



sustainable food & feed systems: **the role of alternative proteins**

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**FOOD SYSTEMS &
GLOBAL CHANGE**

Cornell **CALS**
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The
Economist

Is lab-grown meat kosher?

**CAN CULTURED MEAT
EVER BE MORE THAN A
SCIENCE EXPERIMENT?**

proto.life

**Plant-based meat industry on
a mission to rebrand itself as
healthy option**

FT

**Fake Meat Looks for Revival After
Boom Fizzles Out**

Bloomberg

FoodNavigator
USA

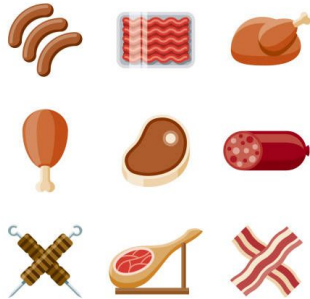
**Bridging the gap between conventional meat and
alternative proteins**

**nature
communications**

**Feeding climate and biodiversity goals with
novel plant-based meat and milk alternatives**

conventional animal-source foods are **diverse**

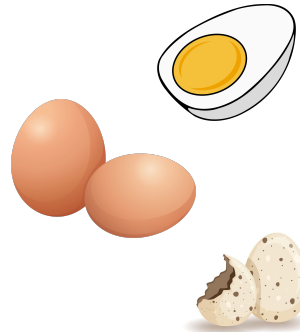
meat



dairy



eggs



aquatic animals

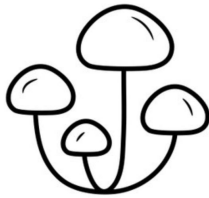


alternative protein category is **expansive & evolving**

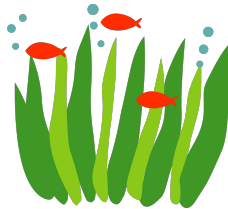
plant
-based



fungi
-based



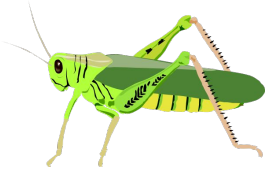
algae
-based



cell
-based



insect
-based



consumed as

substitutes

• • additions

• • ingredients

continuum of “alternative proteins”


BCE

1900s-2000s


future

level of processing


insects




legumes, nuts & seeds




tempeh




tofu




early soy-based meat




myco-protein




plant-based meat alternatives



algae protein (mass cultivation)



insect powders (mass production)



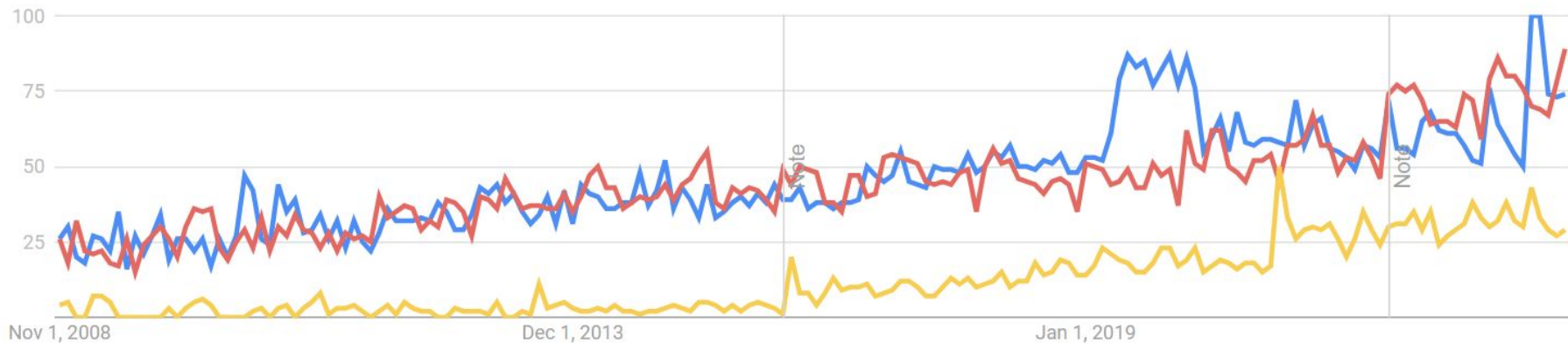
cell-based meat, seafood & dairy



public interest in “alternative protein” has grown in the past 15 years**

Google Search Data

2008-2024



alternative protein

fake meat

cultured meat

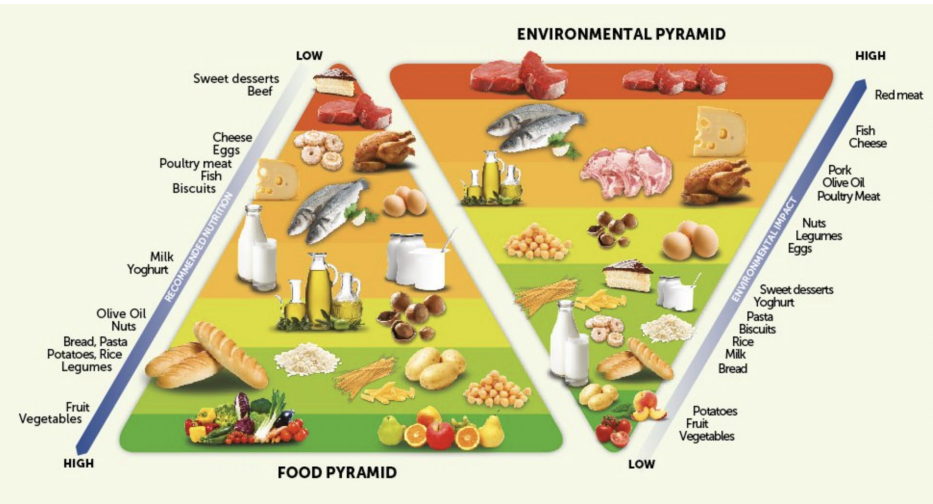
** i.e., meat, poultry, fish, seafood, egg, and dairy

A systematic review on consumer acceptance of alternative proteins: Pulses, algae, insects, plant-based meat alternatives, and cultured meat

