Methane - CH_4



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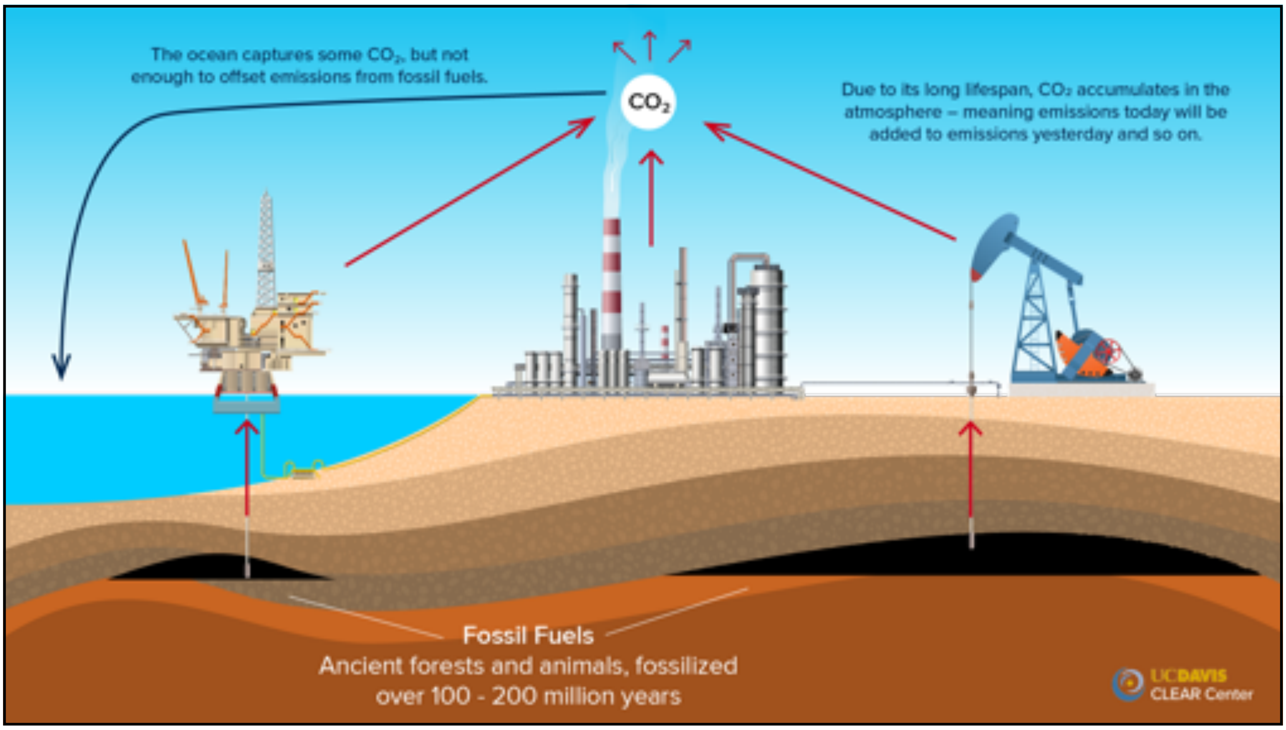

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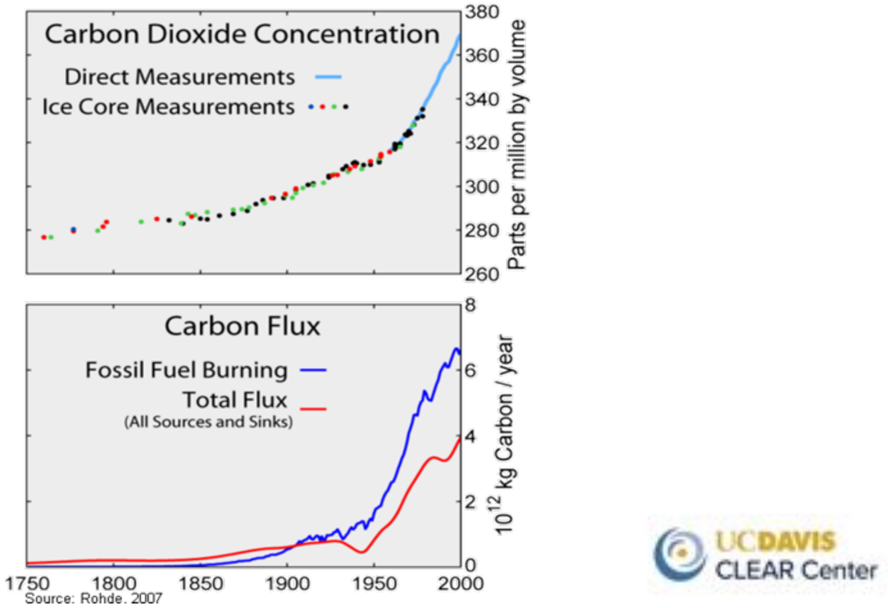
Carbon Dioxide and Carbon Flux



