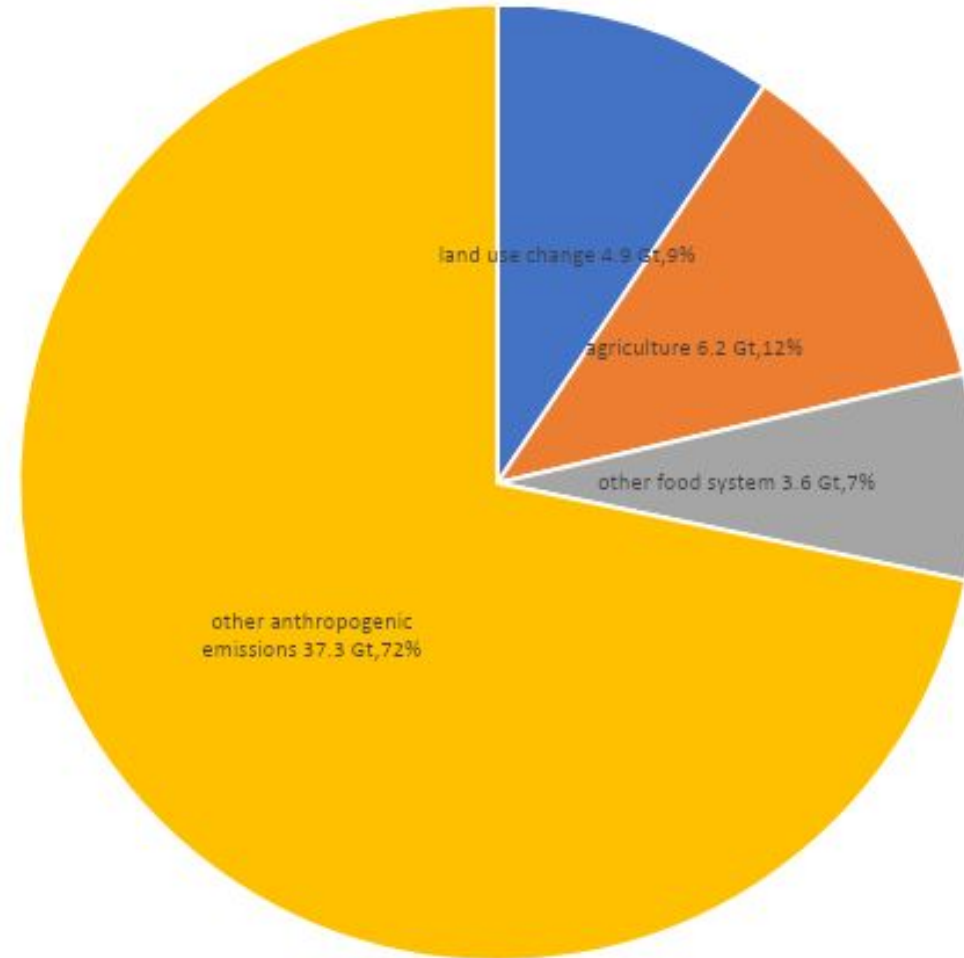


Climate Change Mitigation in the Food System

Eric Toensmeier

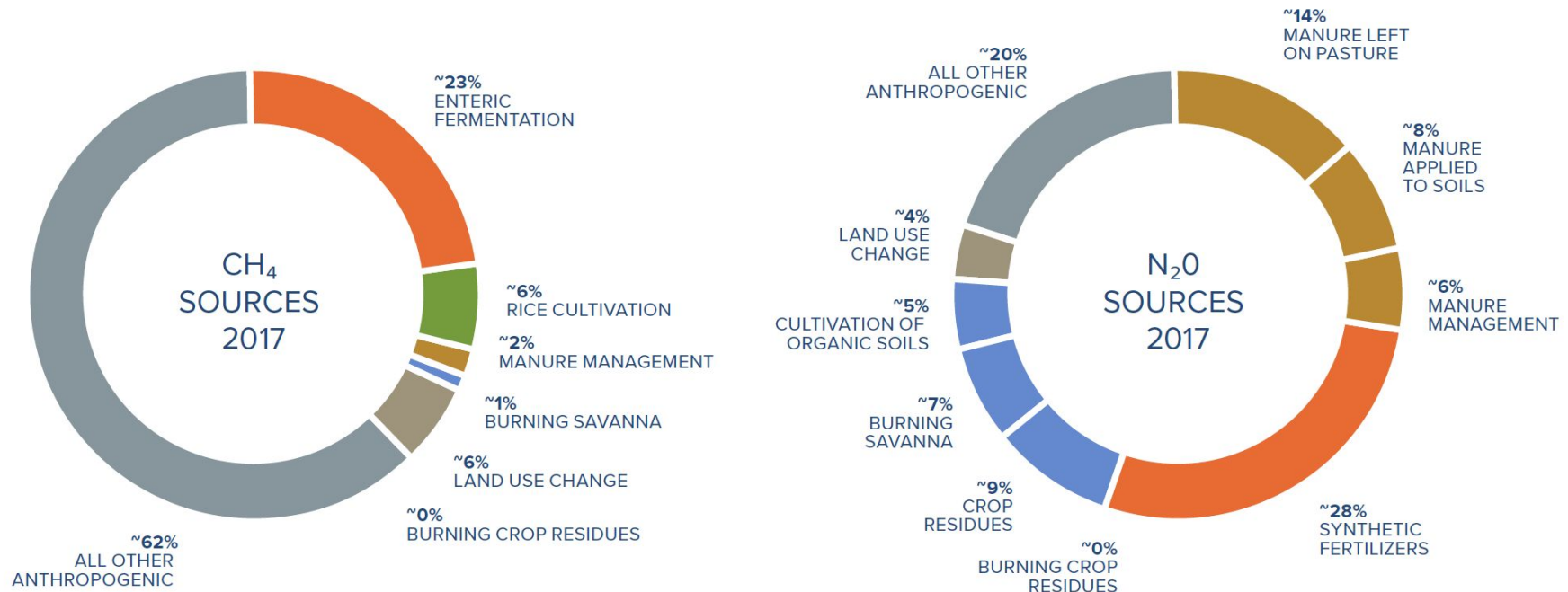
Our Food System Causes 28% of Emissions

Average Food System Emissions 2006-2017



38% of Methane, 80% of Nitrous Oxide

Figure 2.2 — Breakdown of Methane and Nitrous Oxide Emissions⁵



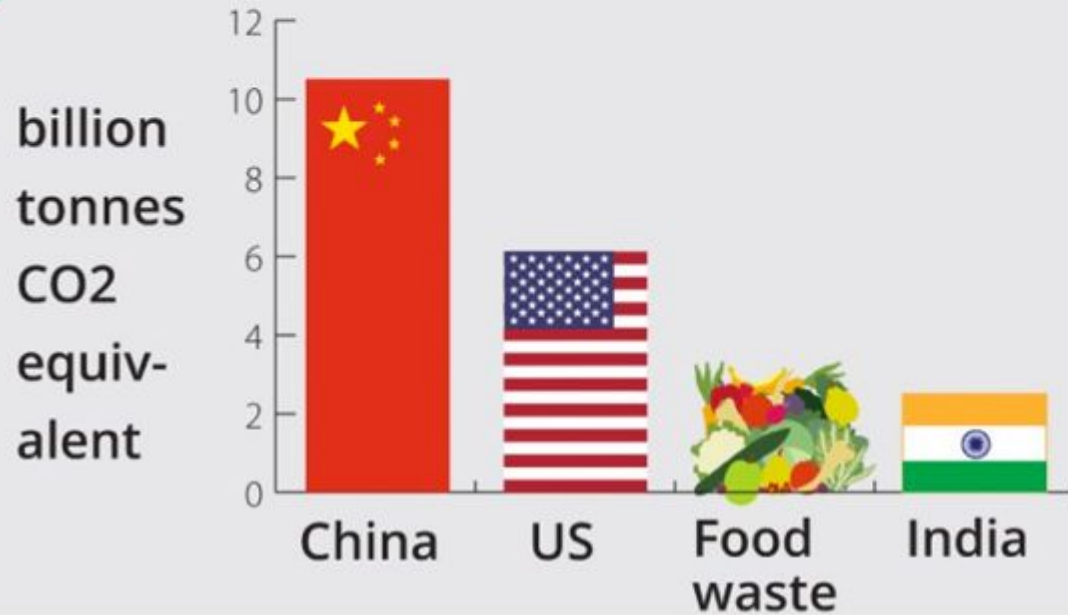
Emissions Reduction vs. Biosequestration