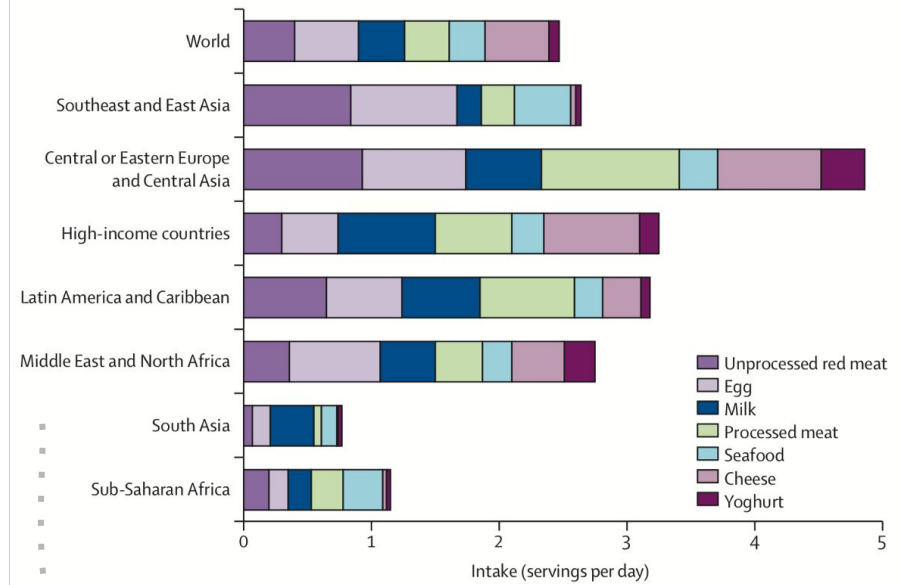
M.C. Onwezen  , E.P. Bouwman, M.J. Reinders, H. Dagevos

momentum has also grown in

research & policy guidance



moderating our consumption of animal source foods carries benefits



Source: Miller et al (2022)

lower ASF consumption
(where high) can reduce:

GHG emissions

land use

non-communicable disease

Source: Willet et al (2019)

