Methane (CH_4) and Agriculture

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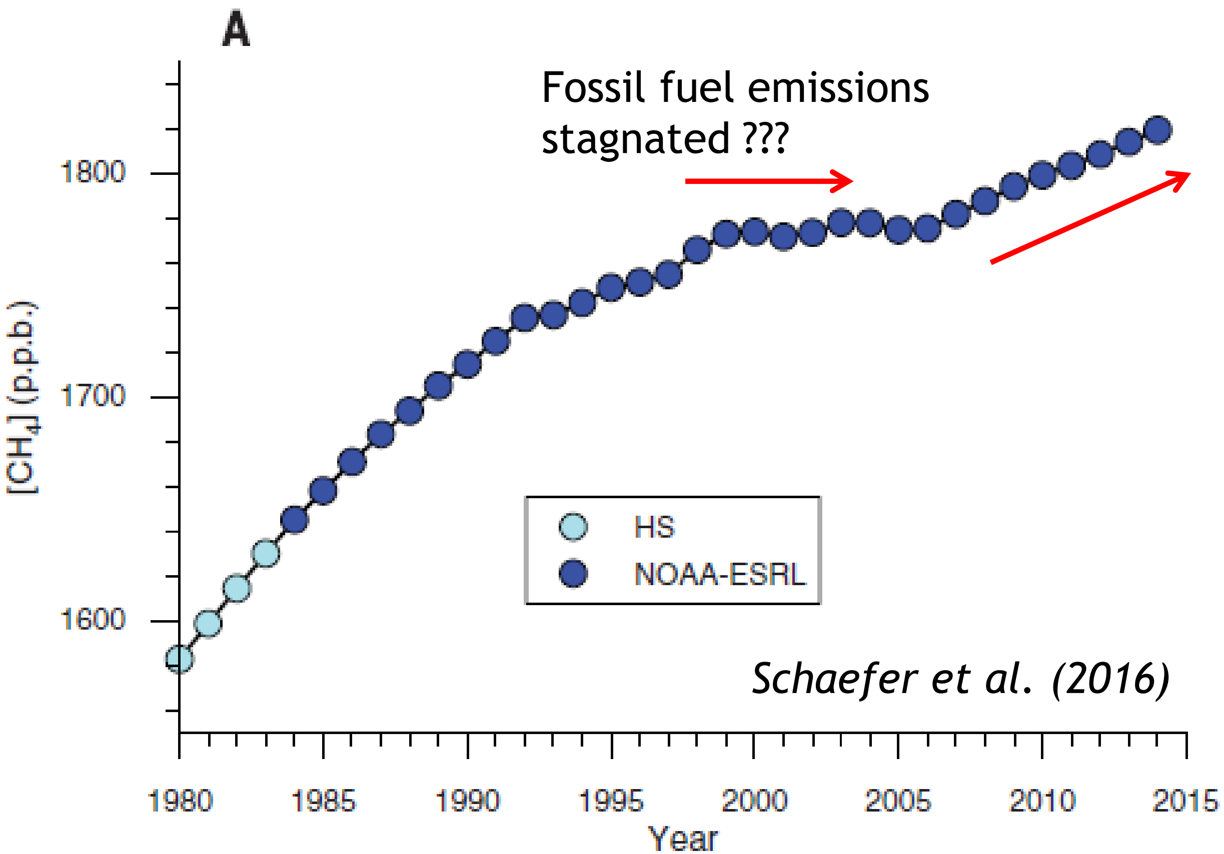
Global trends in CH_4 concentration in the atmosphere