Reducing the Demand for Food,
Avoiding Deforestation

Food Waste Reduction

If global food waste was a country, it would be the third largest greenhouse gas emitter after the US and China



source: FAO

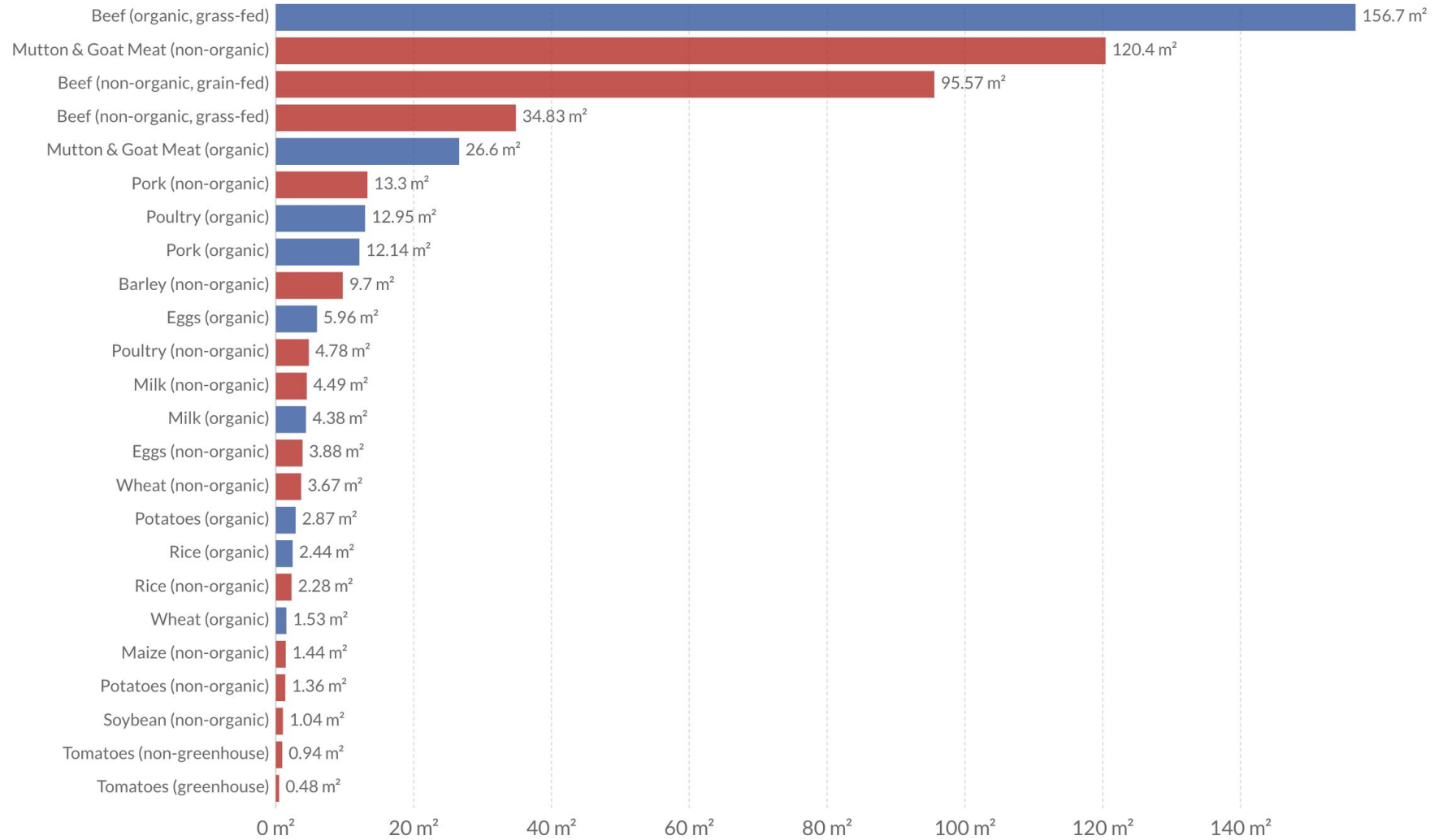
Land Needed to Produce Food

For 3.5 ounces of protein:

- Grassfed beef 41' x 41'
- Soybeans 3'x3'

Land use per unit protein by food and production system

Average land use per 100 grams of protein of food production, by food type and production system measured in metres squared (m²) per 100 grams of protein. Average values are based on a meta-analysis of studies across 742 agricultural systems and over 90 unique foods.



Source: Clark & Tilman (2017)