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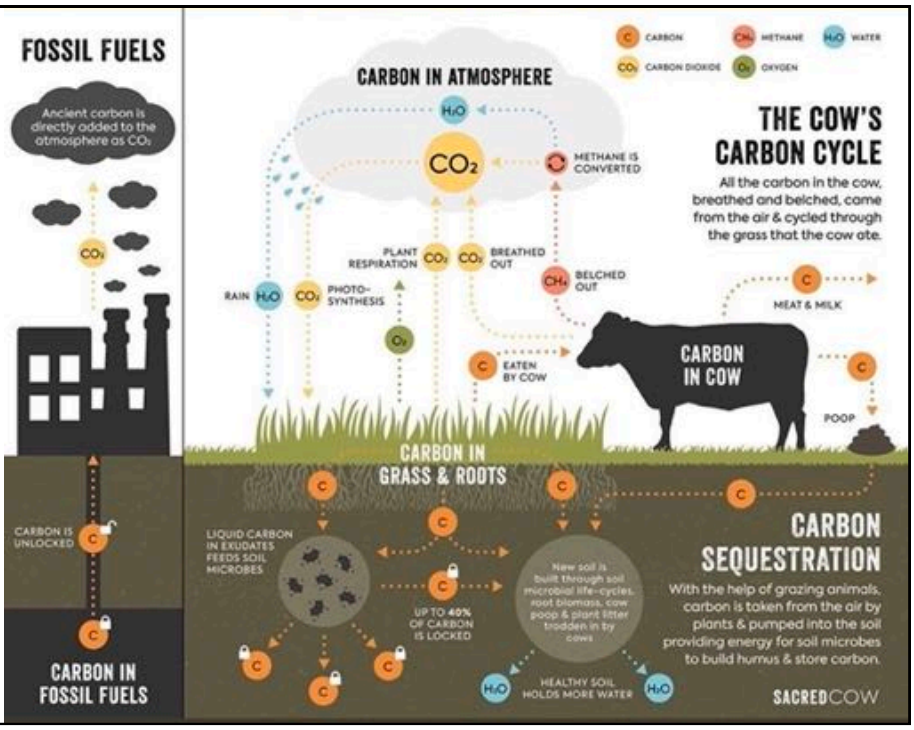
Fossil vs. Biogenic Carbon

Via:
@sustainabledish
sacredcow.info



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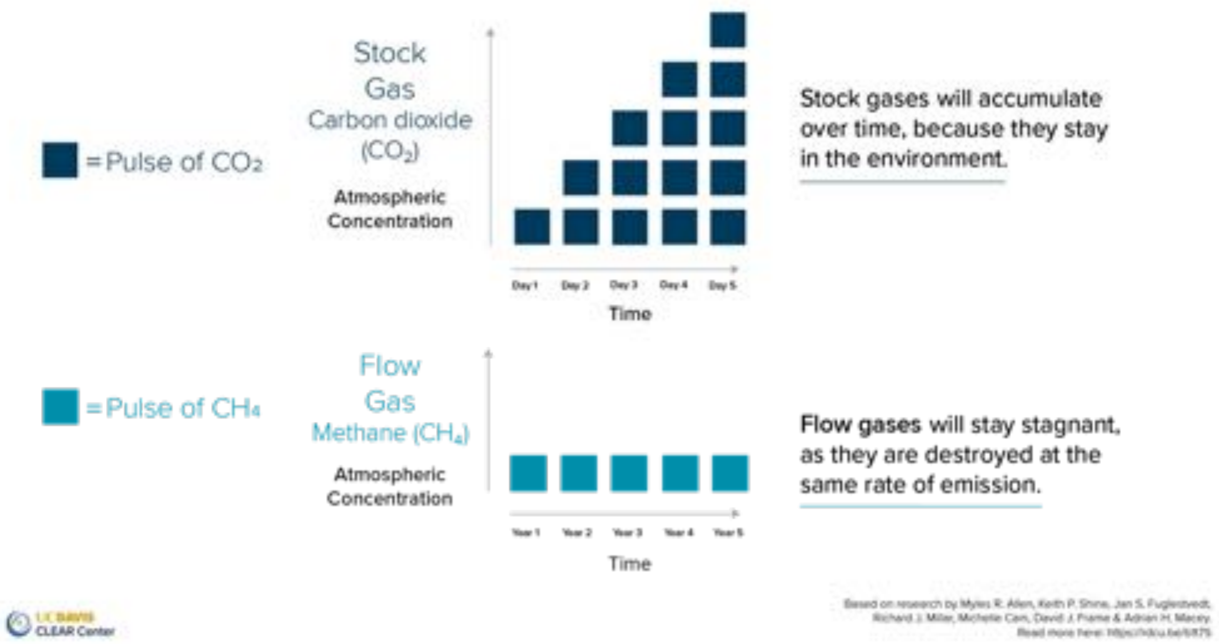

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GWP* - A new way to characterize short-lived greenhouse gases

- GWP100 overestimates methane's warming impact of constant herds by a factor of 4, and overlooks it's ability to induce cooling when CH_4 emissions are reduced.
- GWP* is a new metric out of the University of Oxford that assesses how an emission of a short-lived greenhouse gas affects temperature.
- GWP* not only accounts for methane's short lifespan, but also its atmospheric removal.