understanding the **viability**
of **alternative proteins**

modern alternative proteins can be unaffordable





some cultures may reject certain alternative proteins

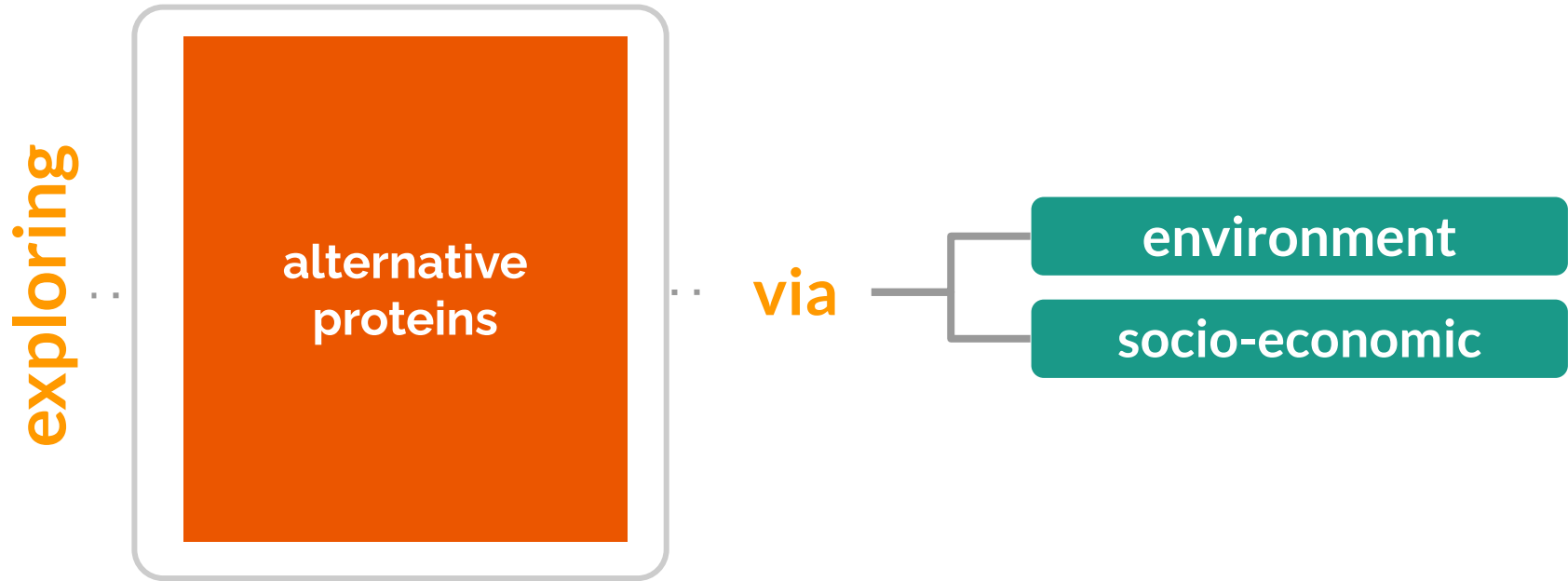


food safety drives trust and scales innovation

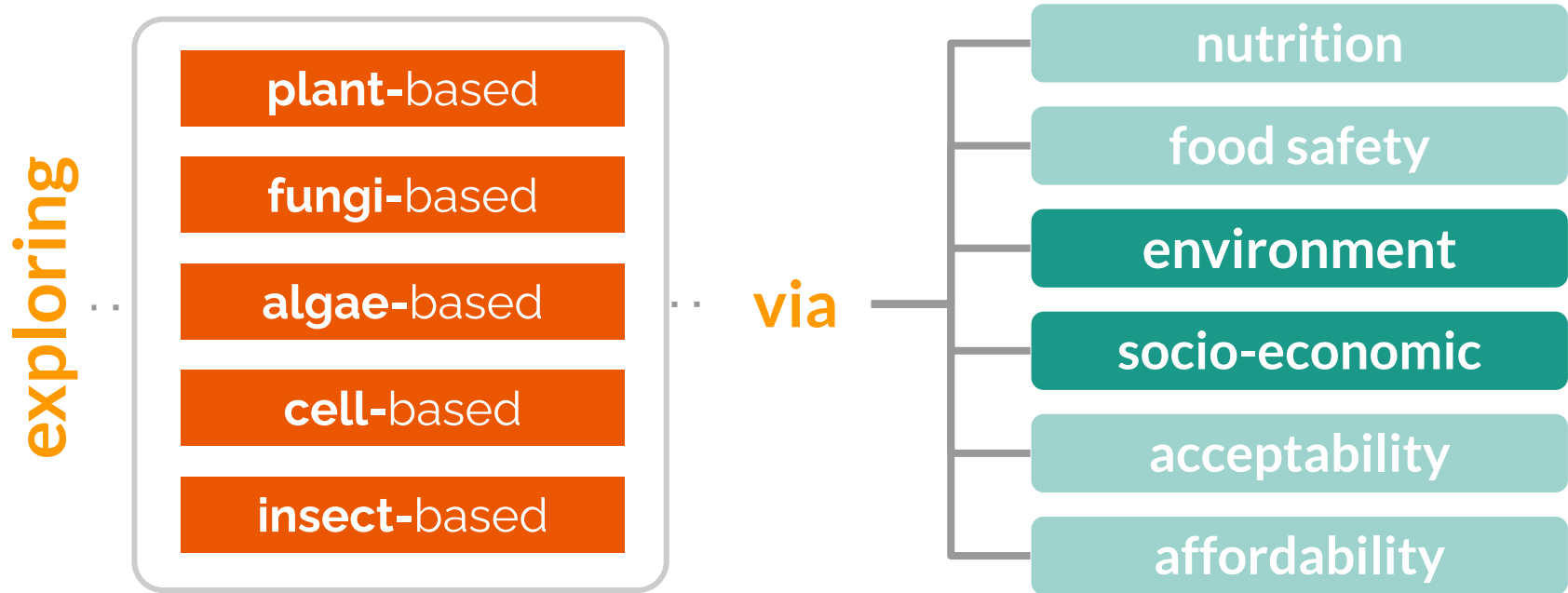
resource scarcity will redefine the menu



what can **alternative proteins** unlock?



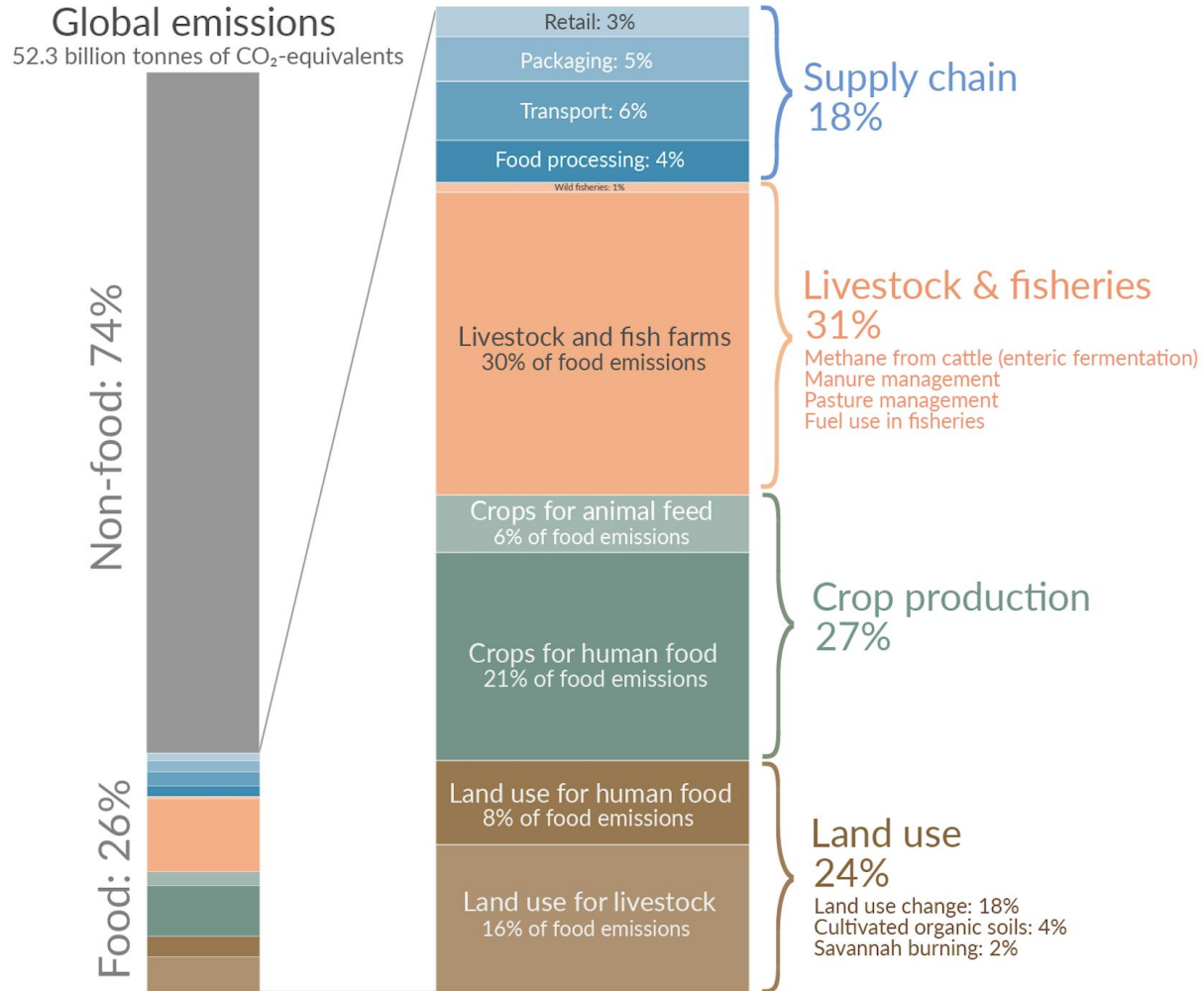
what can **alternative proteins** unlock?



role of alt proteins in sustainable
food systems

global GHG from food production

source:
Poore & Nemecek 2018



protein puzzle

need **70%** more
protein by 2050

need to cut beef
consumption by **90%**





can alternative proteins do more with less?



a greener future?