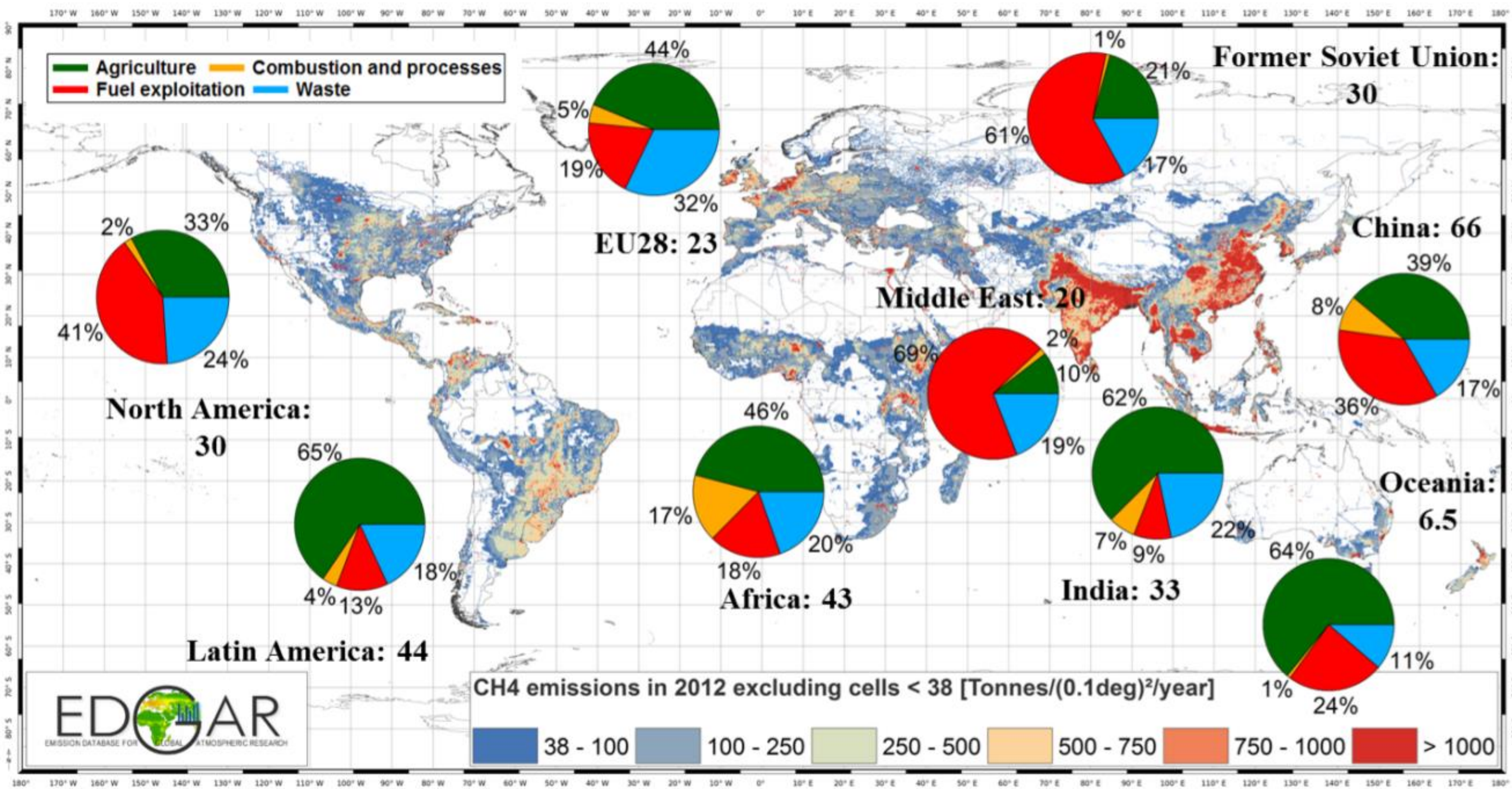
Agricultural emissions? Driven by increased food production

Climate sensitive natural emissions in the tropics (swamps, wetlands)

Decreased cleaning power (hydroxyls) of the atmosphere

2015 Paris Agreement assumed CH_4 emissions would reduce rather quickly….supporting chance of reaching 1.5oC target

Regional sectoral composition of CH_4 emissions



Source: EDGARv4.3.2

Highest CH_4 emissions from agriculture in the tropics (esp. Latin America, Africa & south Asia)

Agriculture ~50% of anthropogenic sources of CH_4

Enteric fermentation

Mitigation: change animal diets, increase animal productivity (e.g. *via* genetic selection)

Manure

Mitigation: anaerobic digesters, manure management (storage and covering), animal housing and feed (affects composition of manure)