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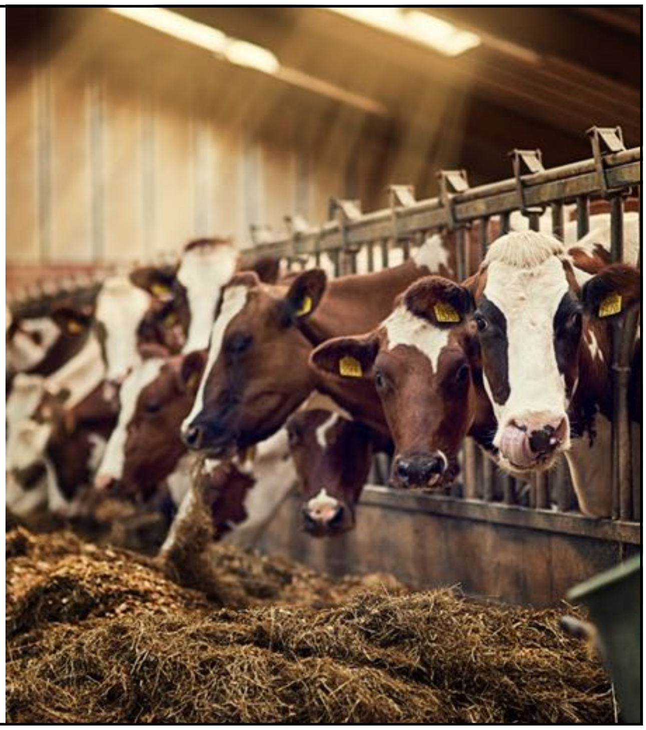

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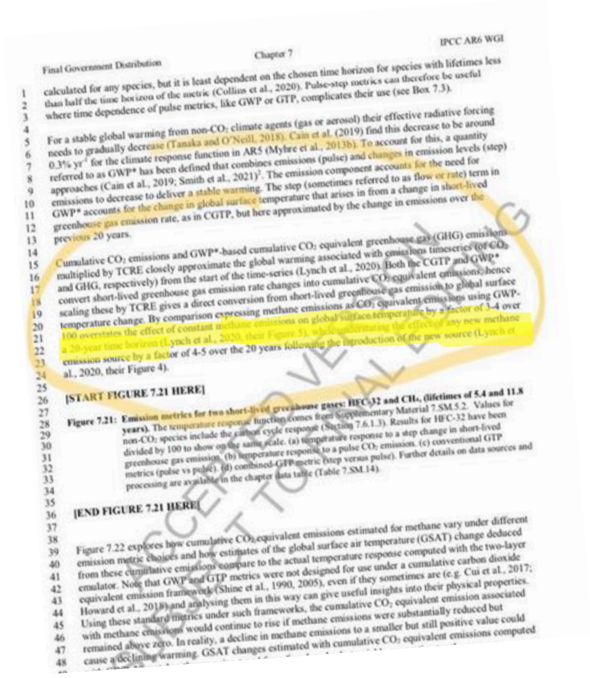

Final Government Distribution | Chapter 7 | IPCC AR6 WGI

calculated for any species, but it is least dependent on the chosen time horizon for species with lifetimes less than half the time horizon of the metric (Collins et al., 2020). Pulse-step metrics can therefore be useful where time dependence of pulse metrics, like GWP or GTP, complicates their use (see Box 7.3).

For a stable global warming from non-CO_2 climate agents (gas or aerosol) their effective radiative forcing needs to gradually decrease (Tanaka and O'Neill, 2018). Cain et al. (2019) find this decrease to be around 0.3% yr^{-1} for the climate response function in AR5 (Myhre et al., 2013b). To account for this, a quantity referred to as GWP* has been defined that combines emissions (pulse) and changes in emission levels (step) approaches (Cain et al., 2019; Smith et al., 2021)[2]. The emission component accounts for the need for emissions to decrease to deliver a stable warming. The step (sometimes referred to as flow or rate) term in GWP* accounts for the change in global surface temperature that arises in from a change in short-lived greenhouse gas emission rate, as in CGTP, but here approximated by the change in emissions over the previous 20 years.

Cumulative CO_2 emissions and GWP*-based cumulative CO_2 equivalent greenhouse gas (GHG) emissions multiplied by TCRE closely approximate the global warming associated with emissions timeseries (of CO_2 and GHG, respectively) from the start of the time-series (Lynch et al., 2020). Both the CGTP and GWP* convert short-lived greenhouse gas emission rate changes into cumulative CO_2 equivalent emissions, hence scaling these by TCRE gives a direct conversion from short-lived greenhouse gas emission to global surface temperature change. By comparison expressing methane emissions as CO_2 equivalent emissions using GWP-100 overstates the effect of constant methane emissions on global surface temperature by a factor of 3-4 over a 20-year time horizon (Lynch et al., 2020, their Figure 5), while understating the effect of any new methane emission source by a factor of 4-5 over the 20 years following the introduction of the new source (Lynch et al., 2020, their Figure 4).