alternative proteins are
generally* more
environmentally
sustainable

carbon footprint

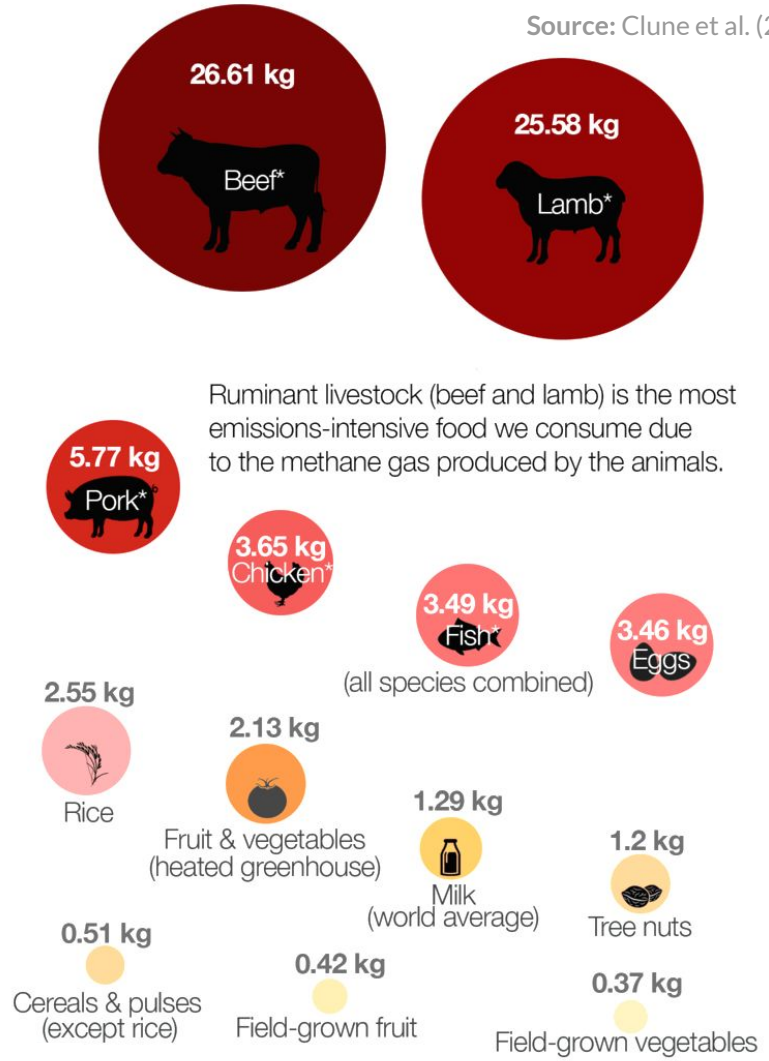
land use

water use

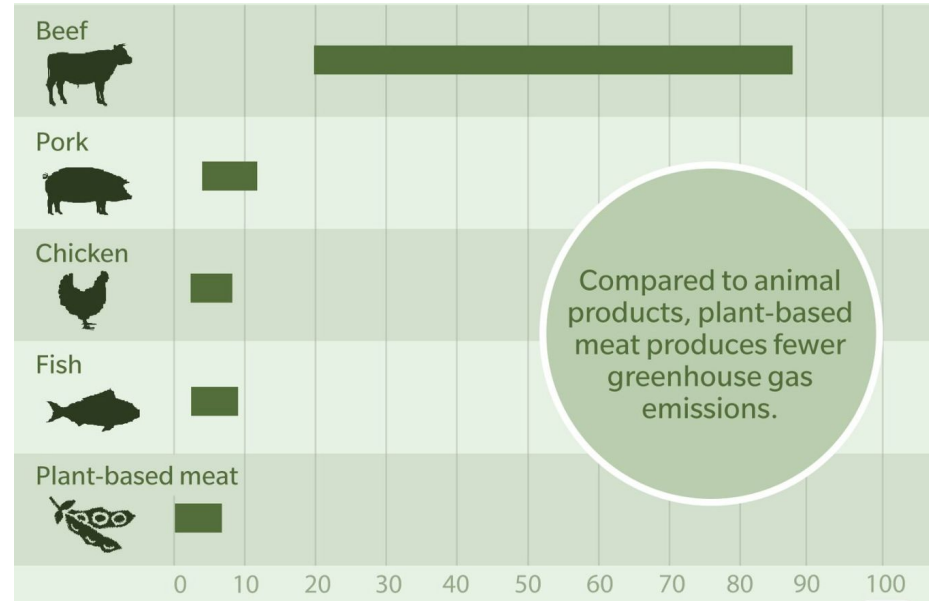
biodiversity

nutrient cycles

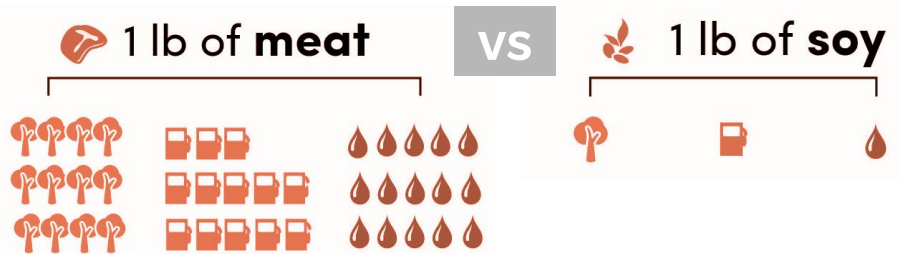
carbon footprint of our foods



alt proteins are an
environmental
bang for buck

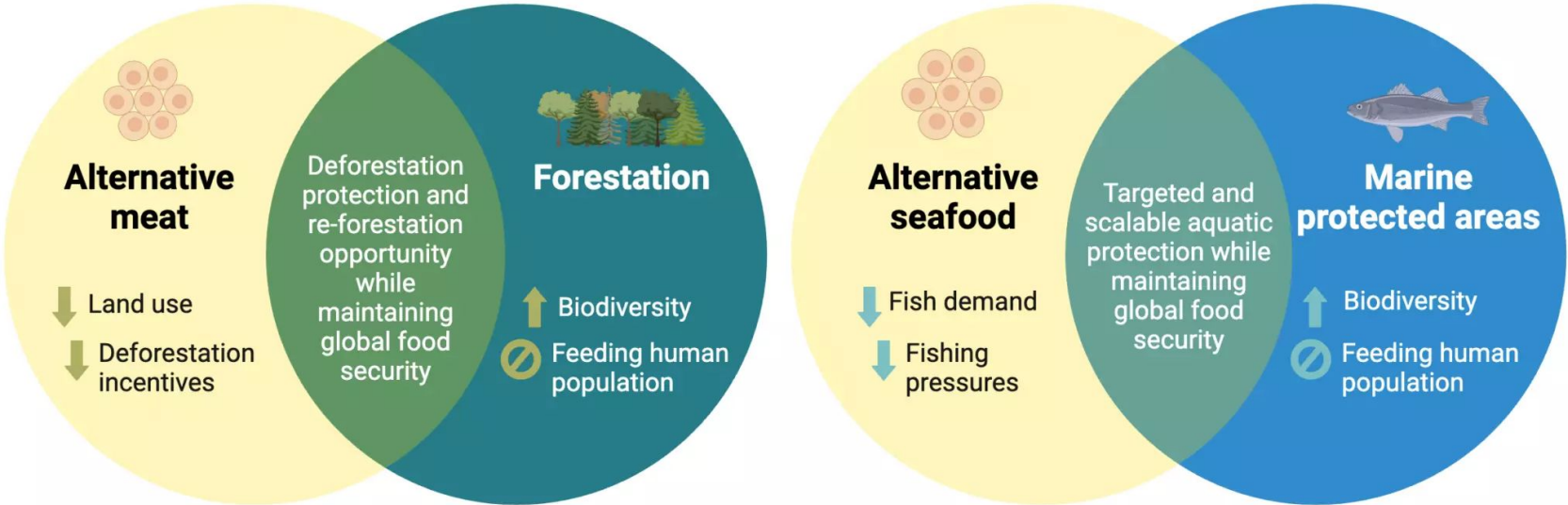