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CHART

DATA

SOURCES



Intensification

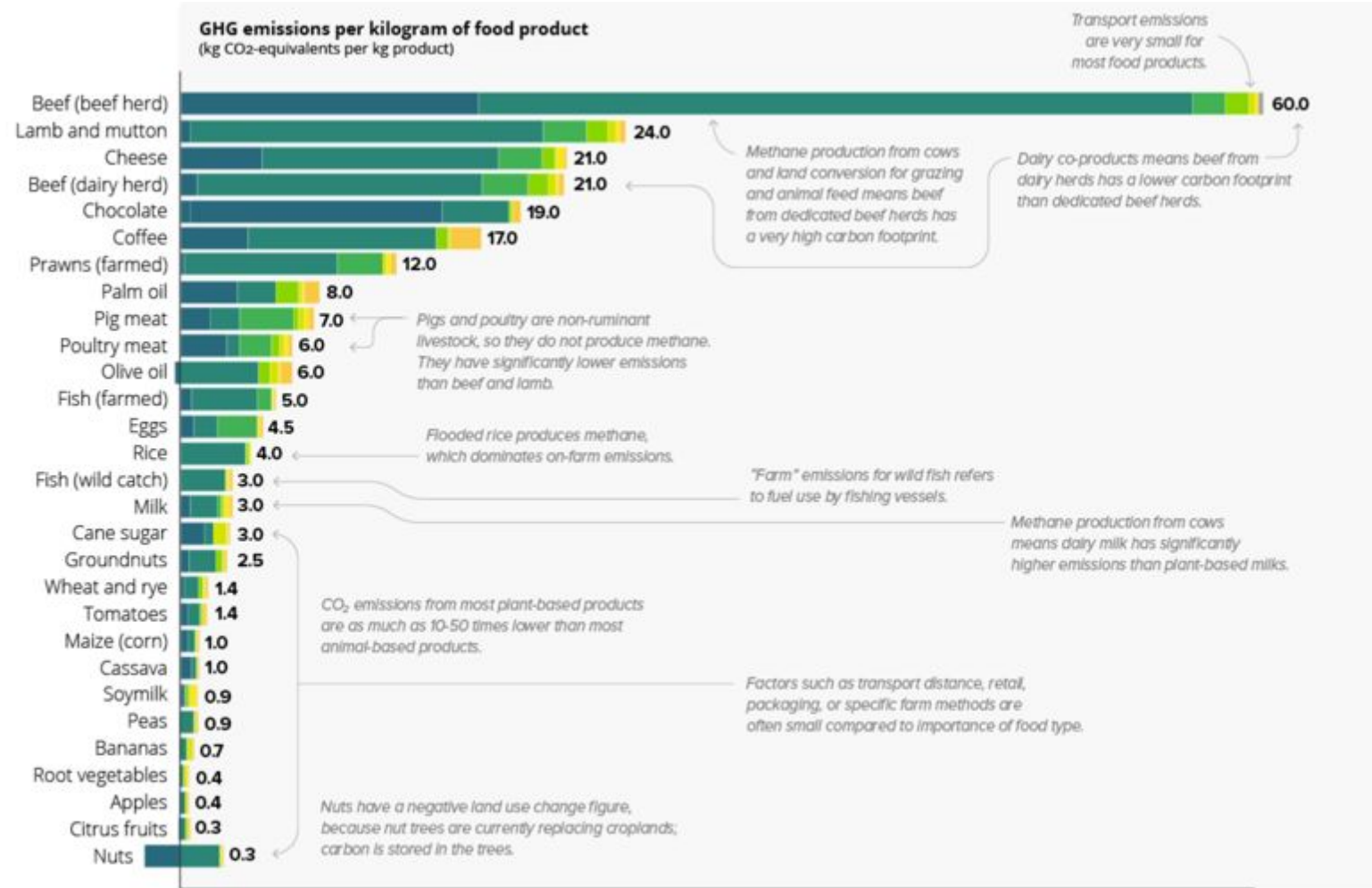
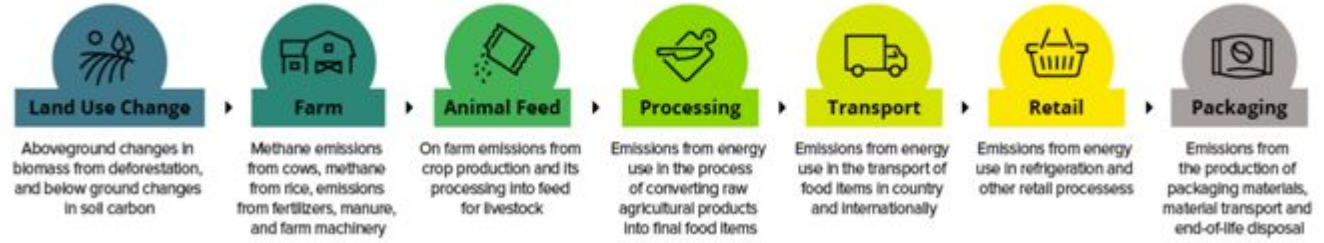
- Growing more on the farmland we have
 - And where no food is grown today
- *Can* reduce pressure on forests
- Many forms of intensification
 - Agrochemical
 - IPM
 - Intercropping
 - AMP grazing
 - Tree intercropping
 - Biointensive
 - Urban agriculture
 - Home gardens
 - Precision agriculture



Diet Change

Neufeld (2020) "The carbon footprint of the food supply chain"

There is a vast difference in greenhouse gases (GHG) that are produced across various food types.

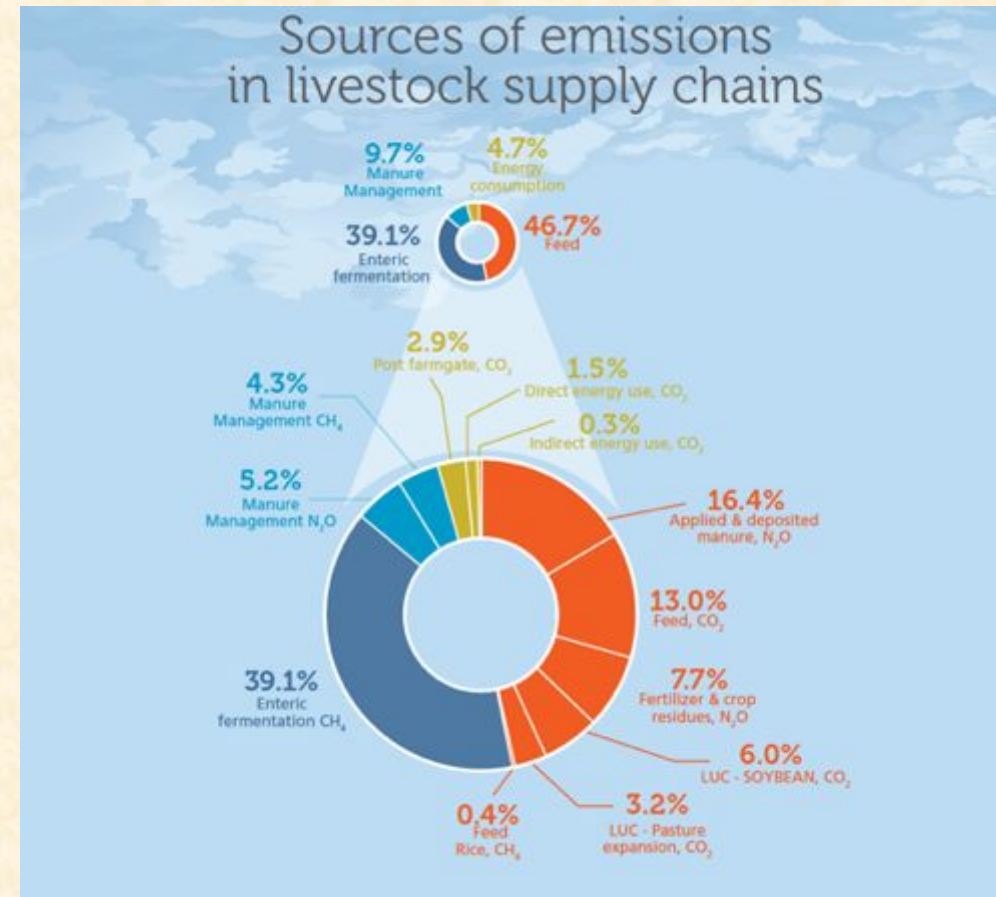


Note: Greenhouse gas emissions are given as global average values based on data across 38,700 commercially viable farms in 119 countries. Data source: Poore and Nemecek (2018). Reducing food's environmental impacts through producers and consumers. Science. Images sourced from the Noun Project. OurWorldinData.org - Research and data to make progress against the world's largest problems.



Livestock Issues

- 65% of farmland
- 33% of crops used as feed
- 10% of calories produced
- 80% of agriculture emissions
- Main driver of deforestation