[START FIGURE 7.21 HERE]

Figure 7.21: Emission metrics for two short-lived greenhouse gases: HFC-32 and CH_4, (lifetimes of 5.4 and 11.8 years). The temperature response function comes from Supplementary Material 7.SM.5.2. Values for non-CO_2 species include the carbon cycle response (Section 7.6.1.3). Results for HFC-32 have been divided by 100 to show on the same scale. (a) temperature response to a step change in short-lived greenhouse gas emission. (b) temperature response to a pulse CO_2 emission. (c) conventional GTP metrics (pulse vs pulse). (d) combined-GTP metric (step versus pulse). Further details on data sources and processing are available in the chapter data table (Table 7.SM.14).

[END FIGURE 7.21 HERE]

Figure 7.22 explores how cumulative CO_2 equivalent emissions estimated for methane vary under different emission metric choices and how estimates of the global surface air temperature (GSAT) change deduced from these cumulative emissions compare to the actual temperature response computed with the two-layer emulator. Note that GWP and GTP metrics were not designed for use under a cumulative carbon dioxide equivalent emission framework (Shine et al., 1990, 2005), even if they sometimes are (e.g. Cui et al., 2017; Howard et al., 2018) and analysing them in this way can give useful insights into their physical properties. Using these standard metrics under such frameworks, the cumulative CO_2 equivalent emission associated with methane emissions would continue to rise if methane emissions were substantially reduced but remained above zero. In reality, a decline in methane emissions to a smaller but still positive value could cause a declining warming. GSAT changes estimated with cumulative CO_2 equivalent emissions computed [illegible]

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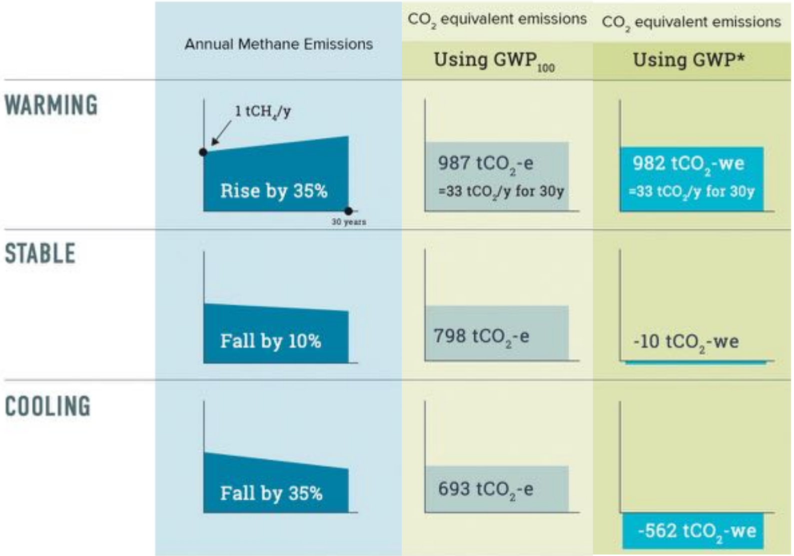

Cain, M., Allen, M. & Lynch, J. *Oxford Martin Programme on Climate Pollutants* (2019). Read more at: https://www.oxfordmartin.ox.ac.uk/downloads/academic/201908_ClimatePollutants.pdf.

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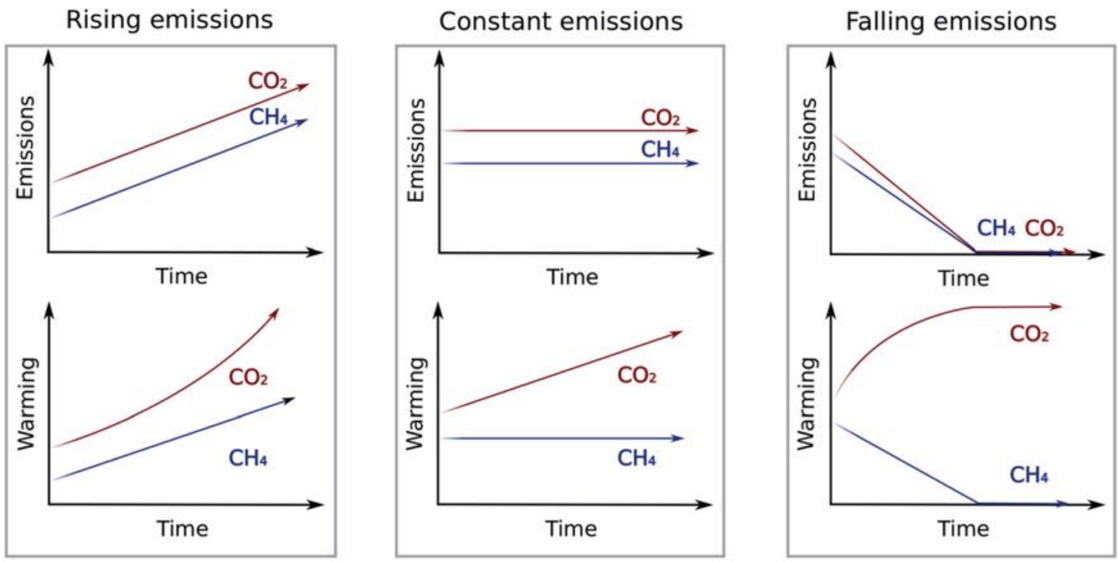