Source: Santo et al. (2020)



Source: Reijnders & Soret (2003)

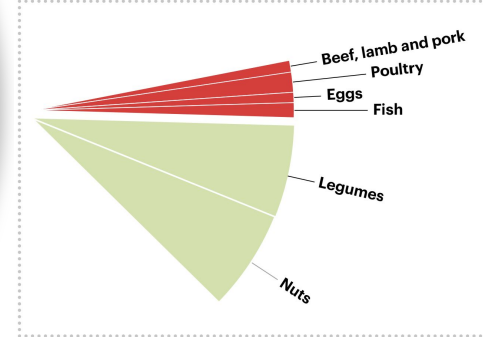
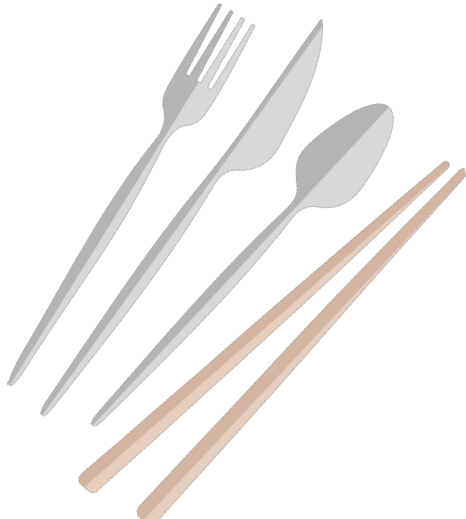
alt proteins can also **protect biodiversity**



“alternative” proteins will become the new normal



EAT-Lancet Reference Diet

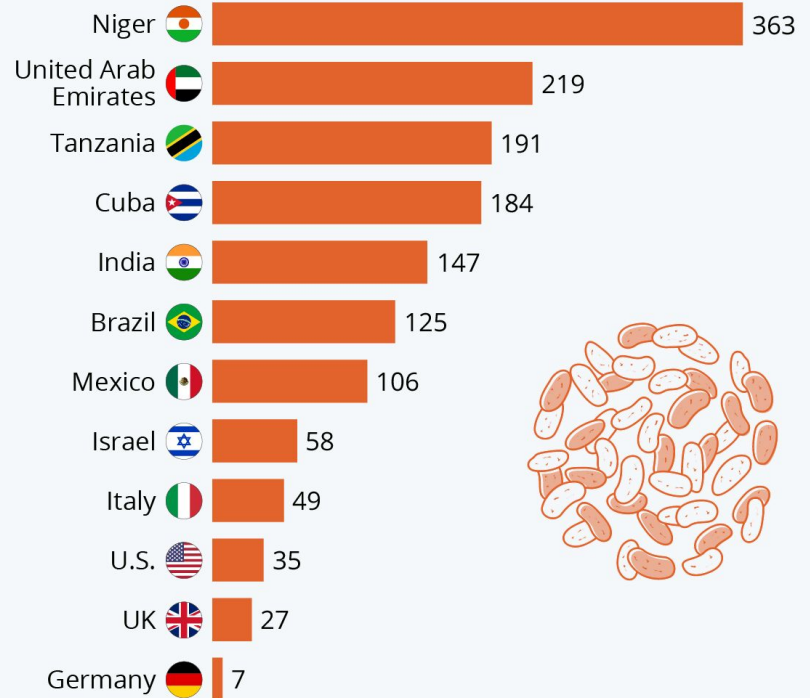


2500 kcal/day

source: FAO 2018

daily staple: where are legumes on the menu?