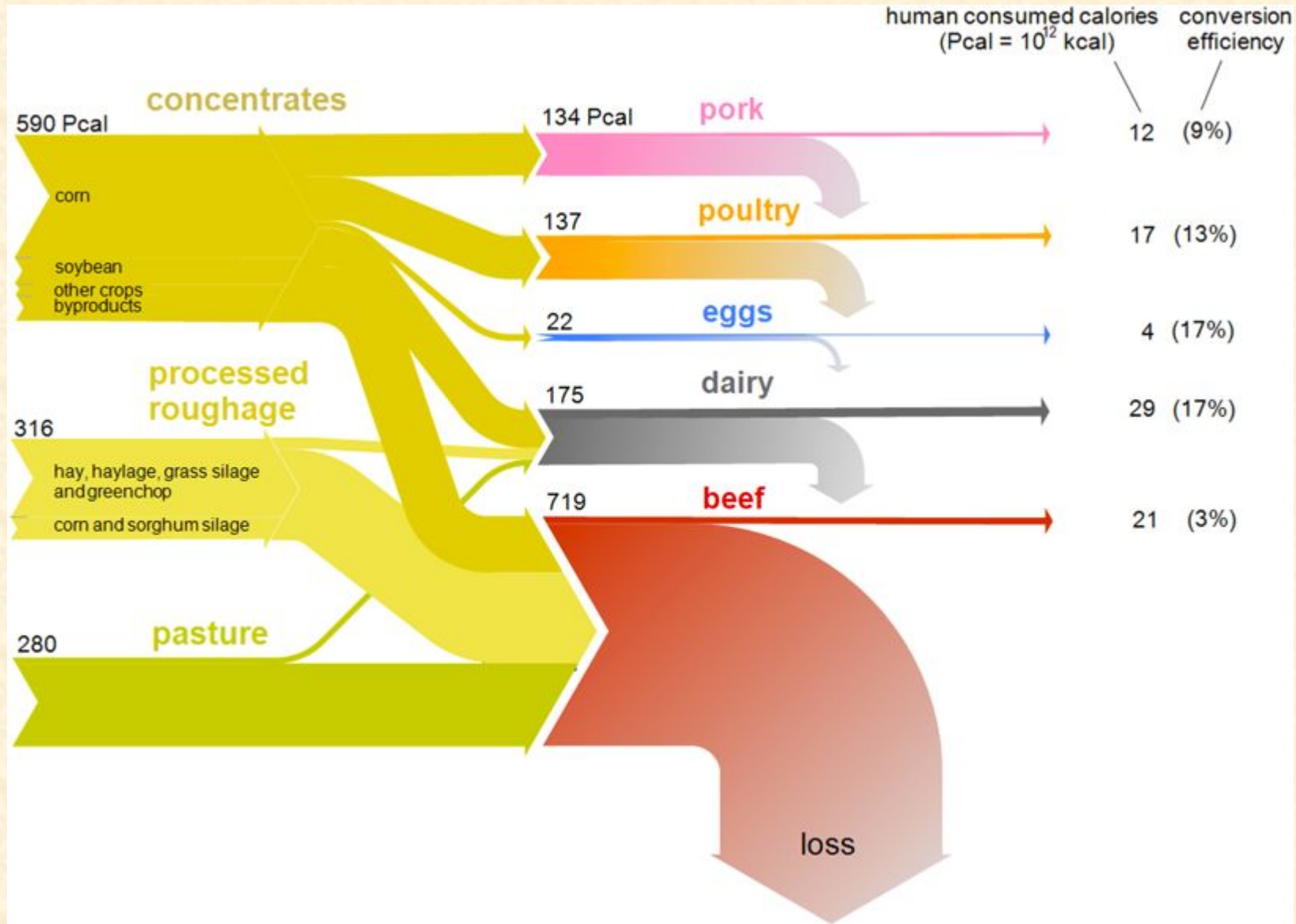
Lal (2012) "Climate change mitigation by managing the terrestrial biosphere"

Drawdown.org

Toensmeier (2016) *The Carbon Farming Solution*

Garnett (2017) *Grazed and Confused*

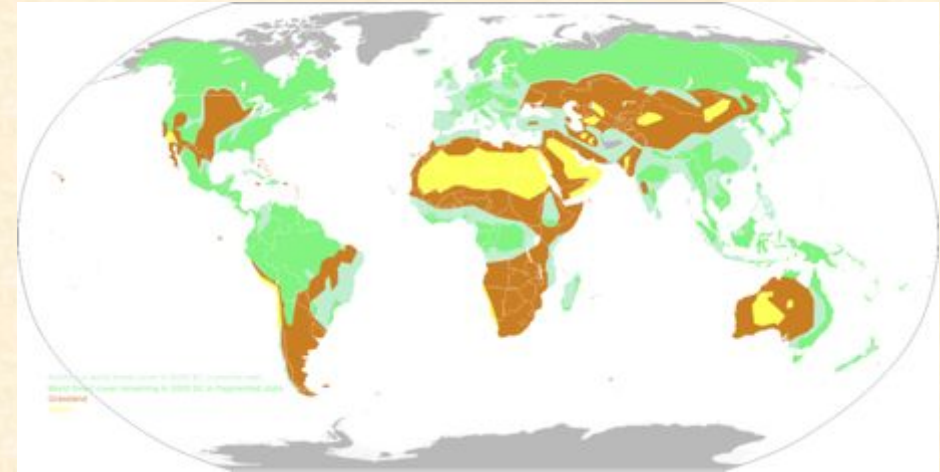
FAO (2016) *Livestock and Climate Change*



Shepon (2016) "Energy and protein feed-to-food conversion efficiencies in the US and potential food security gains from dietary changes"

Agroecological Advantages of Livestock

- Grassland represents 70% of farmland
- Livestock can be raised in places where crop production is difficult
 - too dry
 - too steep
 - too rocky
 - too remote
- Can eat things people can't and turn them into food
 - Crop residues
 - Food waste
 - Grass and tree leaves
- Can cycle nutrients to improve soil fertility



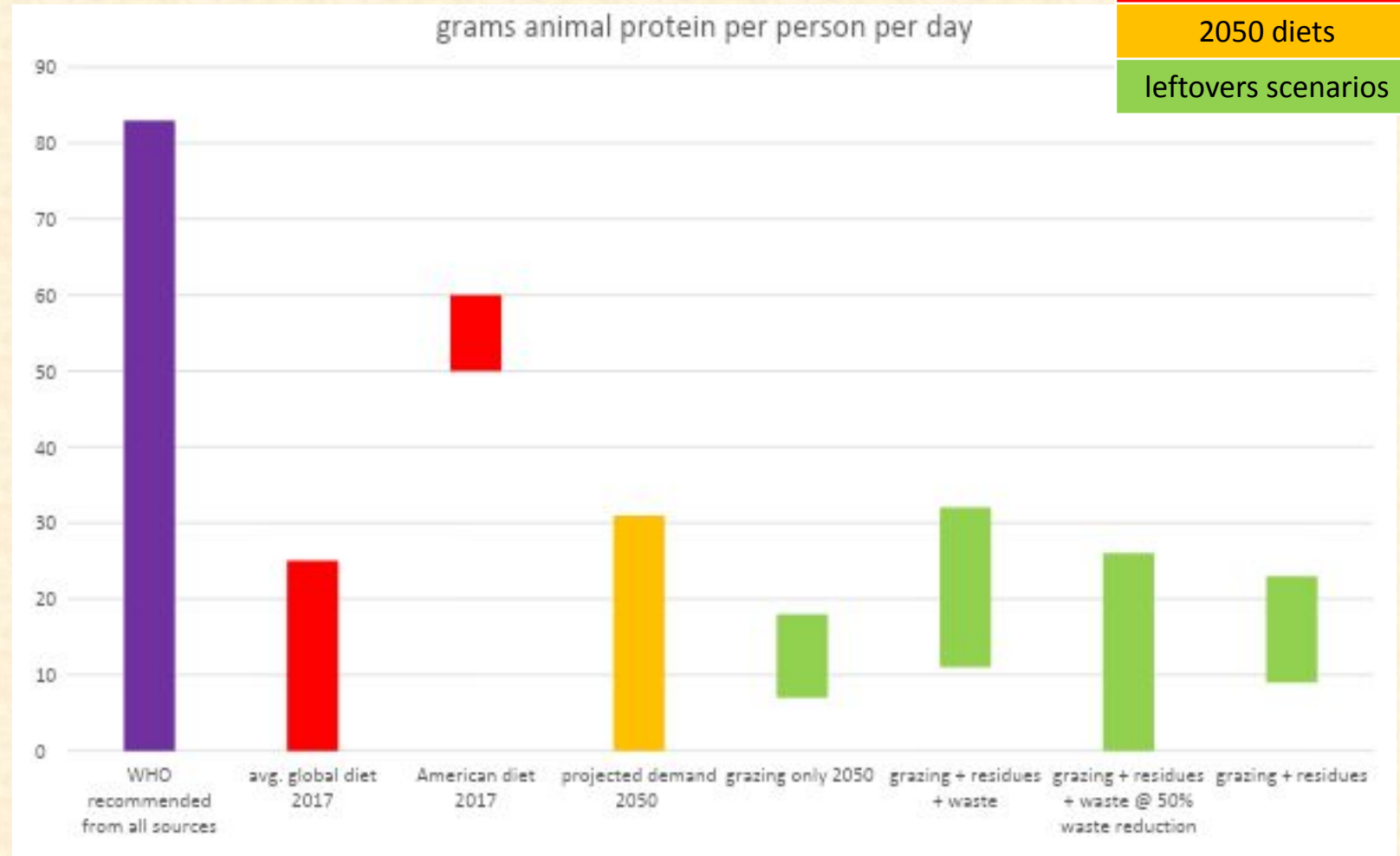
Climate-Friendly Livestock Systems Exist