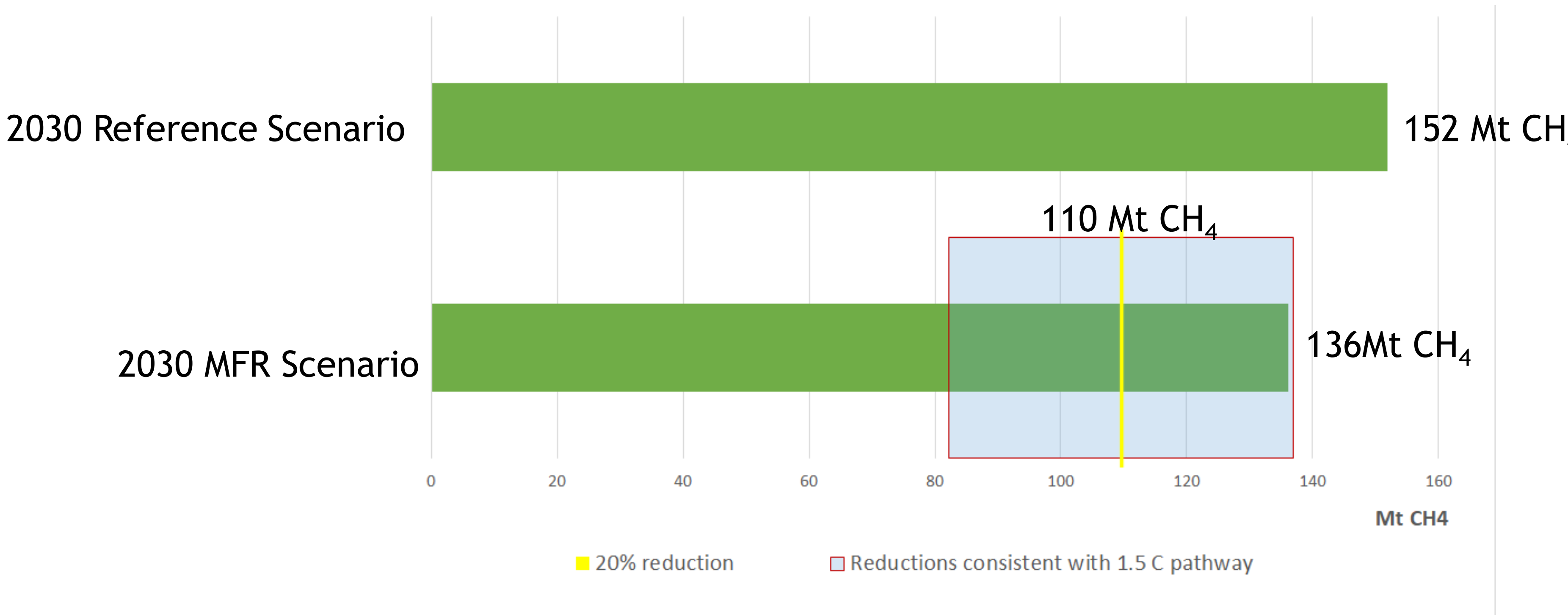
Rice cultivation

Mitigation: intermittent irrigation, change rice varieties, controlled release of fertilizer

Other agricultural sources

Mitigation: Reduce agriculture residue burning, reduce expansion of agricultural lands

