Ollscoil na Gaillimhe
University of Galway

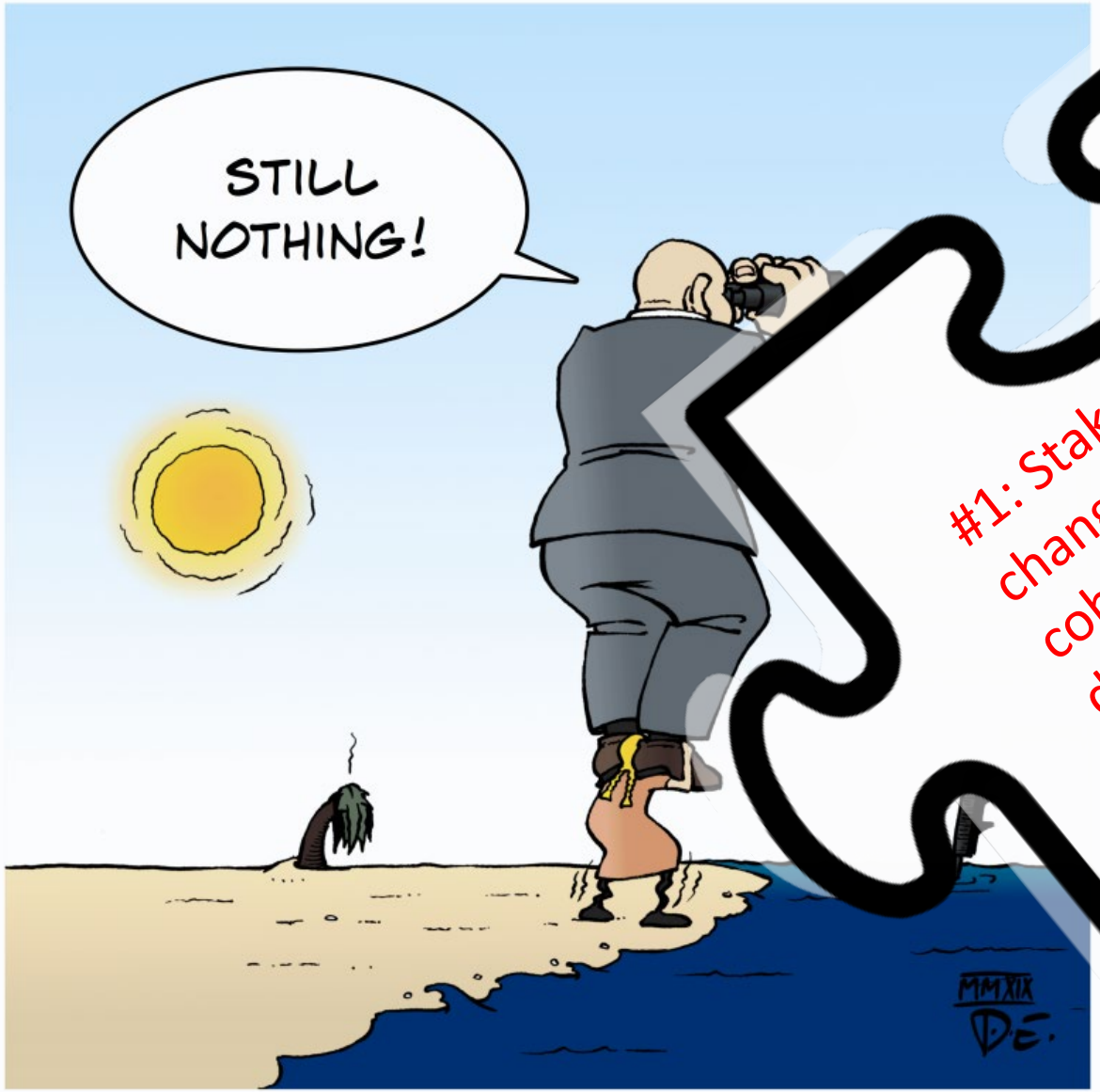
Visioning sustainable & resilient agriculture: known pieces of the confounding puzzle

David Styles, University of Galway

epa Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

Department of Agriculture, Food and the Marine
An Roinn Talmhaíochta, Bia agus Mara

Why vision?