Toensmeier (2018) "How to make beef less terrible for the environment"
Drawdown.org

Livestock On Leftovers

- Livestock consume only what people cannot
 - Grazing and tree fodder
 - Crop residues
 - Food waste
- Mean of 21 g/day



Garnett et al (2017) *Grazed and confused? Ruminating on cattle, grazing systems, methane, nitrous oxide, the soil carbon sequestration question – and what it all means for greenhouse gas emissions.*

Van Zanten (2018) “Defining a land boundary for sustainable livestock consumption”

Home Consumption

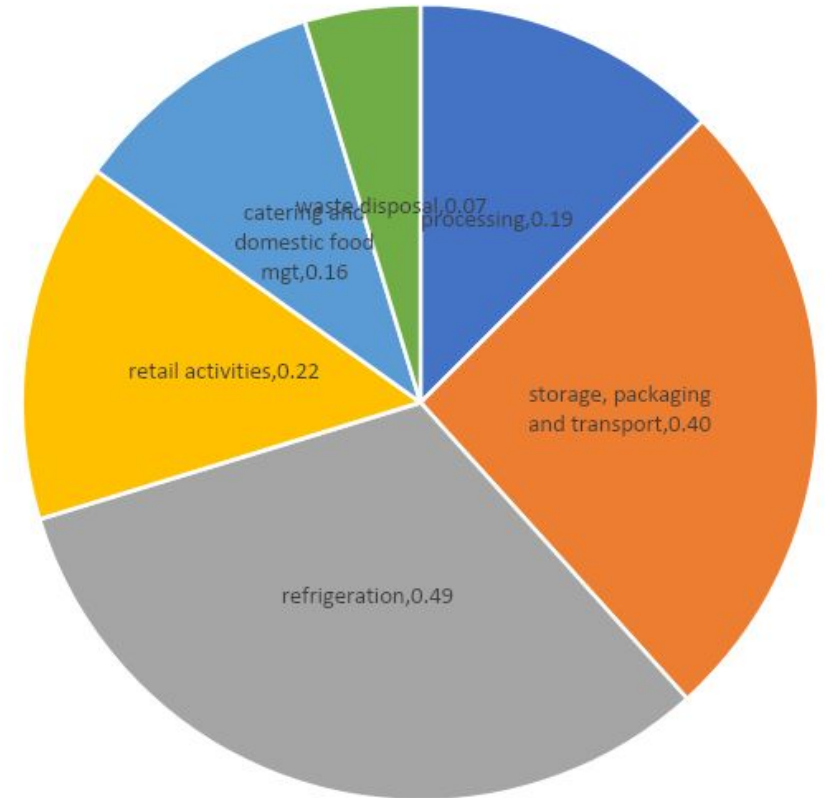
- Reduce food waste
- Compost what you can't reduce
 - Or worm bin, or chickens
- Mostly eat foods with low emissions and land demand
 - Most plant-based foods are great
 - Pork, poultry, and eggs much better than beef and dairy
 - Look to livestock produced in the most climate-friendly ways, but expensive



Reducing Emissions in the Supply Chain

Supply Chain Strategies

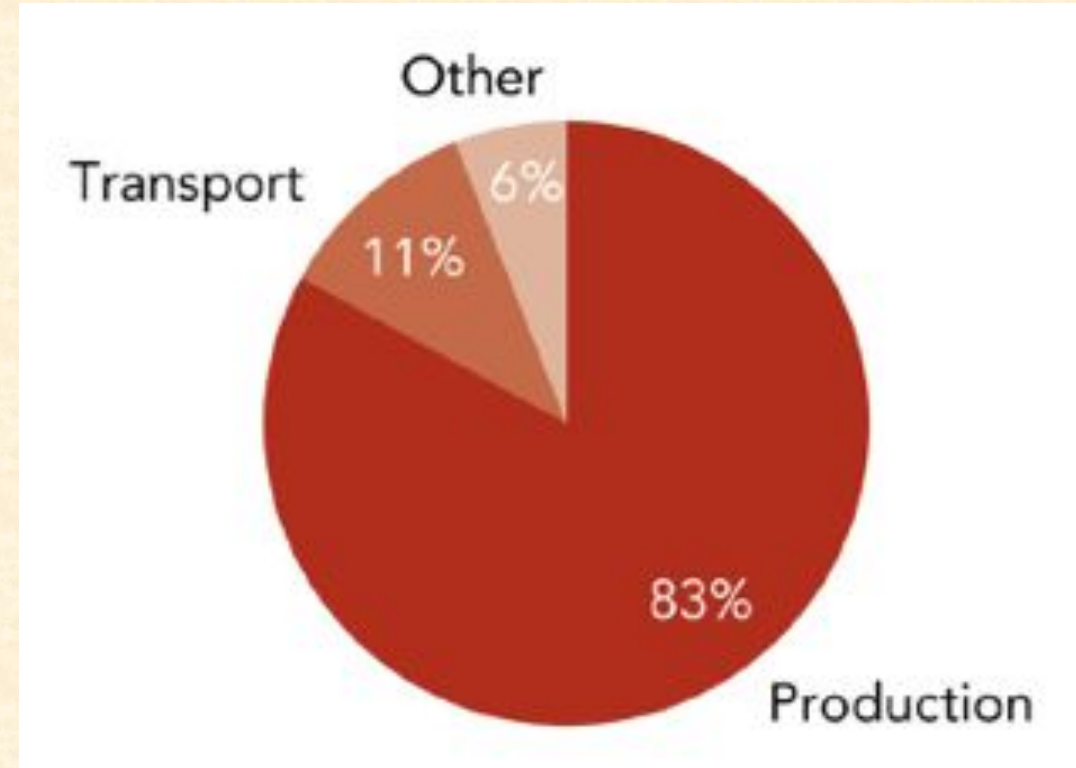
- Refrigerants
- Sustainable sourcing
- Certification
- Electrify & switch to clean energy
- Optimize transportation