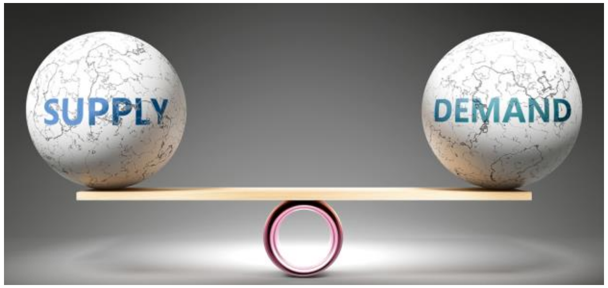
Supply Side CH_4 Mitigation



IIASA GAINS scenarios

Technological measures are not sufficient to achieve the 1.5°C pathway

Supply & Demand CH_4 Mitigation Mechanisms

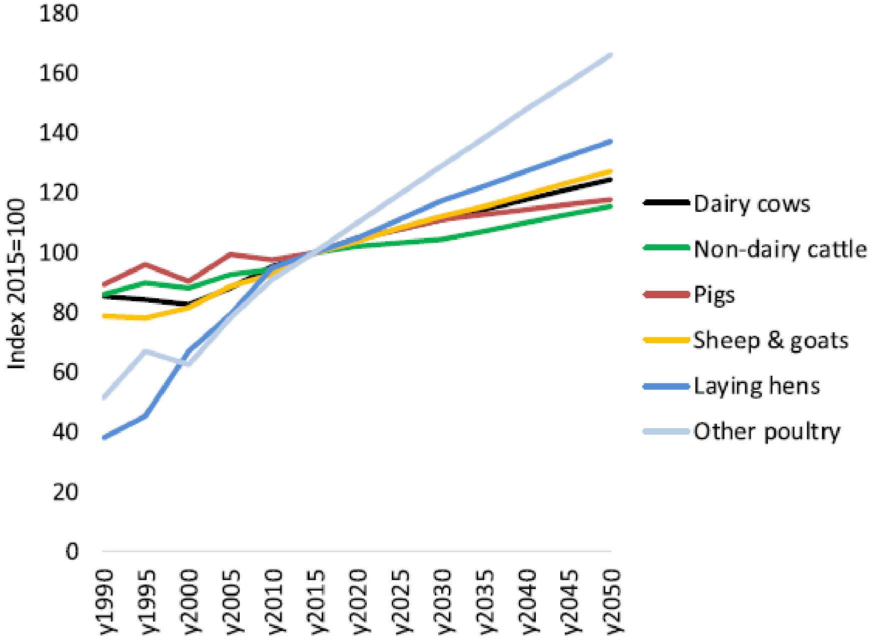


Supply side - Technical options

e.g. change in animal diets, anaerobic digesters, intermittent irrigation