#1: Stakeholder buy in to change requires (a) coherent vision(s) for the destination

dicting the future is a mug's game

- Bu ate sight essential to deal with ncertainty (OECD)

esight critical for a vibrant

(high external costs)

e food system

- Imp of climate change (adaptation & resilience)

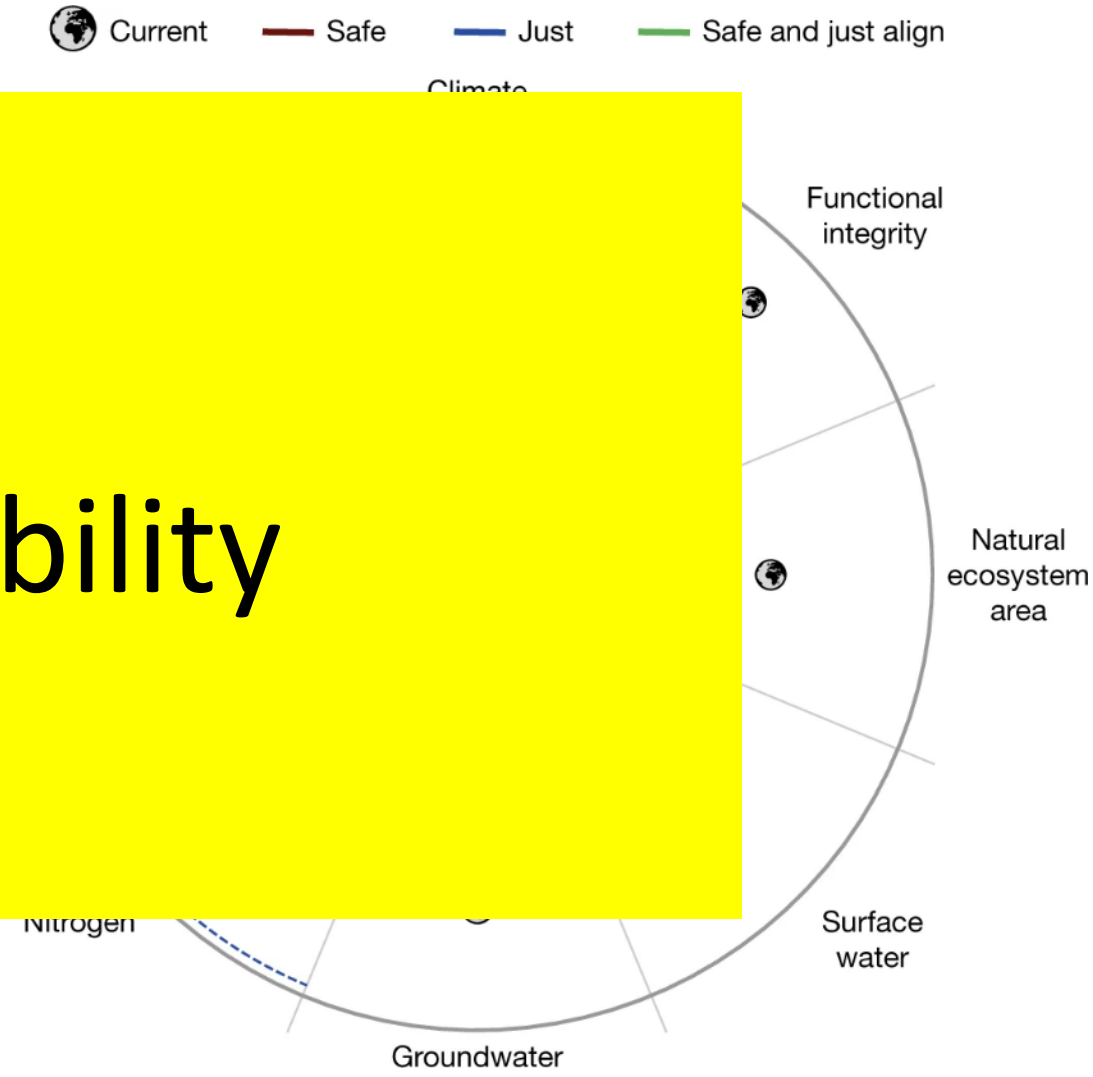
Timely action essential for <u>future</u> sustainability (climate neutrality)

- Reactionary approach = current pickle!