Oxford Martin, Climate Metrics for Ruminant Livestock, July 2018, https://www.oxfordmartin.ox.ac.uk/downloads/reports/Climate-metrics-for-ruminant-livestock.pdf%C2%A0

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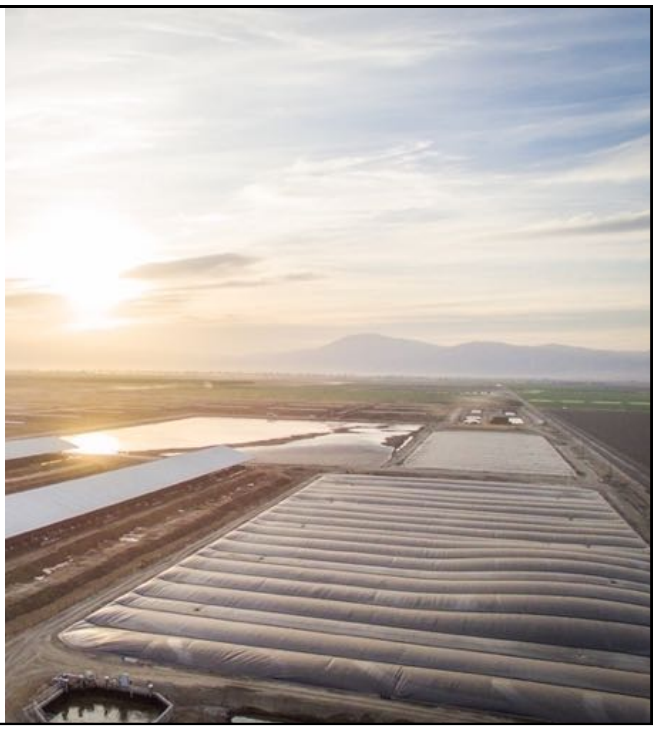
Since 2015 California dairies have reduced greenhouse gases by **2.2 million metric tons.**



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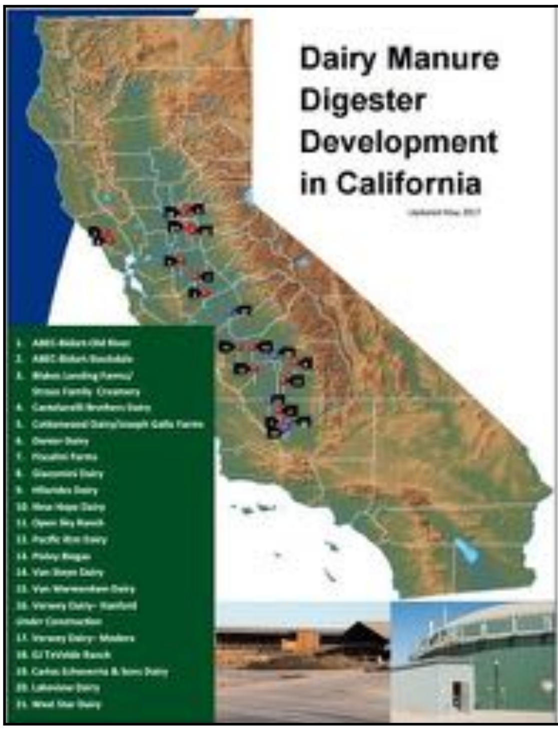

That’s a **25 percent** reduction in GHG emissions.

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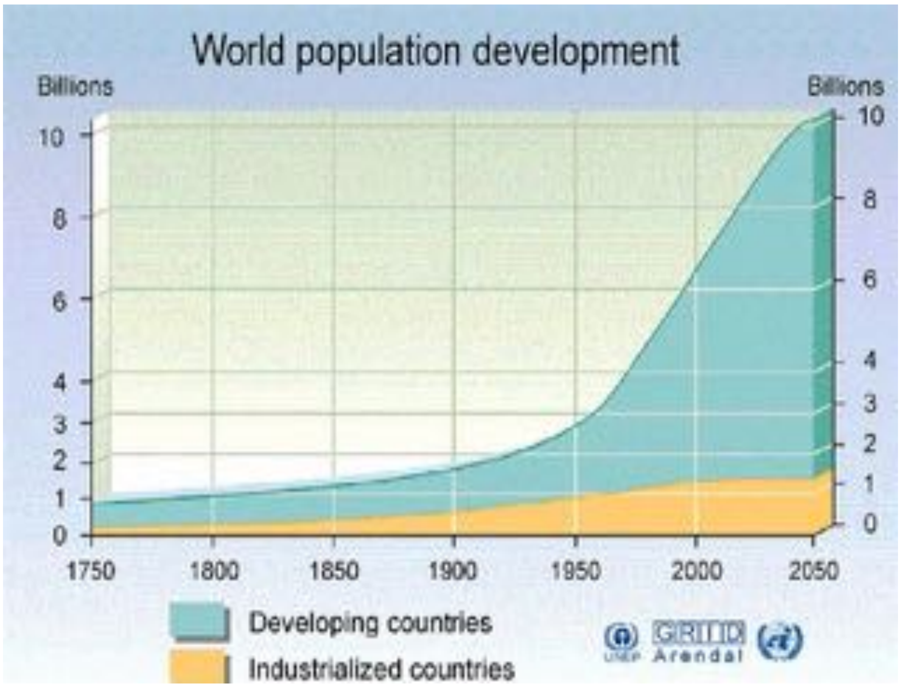