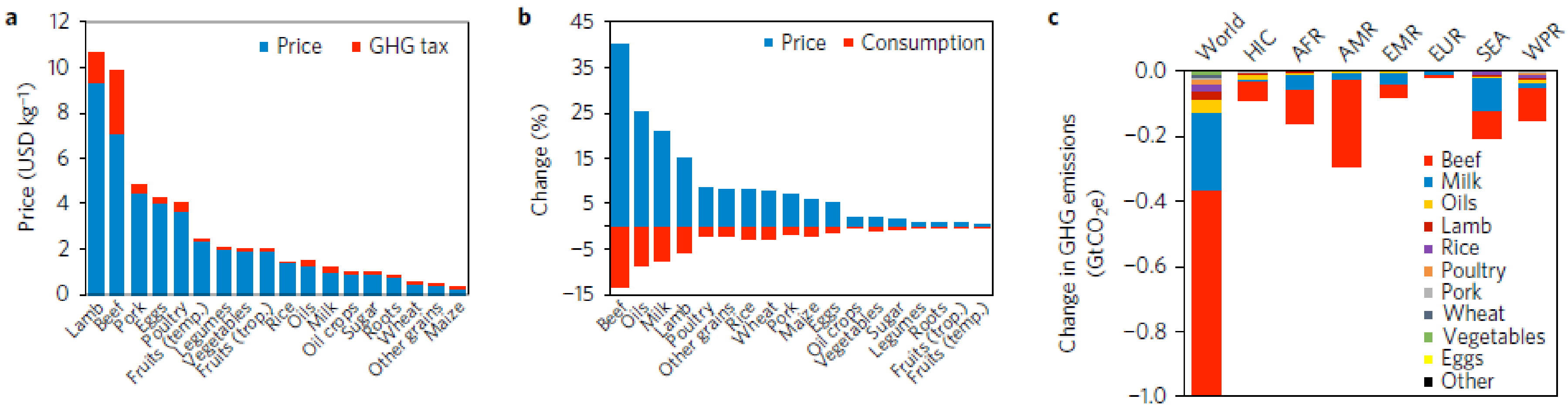
Demand side - Behavioural change

e.g. shifting human diets towards less animal product-based diets

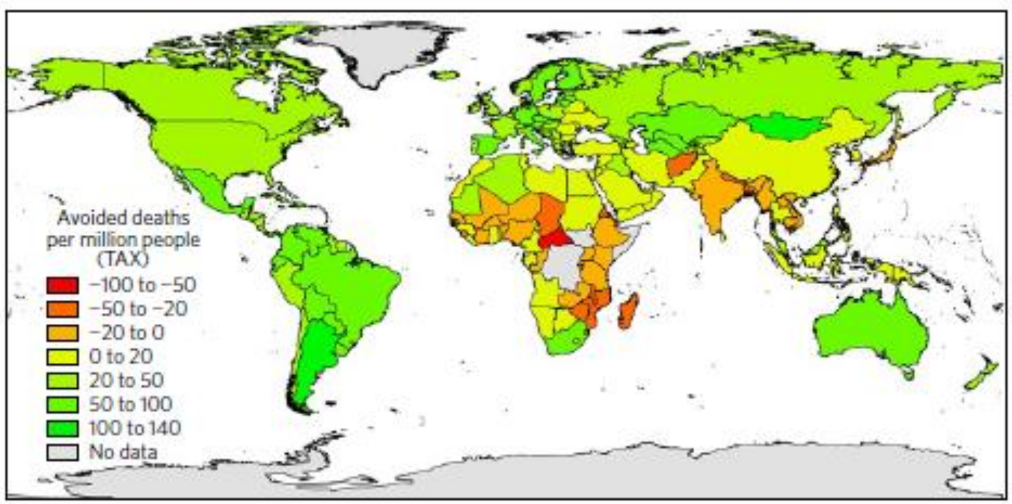


Demand Side CH_4 Mitigation

Emissions pricing of food commodities



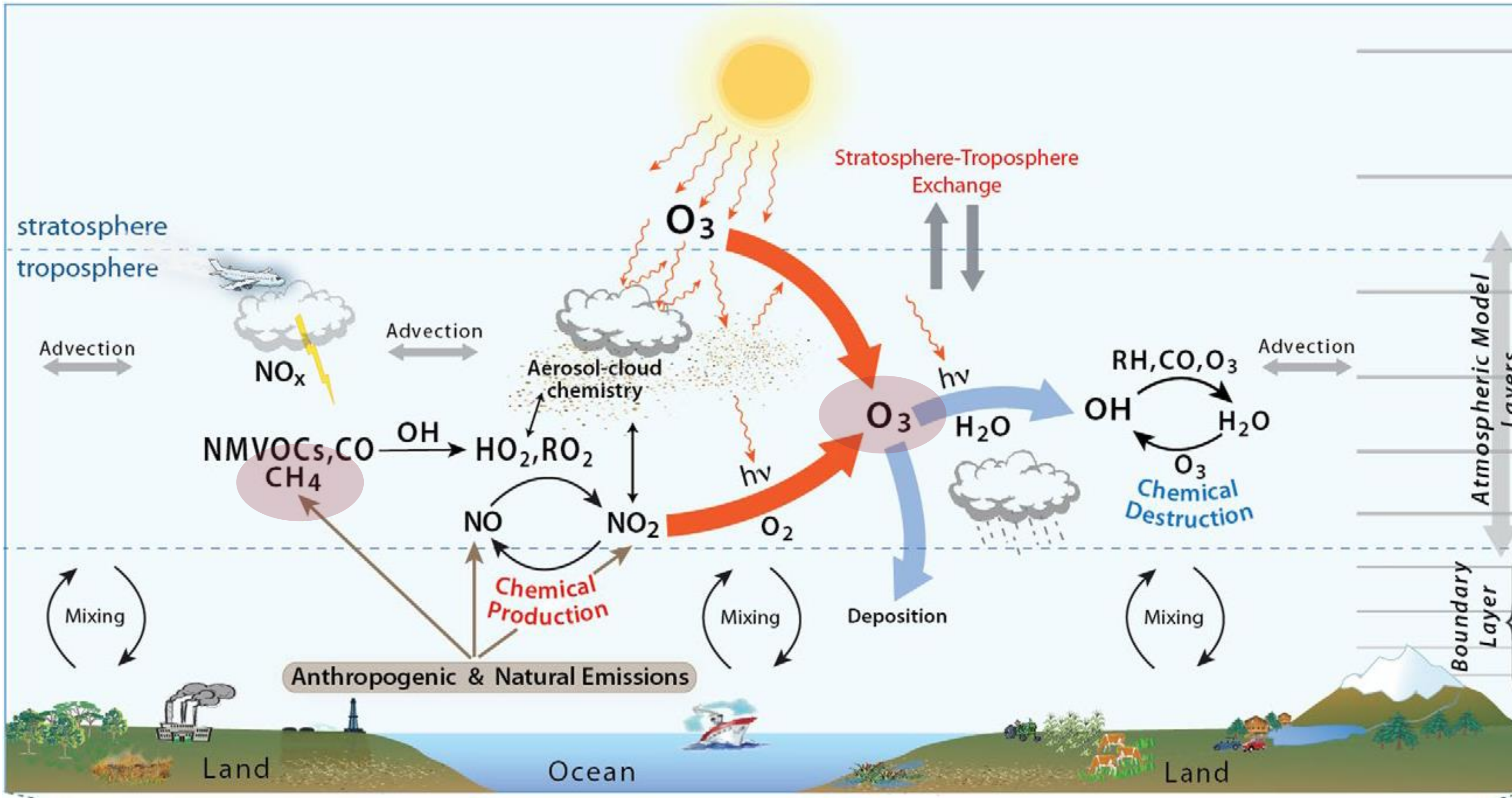
Regional health impacts of levying GHG taxes on food commodities