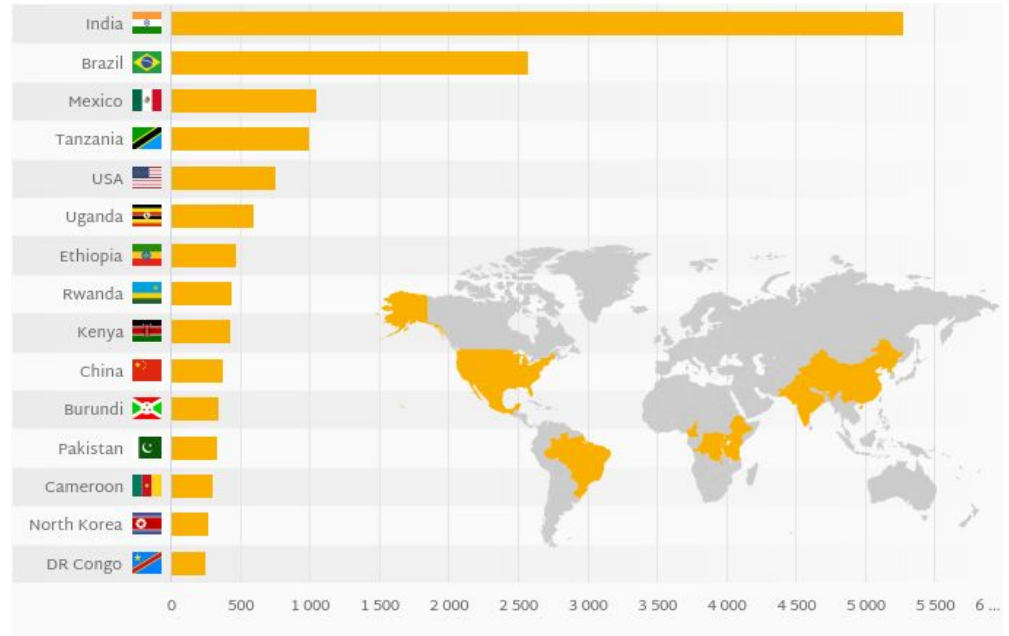
kcal / capita



source: Hegli 2021

global giants: pulse production and imports

kilotons / country



**eat food.
not too much.
mostly plants.**

— Michael Pollan

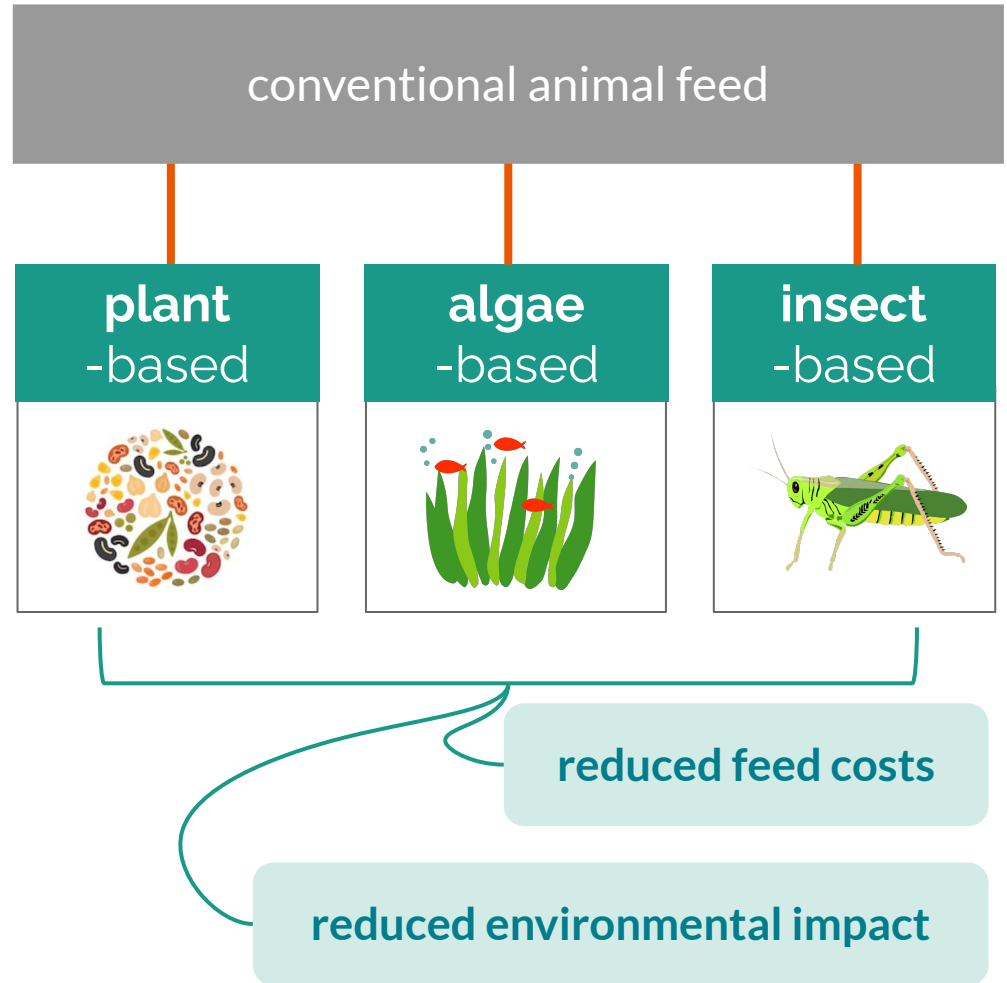


role of alt proteins in sustainable
feed systems

animal feed can account for a significant share of emissions



alternative
protein as
animal feed



black soldier flies provide a nutrient-dense, efficient alternative to traditional feeds, lowering costs and dramatically reducing agricultural waste streams



source: Van Huis et al. 2022

spirulina is a powerful alternative animal feed, boosting livestock health, growth, and fertility — making it a cost-effective solution for sustainable farming and future food security