“Sustainable” food

- Econor
  bound
- Food p
- Popn c
  nourisl
- Overcc
- 30-40%
- Farme
- Production & revenues poorly distributed
- Retailers strive to sell more every year

≠ sustainability



Rockström et al. Safe and just Earth system boundaries. Nature (2023). https://doi.org/10.1038/s41586-023-06083-8

“Resilient” farming & food

- Resilience ≠ efficiency
- Ability to respond to changes (manage risks)…
- Changing input/import availability & prices
- Changing demands
- Changing regulations
- Changing climate
- ???

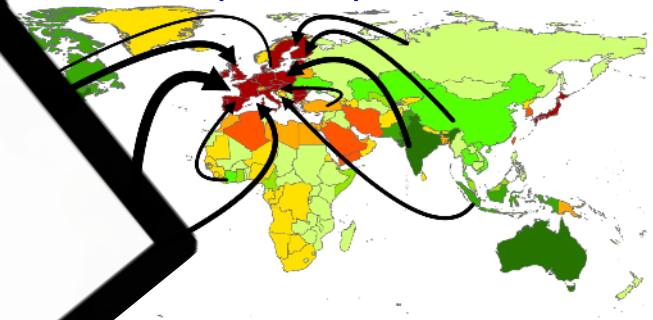
= Diversity & adaptability

Climate impacts (e.g.

Alternative protein growth

#2: Future agri-food systems will have to look very different

ed water (stress)

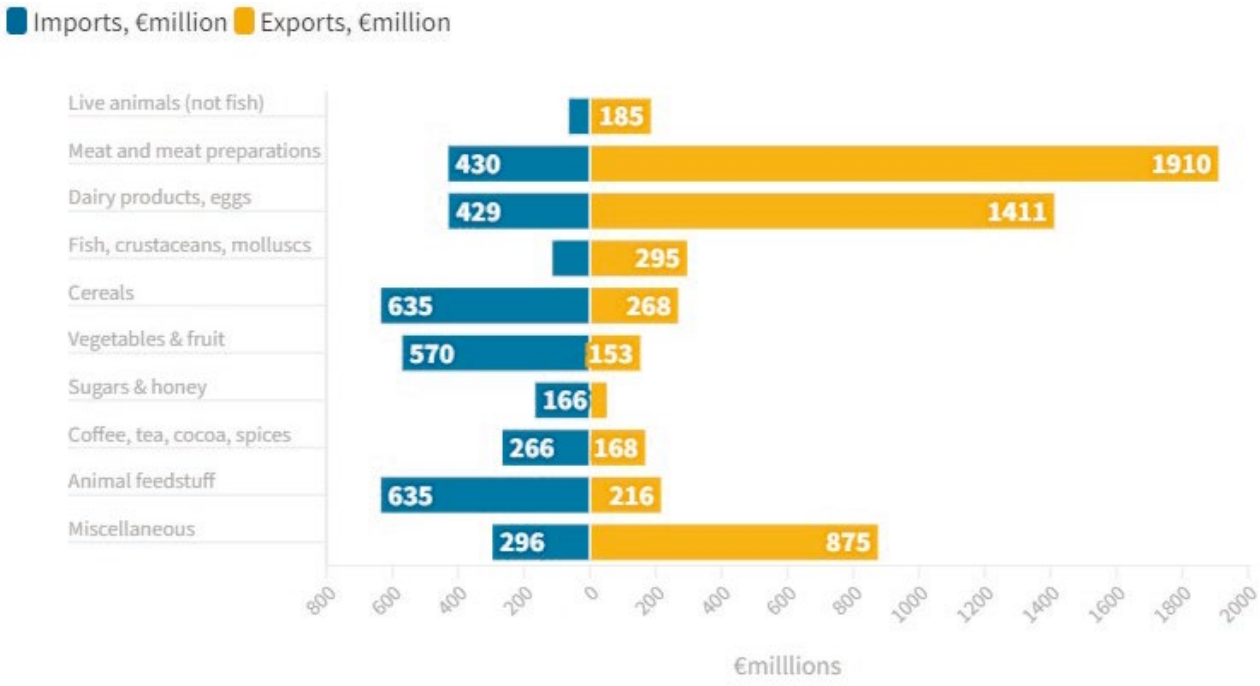


://www.w g/time-for-action/what-can-governments-do/

Bioproducts

Ireland in global food system

- ✓<u>Comparatively</u> low carbon footprint milk & beef
- ✓Productive grass platform: low-cost milk solids
- ✓ 7% IE GNI & employment, 10% exports, 1.8 - 2.5 x multiplier
- ✓Effective green marketing (green & pleasant land)