Two thirds due to change in dietary risk factor
One third due to change in overweight/obese

Springmann et al. 2017

CH_4 contributes to O_3 formation and near-term and regional climate change



Increases in CH_4 abundance lead to increases in global background tropospheric O_3 concentrations

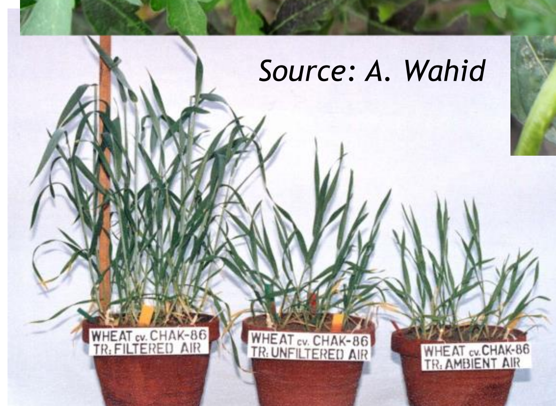
Young et al (2018)

O_3 pollution causes a wide range of adverse effects on ecosystems

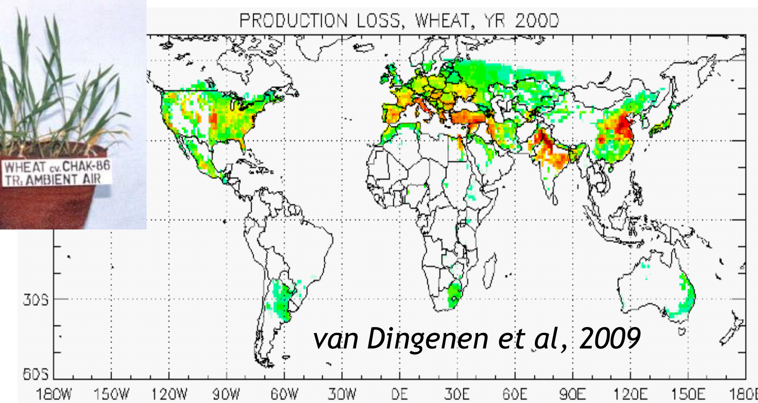
- Visible injury
- Crop yield loss (5-15%)
- Loss of protein content of grains
- Loss of forage quality of grasslands
- Forest productivity loss
- Losses to carbon sequestration

- Etc….