Transport

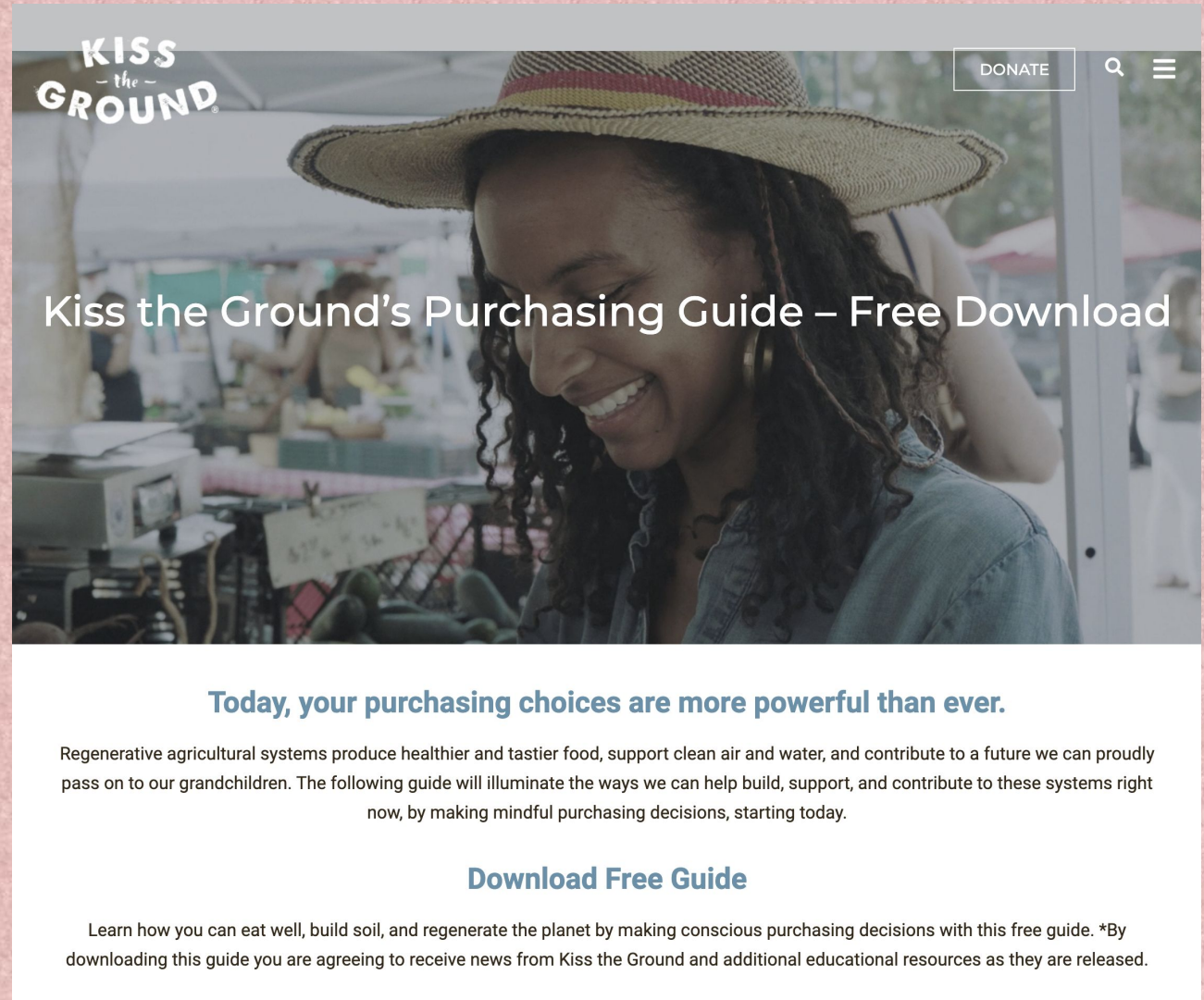
- 14% of human emissions
 - 6% of that is food
- local often **worse** because it increases driving
- Within 25 miles local often better
- Food hubs, better distribution

Transport emissions in the US food system



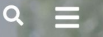
Home Consumption

- Buy foods grown in the best way possible
- Buy extremely local or with no extra driving
- Buy minimally processed foods

The image shows a screenshot of the Kiss the Ground website. At the top left is the logo "KISS the GROUND". To the right are navigation links for "DONATE", a search icon, and a menu icon. The main banner features a photograph of a smiling woman with curly hair wearing a straw hat, looking down at something in her hands. Overlaid on the photo is the text "Kiss the Ground's Purchasing Guide – Free Download". Below the photo, there is a sub-headline "Today, your purchasing choices are more powerful than ever.", followed by a paragraph of text explaining the benefits of regenerative agriculture and the purpose of the guide. At the bottom of the banner is a "Download Free Guide" button and a disclaimer about receiving news from Kiss the Ground.

KISS
-the-
GROUND

DONATE



Kiss the Ground's Purchasing Guide – Free Download

Today, your purchasing choices are more powerful than ever.

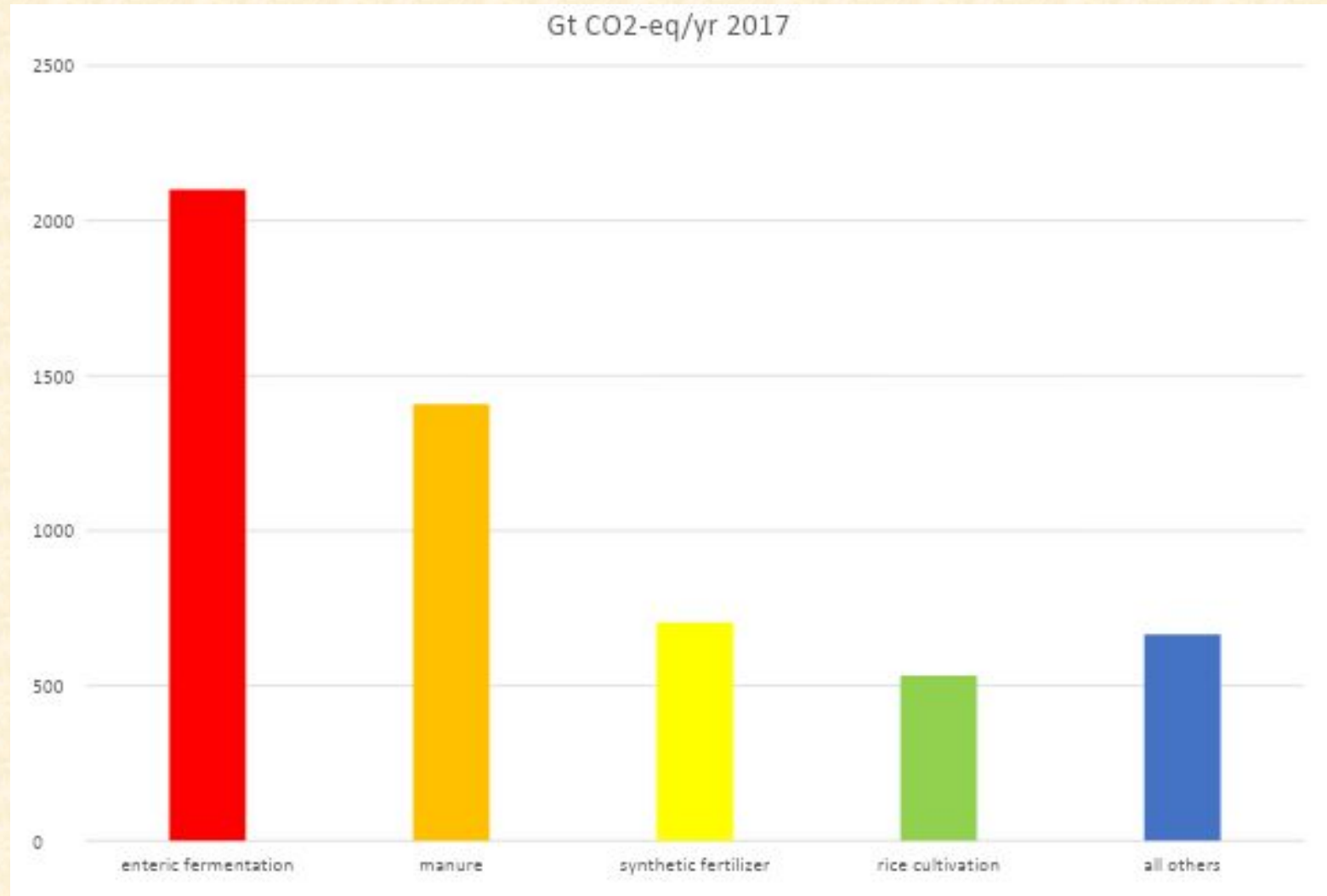
Regenerative agricultural systems produce healthier and tastier food, support clean air and water, and contribute to a future we can proudly pass on to our grandchildren. The following guide will illuminate the ways we can help build, support, and contribute to these systems right now, by making mindful purchasing decisions, starting today.