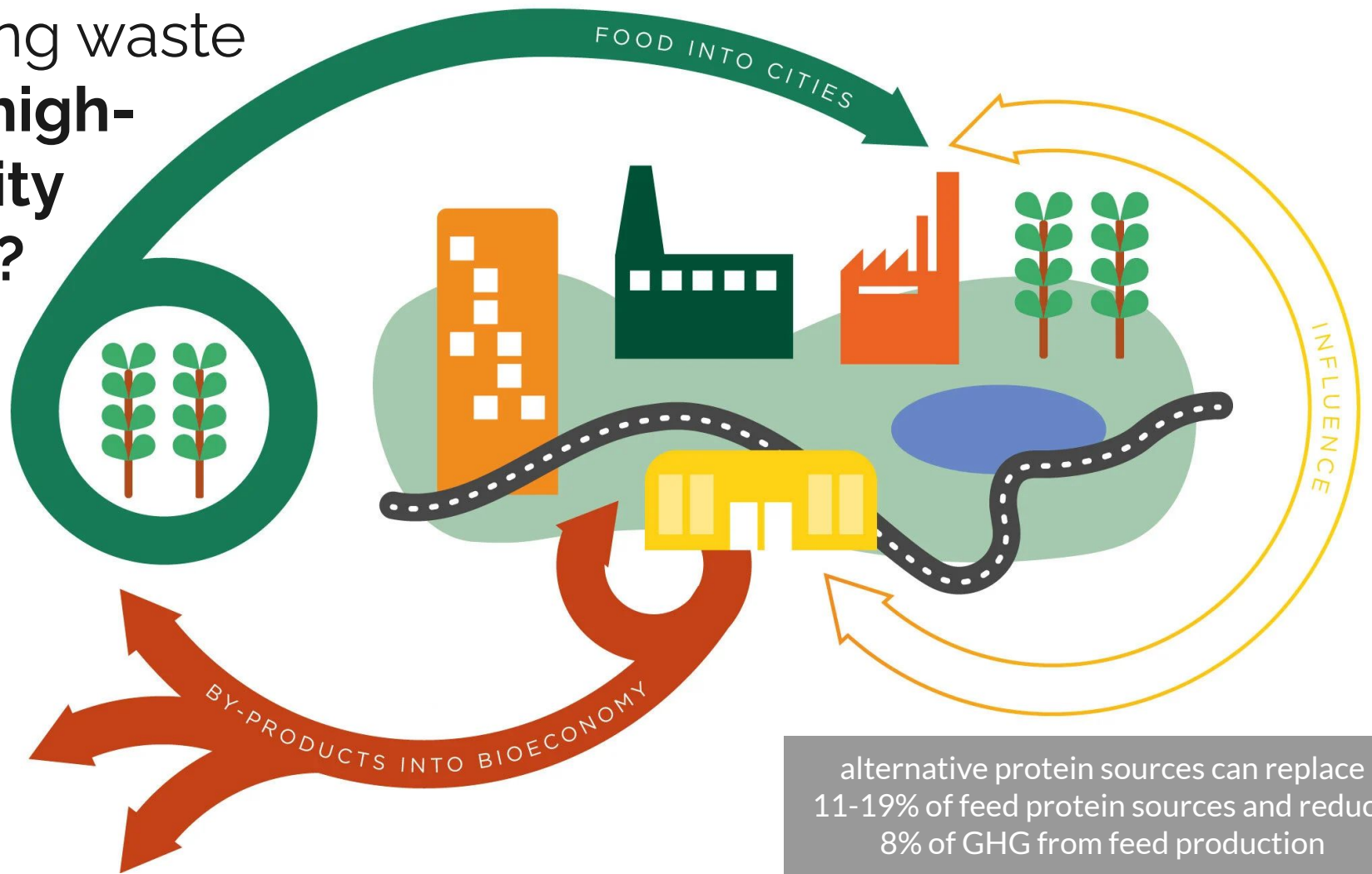
source: Waheed et al. 2024

peas & fava beans offer a sustainable and protein-rich feed option, enhancing livestock nutrition while promoting crop diversity and reducing reliance on resource-intensive soy



source: FAO 2021

turning waste
into **high-
quality
feed?**

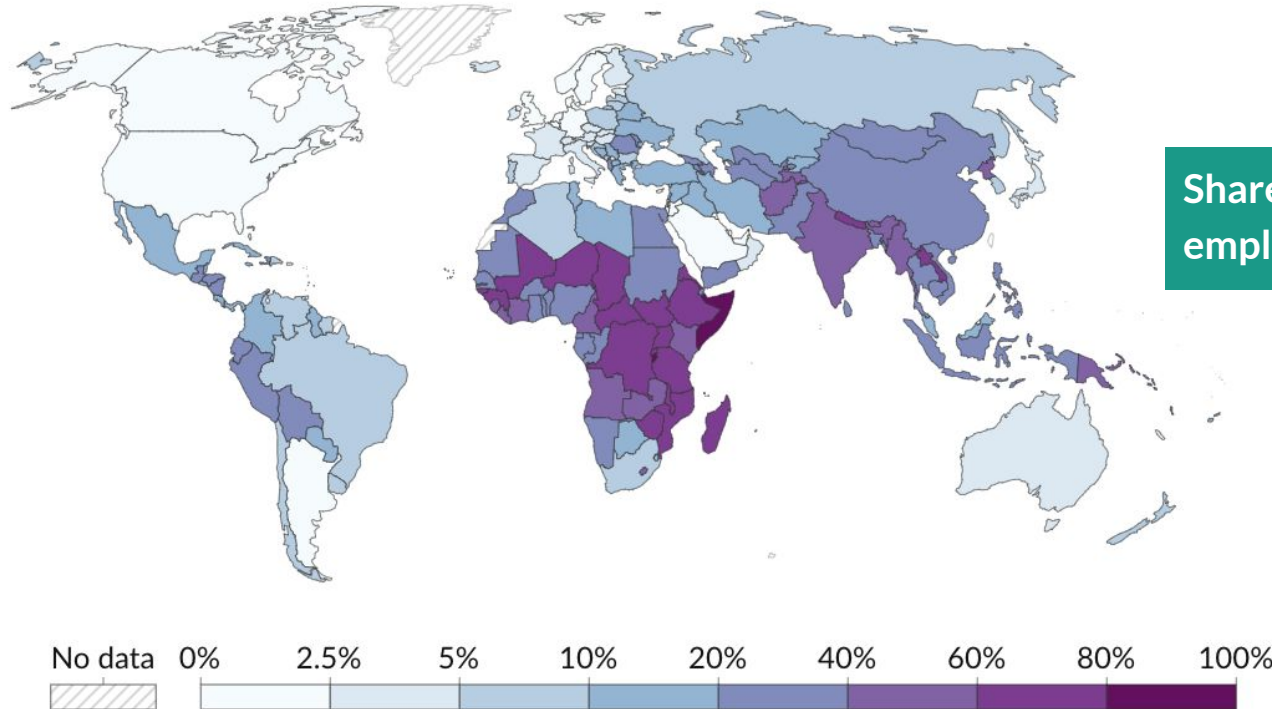


alternative protein sources can replace
11-19% of feed protein sources and reduce
8% of GHG from feed production

sustainability =

livelihoods

shifts in food systems **impact livelihoods**



Share of national labor force employed in agriculture (2019)