Source: Z Feng



Source: A. Wahid



van Dingenen et al, 2009

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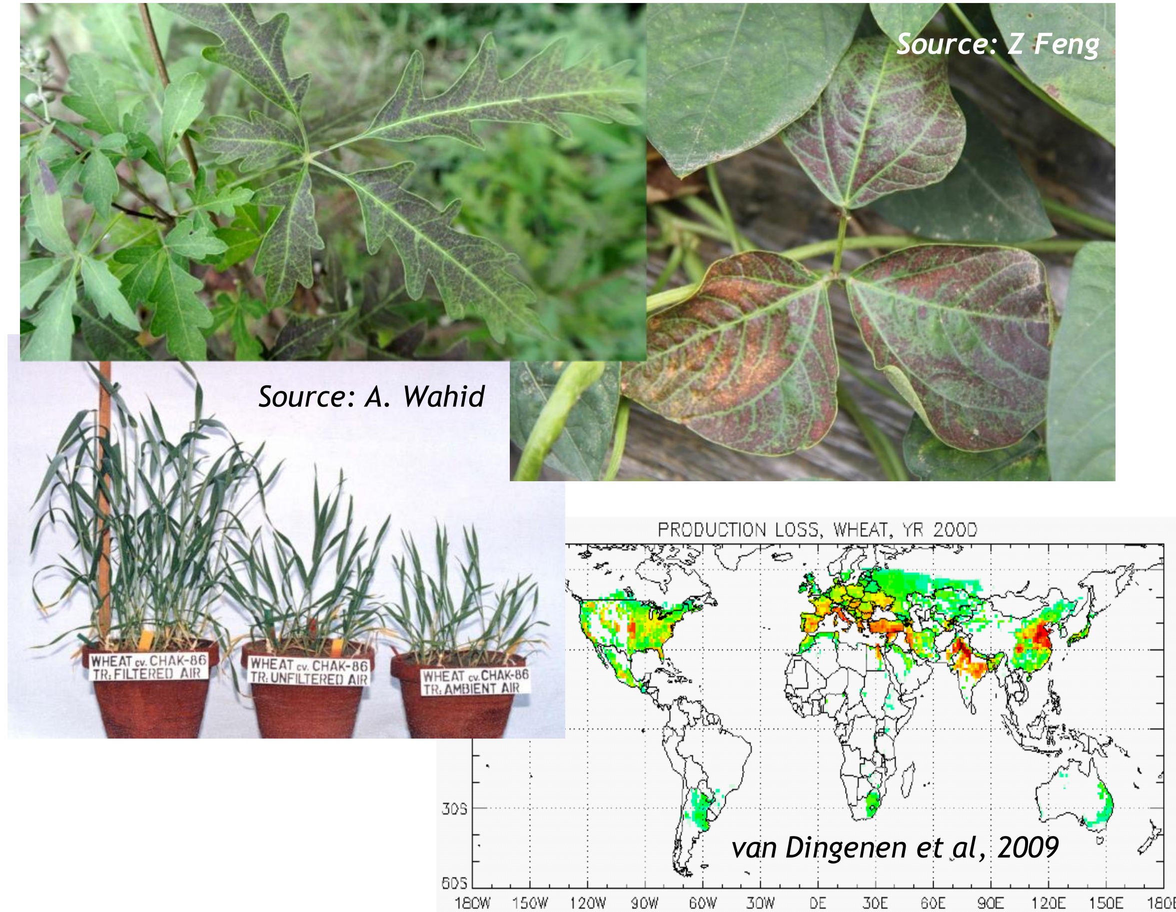

Economic losses of ~$US 15 to 20 Billion; ~40% of damage occurring in India and China

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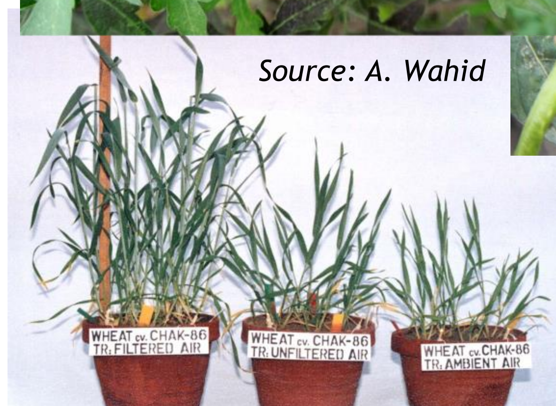