Download Free Guide

Learn how you can eat well, build soil, and regenerate the planet by making conscious purchasing decisions with this free guide. *By downloading this guide you are agreeing to receive news from Kiss the Ground and additional educational resources as they are released.

Reducing Emissions from Production

Sources of Agricultural Emissions



Data from Drawdown (2020) *Farming Our Way Out of the Climate Crisis*

Reducing Agricultural Emissions

Enteric fermentation	Manure	Synthetic fertilizers	Rice Methane	Others
<ul style="list-style-type: none"> Concentrate feeds Feed additives Breeding & management Improved forage quality Tree fodder <i>Brachiaria</i> grasses 	<ul style="list-style-type: none"> <i>Brachiaria</i> grasses Nitrification inhibitors Restore degraded pastures Improved manure management Feed additives Timing of spreading on fields Tree fodder Biodigestors 	<ul style="list-style-type: none"> Nutrient management Compost Green manures Nitrogen fixing trees Livestock integration 	<ul style="list-style-type: none"> Water management Aerobic cultivars Nutrient management Reduced tillage 	<ul style="list-style-type: none"> Reduce tillage Reduce residue burning Savanna fire management Rewetting of peat soils



For the Home Landscape

- Use the right amount of synthetic fertilizer
- Or replace with compost or organic



Sequestering Carbon

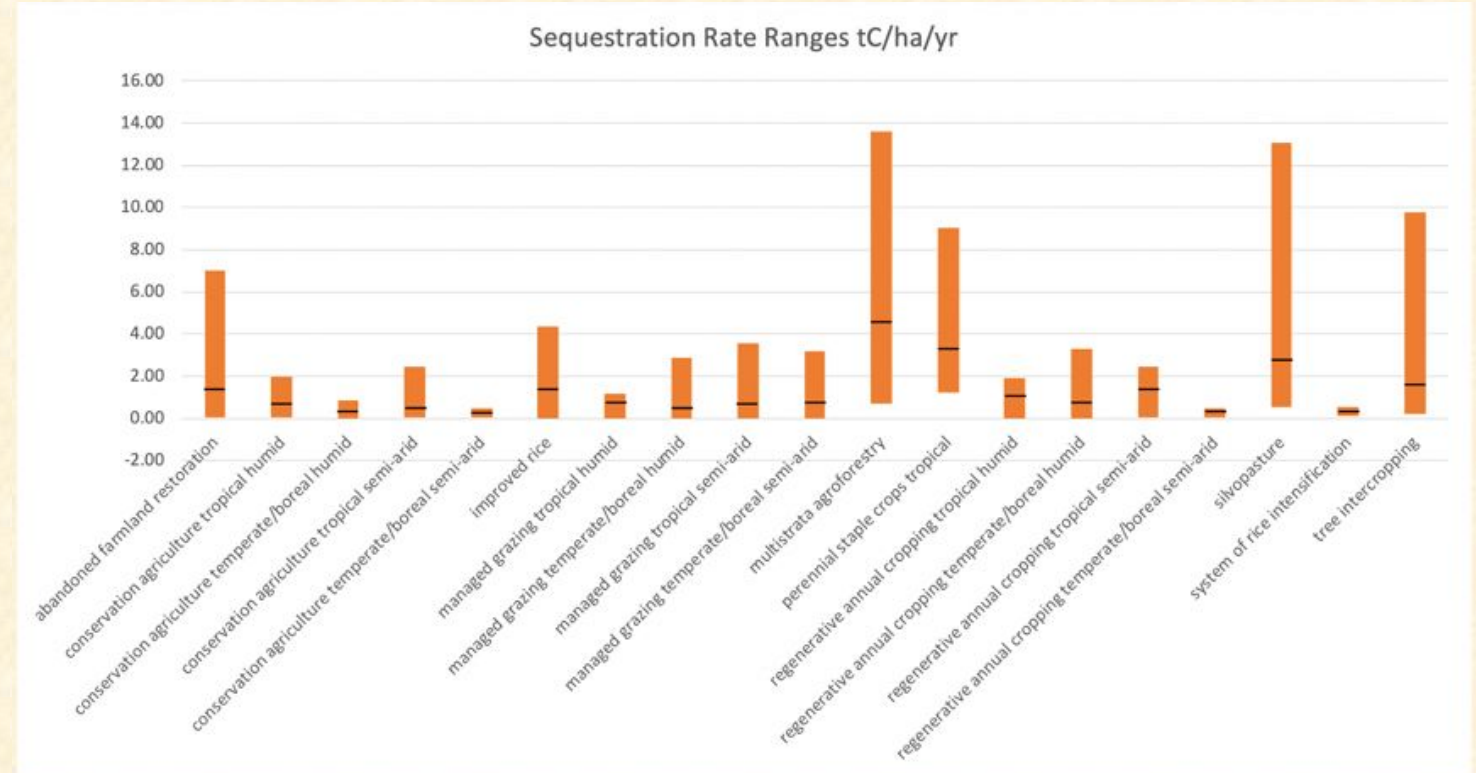
Sequestration

- Photosynthesis:
 - CO₂ → carbohydrates in plants, becomes biomass
- 10-40% exuded from roots within 1 hour
 - Kumar et. al., “Plant Roots and Carbon Sequestration”
- Much biomass becomes organic matter over time
 - Root and leaf decomposition
 - Much also re-released as CO₂