But most consumed food is imported, and…

A leaky system

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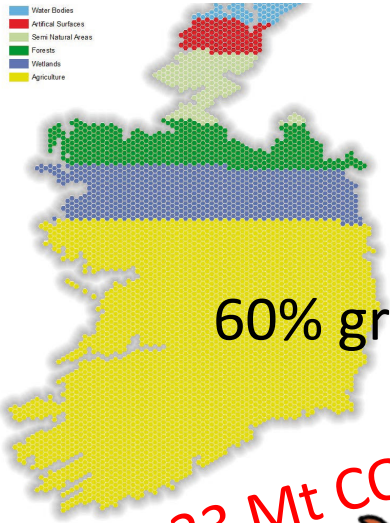


60% grassland

120 kt am nia

87 kt

ca ure

+23 Mt CO_2e fr

#3: Continued specialisation in leaky food production (& expensive abatement) is a huge gamble on the future

+9 Mt CO_2e fror
drained organic

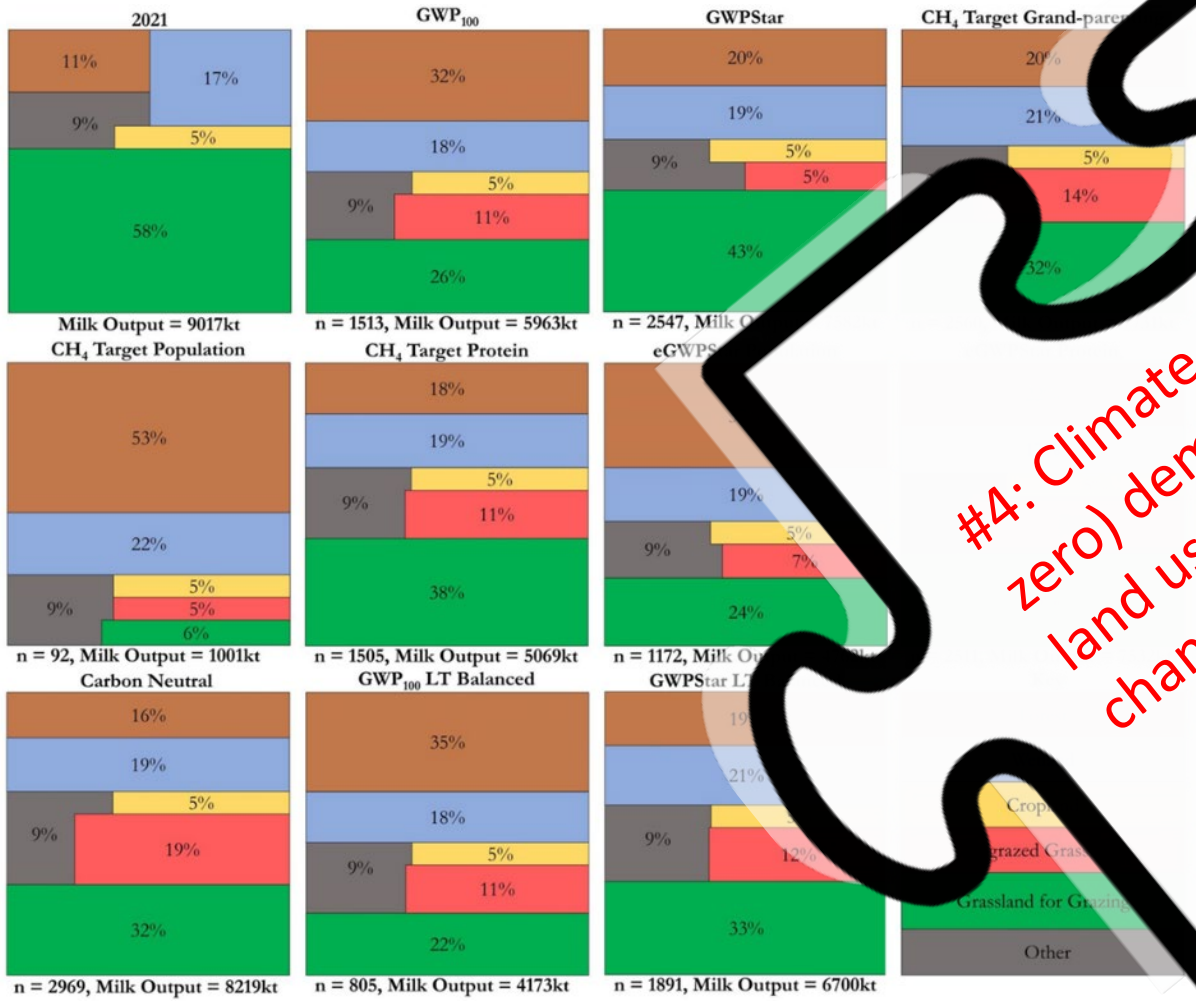
from
improve.