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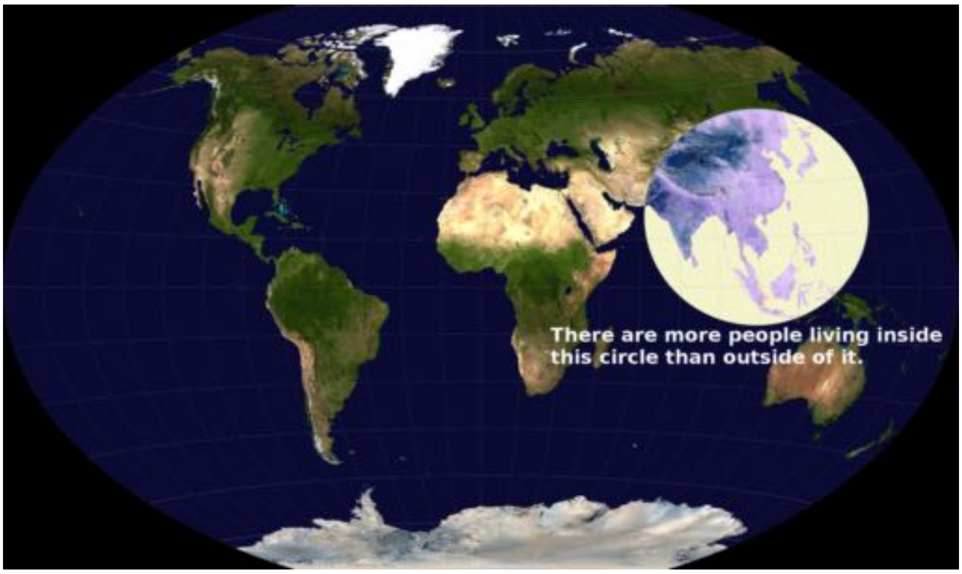
There are more people living inside this circle than outside of it.
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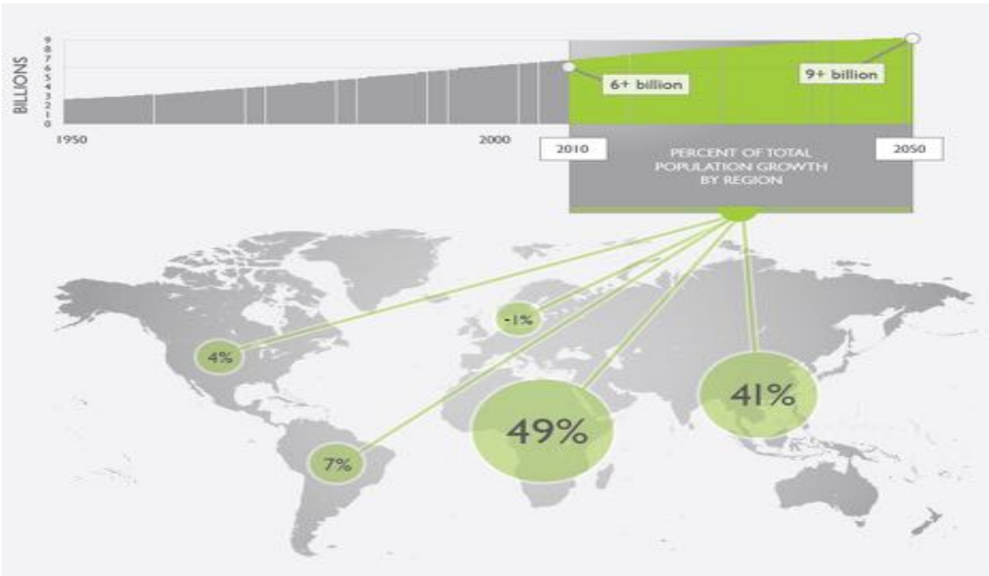
BILLIONS
1950
2000
2010
2050
6+ billion
9+ billion
PERCENT OF TOTAL POPULATION GROWTH BY REGION
4%
-1%
7%
49%
41%
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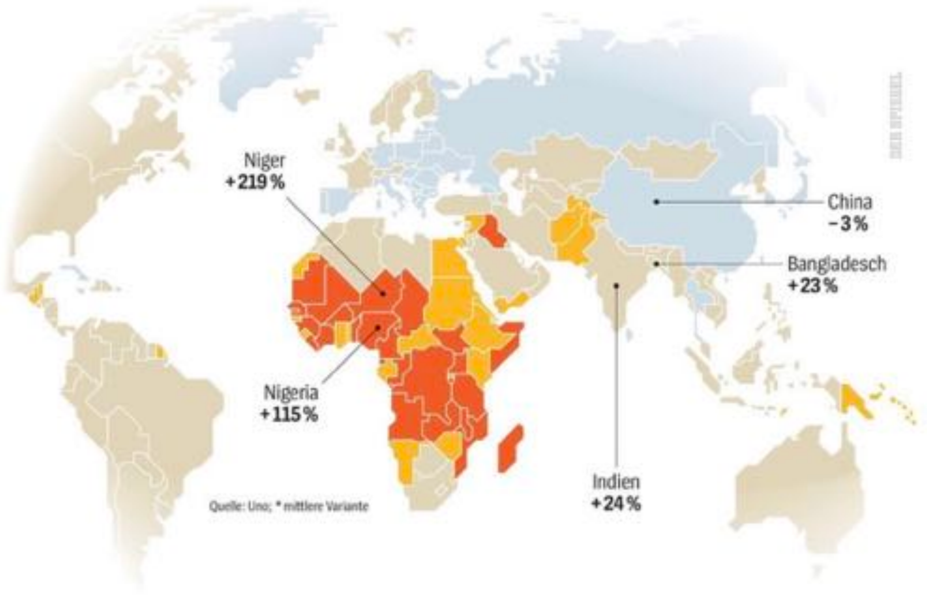
22