source: ILO / World Bank



livestock sector supports **1.7b** low-income people

wider adoption
of alt proteins
can also **offer
opportunities**

land access

location

skills & education

job quality





source: Xin et al. 2021

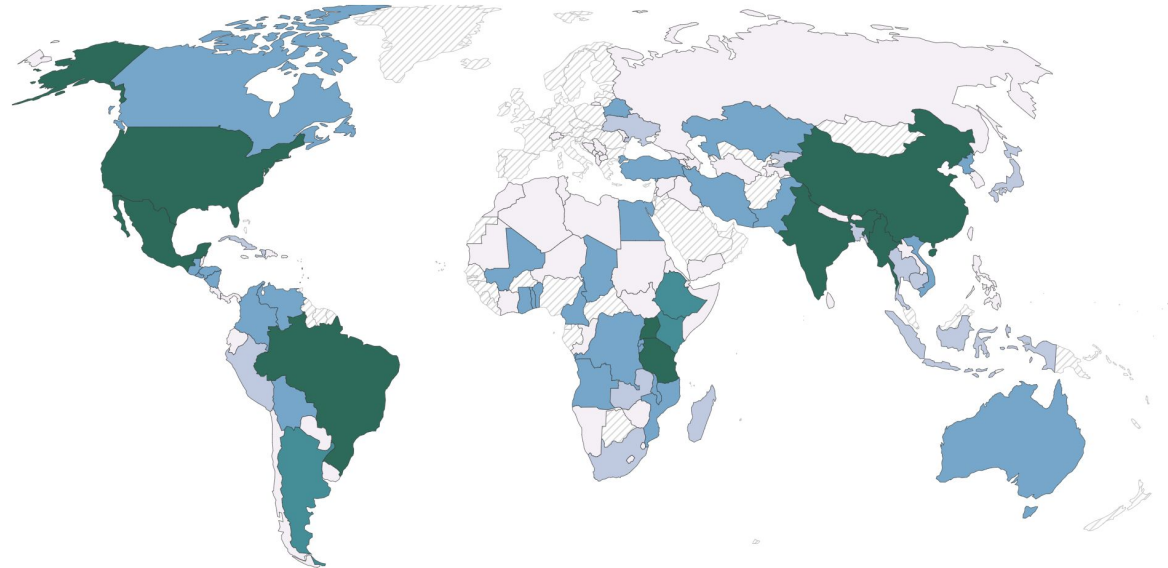
cultured meat
rooted in the
global north



global legume production

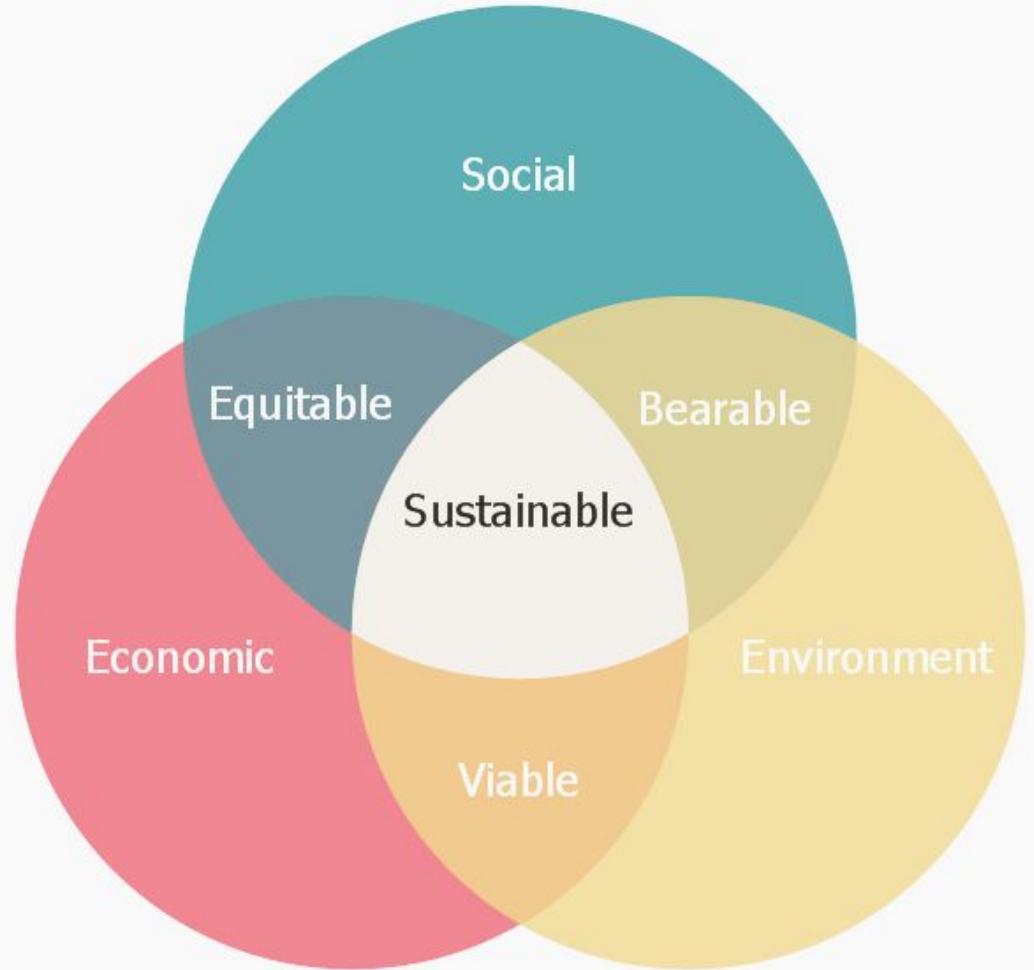
source: FAO

plant-based
protein:
**a global
enterprise**





**an alt protein
revolution** must
strike a balance



An illustration of an airplane cabin interior. Three rows of blue seats are visible, each with a screen on the backrest. The middle seat of the front row has a meal tray extended. The tray contains a white bowl with green vegetables, a hard-boiled egg, and a piece of chicken. Next to the bowl is a red apple and a glass of water. A fork and a spoon are also on the tray. A white text box is overlaid on the left side of the image.

flight attendant: **chicken or pasta?**

passenger: **ginger ale**



thank you

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