11% forest

- 2 Mt CO_2e (sink) from forestry & wood products

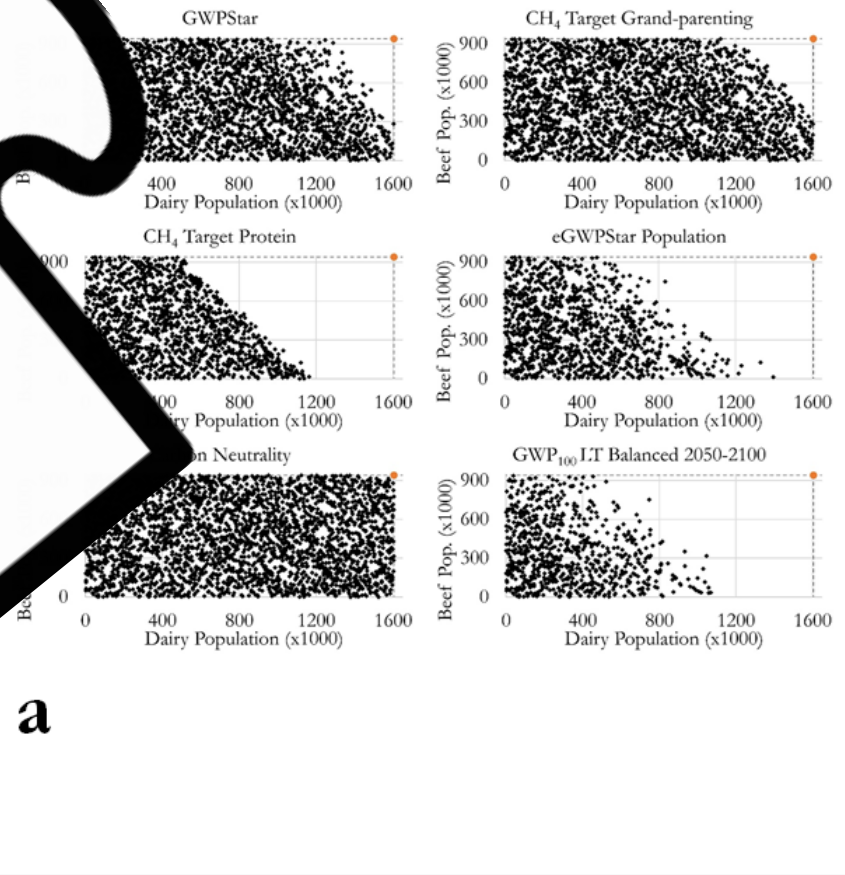
Climate-neutral AFOLU in 2050

95%ile milk output by definition 2050-2100



iations & bounds across parameters

(by definition)



#4: Climate neutrality (net zero) demands large scale land use & management changes (0.8 M ha +)

Figures include 30% technical abatement of CH_4 & N_2O

Duffy et al. https://doi.org/10.1038/s41893-022-00946-0 Bishop et al. (in review)