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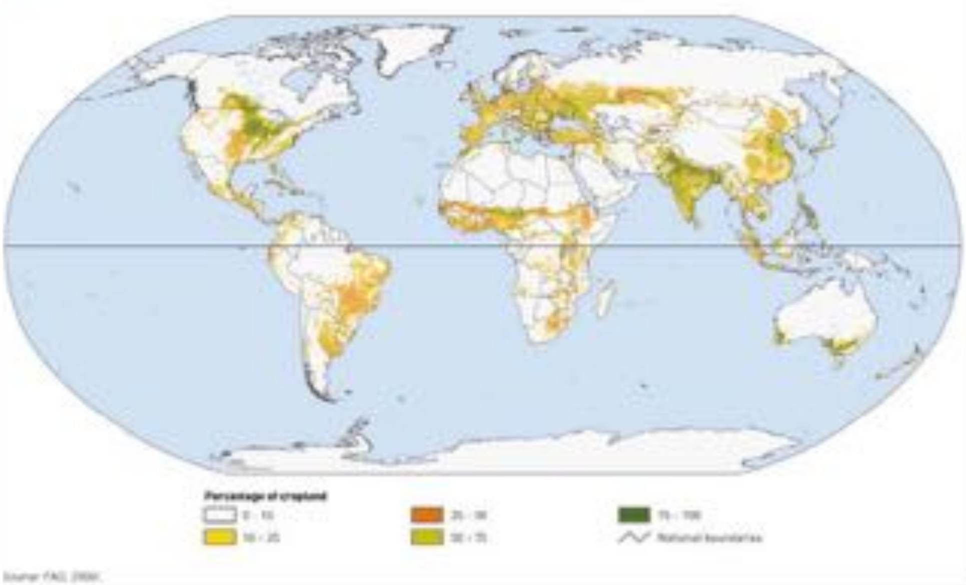
Distribution of cropland



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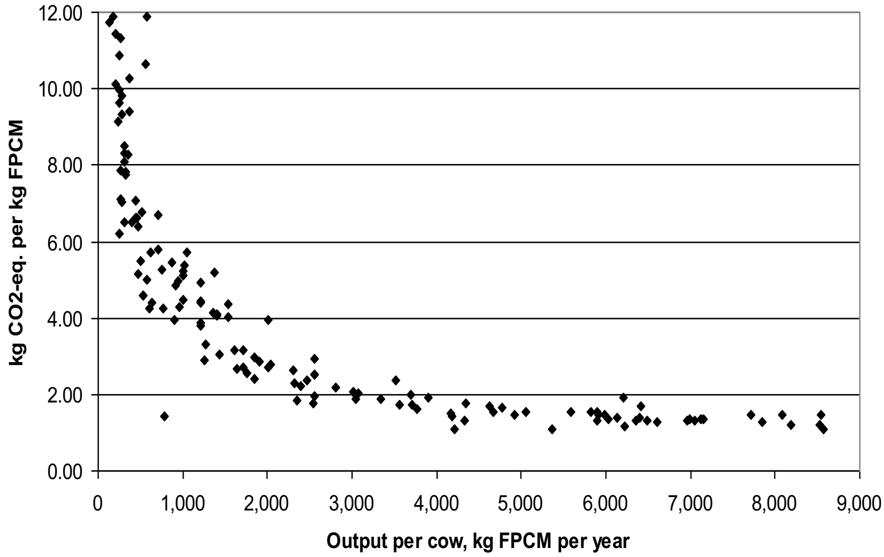
FAO (2006)