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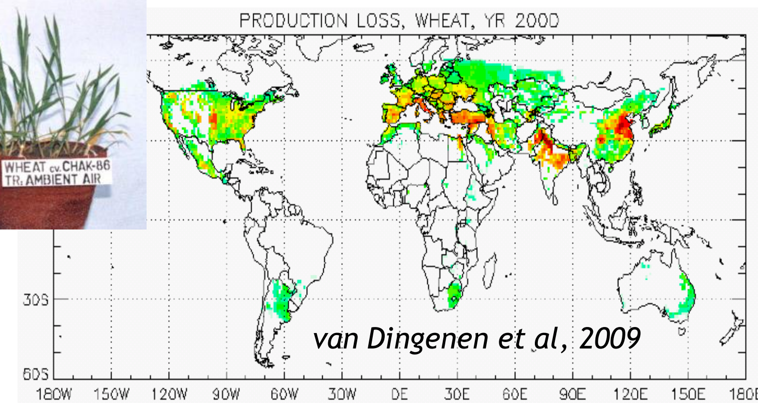

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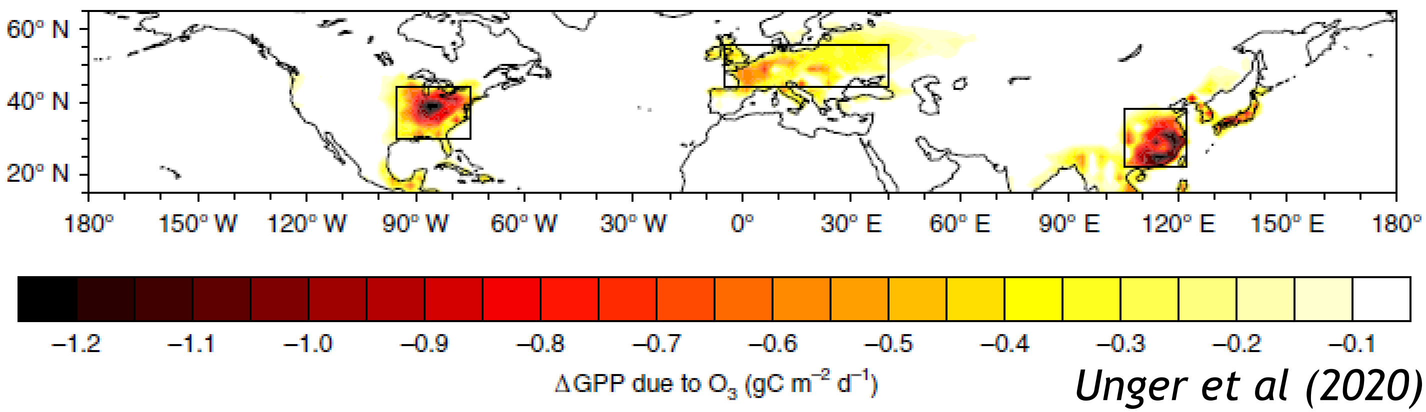
O_3 can indirectly affect climate change through reductions in vegetation biomass

The world's land ecosystems are slowing climate change by storing about 30% of human released CO_2 emissions every year

(Le Quere et al., 2018)



Unger et al (2020)

Over the past century the indirect increase in CO_2 caused by O_3 impacts on biomass contribute more to radiative forcing than would be caused by change in $[O_3]$

Sitch et al (2007)

Summary

- ~50% of anthropogenic CH_4 emissions are from the agricultural sector
- 'Supply side' technical mitigation measures are not sufficient to achieve a 1.5^{o}C pathway
- Likely require additional 'Demand side' mitigation measures which have additional health benefits
- CH_4 emission reductions will also reduce O_3 concentrations
- Reduced O3 will improve crop productivity and C sequestration

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