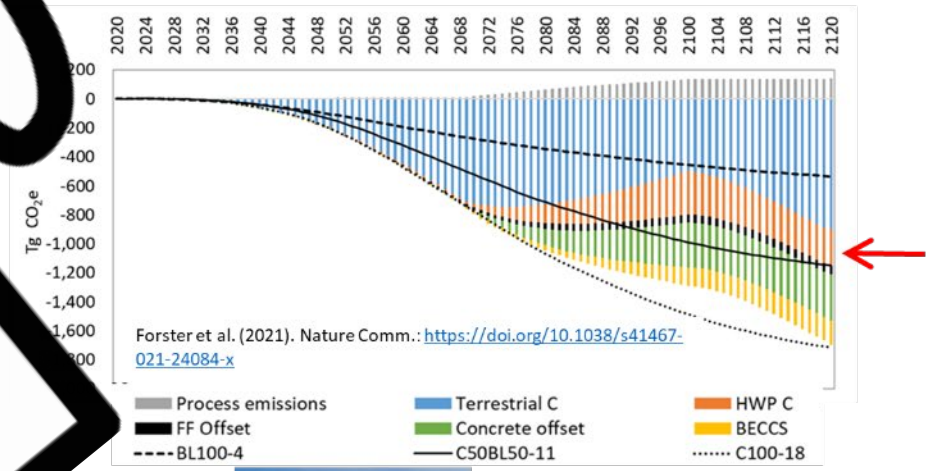
Forestry

- > 0.5 Mha new forest by 2050
- Cascading wood use:
  - faster & longer offset
  - lower biodiversity value
- Semi-natural woodland:
  - bigger biodiversity benefits
  - overlap with Nature Restoration?
- Need to avoid organic soils:
  - displacement of liv
- Need to plant now for 2
- Future pest, disease & fire
- Distribution across catchments?
- What to plant where?

#5: Carbon off-setting will require commercial & native forests to replace livestock on mineral soils

Harvested Wood Products (40-100+ yrs)

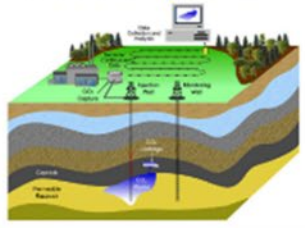
- HWP C s
- Substi



5-60 yrs

45-70 yrs

1000s of years?



Organic soils

- Ca. 70 kha exploited peatlands (good progress) & 300 kha peat soils under grass require water table management by 2050
- Uncertainty over drained and (partially) re-wetted emissions
- Uncertainty over (partially) re-wetted productivity potential
  - But ideal nature restoration areas?
- Uncertainty over extent of grazing and drainage on upland peat
- Nonetheless, water tables need to be raised to reduce these emissions
- Longer-term benefits for water quality, flood regulation & biodiversity

Grass biorefineries?

- Biomethane strategy (5.7 TWh/yr, ca. 150 kha)
- Avoided manure emissions, livestock displace… modest fossil fuel substitution
- Grass-clover: reduced field NH_3 & N… tiliser (… more reactive-N in digestate)
- Fugitive CH_4 & NH_3 emission… digestate
  - air & water quality risk
- No carbon sink (offset) for the ag se… cost of 150+ kha!)
- No land cover diversification, … biodiversity benefits
- Biorefinery approach to derive real e…ssion be…
  - grass-protein extraction
  - refined biofertilizer production
  - future $C(O_2)$ removal (H_2 fuel)?

#7: Biomethane strategy alone incremental at best; grass biorefineries could deliver > emission savings

Styles et al. (2018). https://doi.org/10.1016/j.scitotenv.2016.03.236

Alternative proteins

chickpea pasta vs. wheat pasta

https://doi.org/10.1016/j.spc.2020.06.012

pea protein balls vs. meatballs

https://doi.org/10.1016/j.jclepro.2021.126447

pea and soy burger vs meat burger

https://doi.org/10.1016/j.spc.2021.07.017

gin from peas vs. gin from wheat

https://doi.org/10.1016/j.envint.2019.05.064

Vegan mayo (w/*aquafaba*) vs. egg mayo

https://doi.org/10.3390/su13094726

- Growing markets for plant-based proteins (also for animal feed)
- Expansion of arable area in CAP – soil C loss vs livestock (emission) displacement, diversification & food security benefits

Implications for farmers

- Current agri-food system is environmentally, socially and economically (for many farmers) unsustainable
- Efficiency & abatement measures alone insufficient & huge gamble on uncertain future
- Climate action will require 0.8 Mha +++ diversification (afforestation + rewetting)
- Biodiversity action will require additional areas returned to nature
- Likely to realise substantial water, air quality & resilience co-benefits
  - Spatial assessment needed to maximise benefits & minimise trade-offs
  - Financing instruments will be necessary
- The bioeconomy and alternative proteins will drive further diversification
- Despite uncertainties, initial direction of travel clear (learning by doing inevitable!)
- Farmers are the agents of change, but require a coherent policy & market framework guided by a strategic, long-term (decades) vision
- Ireland's land offers a plethora of opportunities – let's harness more of them!

david.styles@universityofgalway.ie

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