24



Relationship between total greenhouse gas emissions and milk output per cow

H. Steinfeld, 2015

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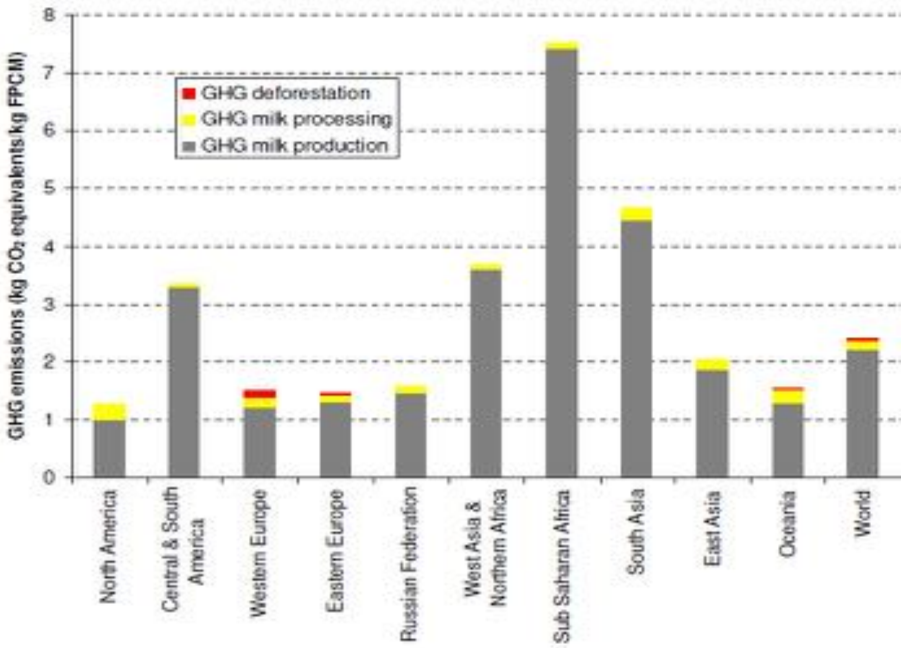
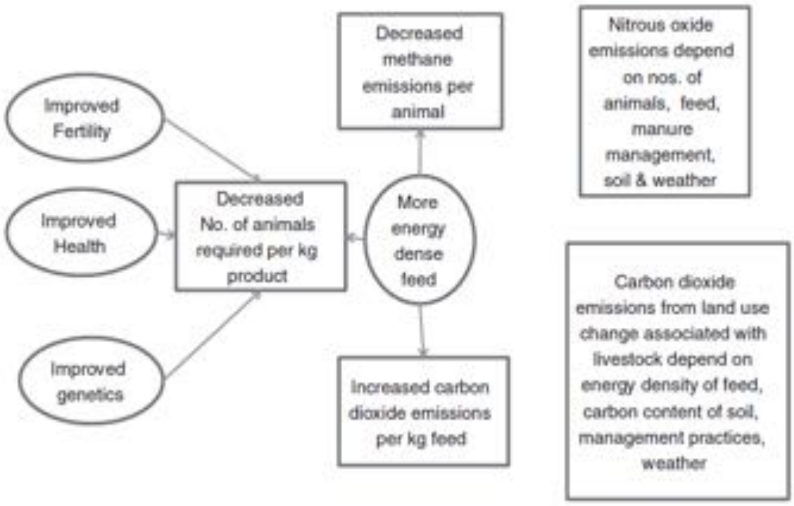


FAO (2010)

26



Mitigation: interventions to improve productivity

Gill et al. (2010)

27

US Dairy Trends

- In 1950, there were 25 million dairy cows in the U.S. Today there are 9 million.
- 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.

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US Beef Trends

- In 1970, the U.S. had 140 million head of beef.
- By comparison, today there are 90 million head.
- In both 1970 and 2010, 24 million tons of beef were produced.

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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)

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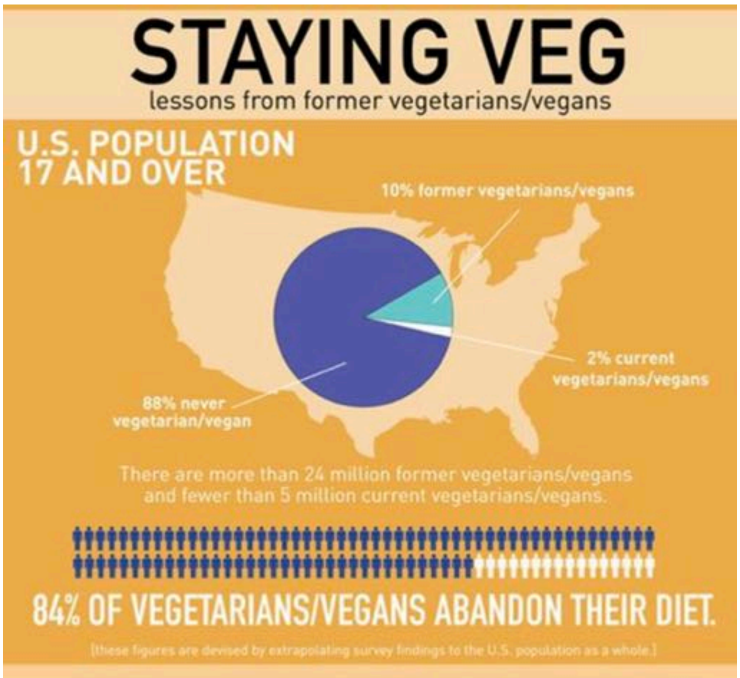

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National Geograpic

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