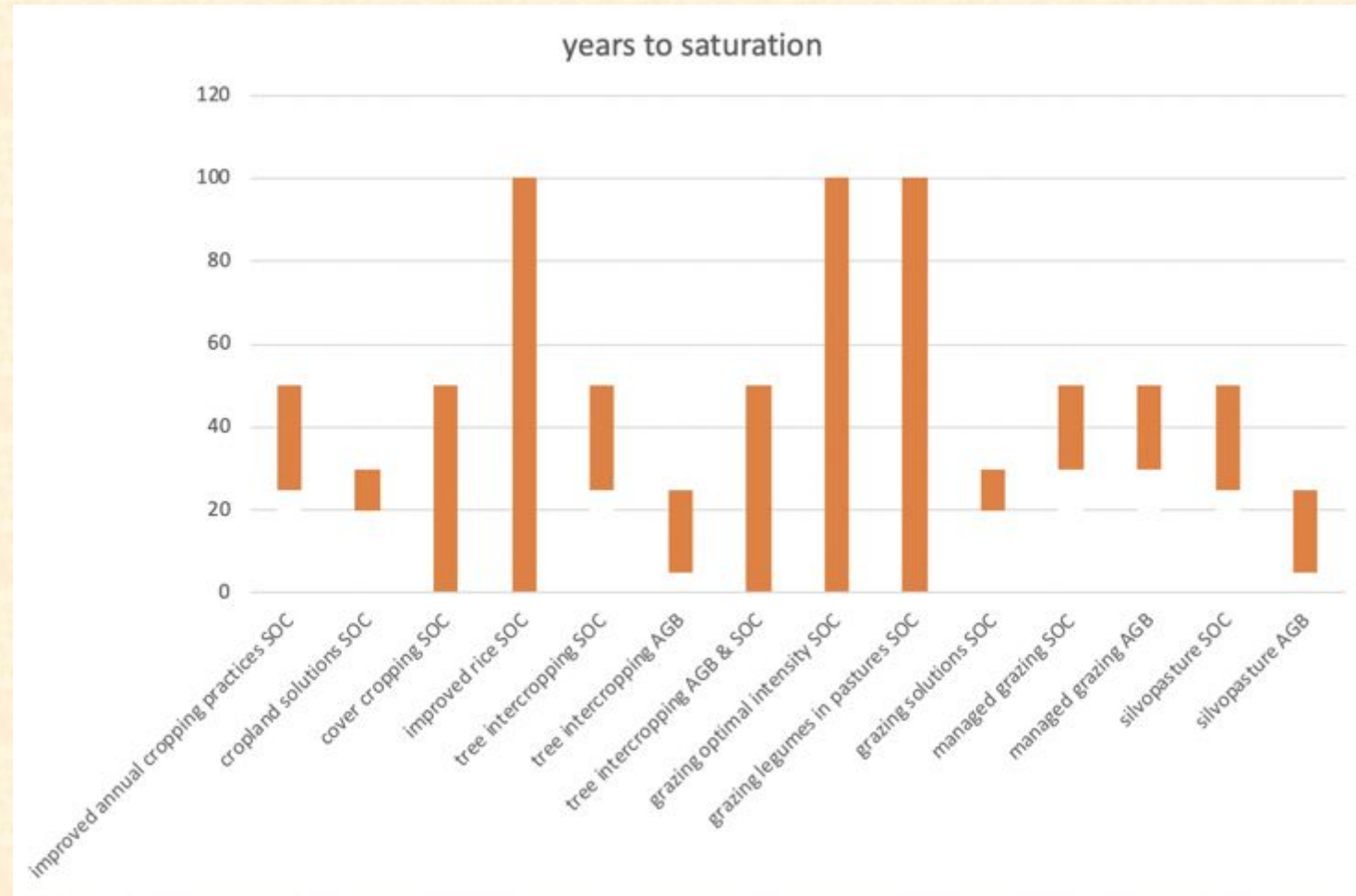
Rates Vary by Practice and Climate

- Climate justice:
 - Did least to cause problem, most impacted
 - Highest rates limited to tropics
 - Lowest cost



Drawbacks

- Not unlimited
 - Generally 20-50 years to slowdown
- Not permanent
- Reversible
 - Change in farming
 - Change in climate



Annual Cropping



conservation agriculture



System of Rice Intensification



organic annual cropping

Agroforestry: Protective Systems



windbreaks



living fence/
hedgerow



living fenceposts



riparian buffer

Tree Intercropping



irregular intercropping



strip intercropping



border plantings



pasture cropping

Perennial Crops



- *Perennial staples: carbohydrates, protein, fats*
- *Fruit trees*
- *Vegetable trees*
- *Perennial crops for materials, chemicals, and energy*
- *Timber crops*
- *Bamboo*

Grazing Systems



managed grazing



intensive/adaptive



compost application on rangeland

Silvopasture Systems



standard silvopasture



fodder silvopasture



intensive silvopasture

The Urban Landscape

- Reduce tillage and bare soil
 - Mulch, organic-no-till, cover crops
- Turn lawns into food gardens
 - If no lead, enough sunlight etc.
- Plant more trees and shrubs
 - Especially fruits and berries



Food for the Urban Landscape



serviceberry



jujube



pawpaw



mulberry



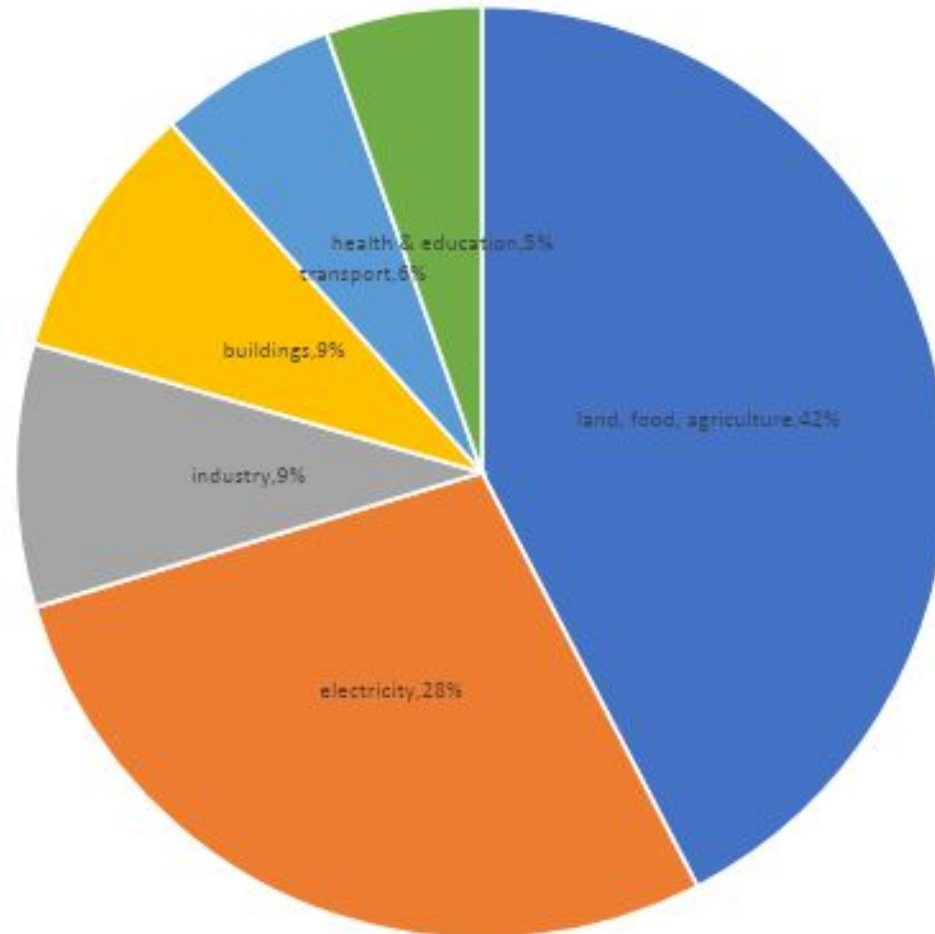
pear

Food System Contribution to 1.5°C

contributes 28% of emissions today

offers 42% of mitigation

Sector Contribution to Achieving 1.5°C



carbonfarmingsolution.com
drawdown.org
tabledebates.org

The Carbon Farming Solution

A Global Toolkit of Perennial Crops and Regenerative Agriculture
Practices for Climate Change Mitigation and Food Security

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"In *The Carbon Farming Solution*, Eric Toensmeier admirably harnesses available data with traditional wisdom to propose a practical response to climate change. Toensmeier's solution-oriented ideas combine his clear understanding of ecology, agriculture, and the magnitude of the challenge we face with a set of agriculture-based solutions that are suited to various livelihoods, communities, and systems of production. This book will surely be a benchmark in policy-relevant knowledge."

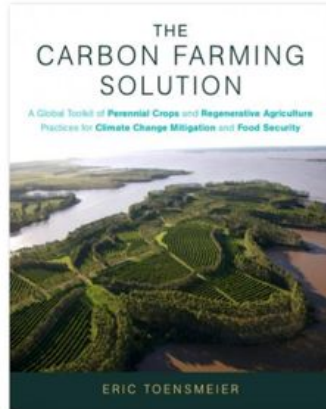
--Dr. Cheikh Mbow, IPCC panelist and senior scientist on climate change and development, World Agroforestry Centre

[Read more reviews](#)

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Click [HERE](#) to buy the *Carbon Farming Solution* for your Kindle today!

In the meantime, please consider joining our [mailinglist](#).



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A DRAWDOWN PRIMER

FARMING OUR WAY OUT OF THE CLIMATE CRISIS

Changing Our Land Use, Agricultural Practices, and Food System Offers
Numerous Opportunities to Reduce Greenhouse Gas Emissions, Sequester
Atmospheric Carbon, and Help Address Climate Change

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