

# **A role for Agriculture in achieving UK's 'Net Zero' Ambitions?**

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Maize-Growers' Association Conference

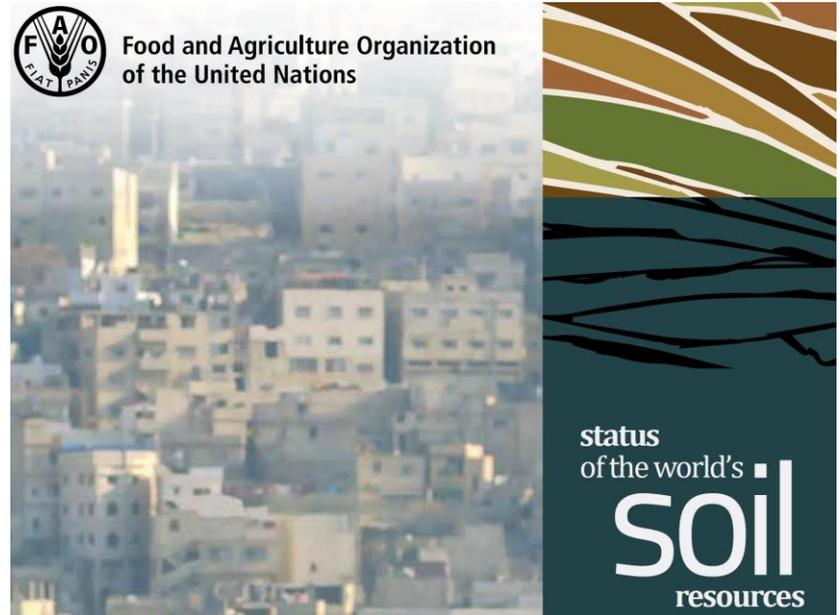
6<sup>th</sup> February 2020

# Need to enhance carbon in soils and vegetation

- The world's soils may only have 60 (ish) harvests left in them according to the FAO.
- Key issues are:
  - Soil degradation
  - Water availability
  - Soil organic matter = soil carbon
  - Above ground vegetation carbon stocks and fluxes = yields



Food and Agriculture Organization  
of the United Nations



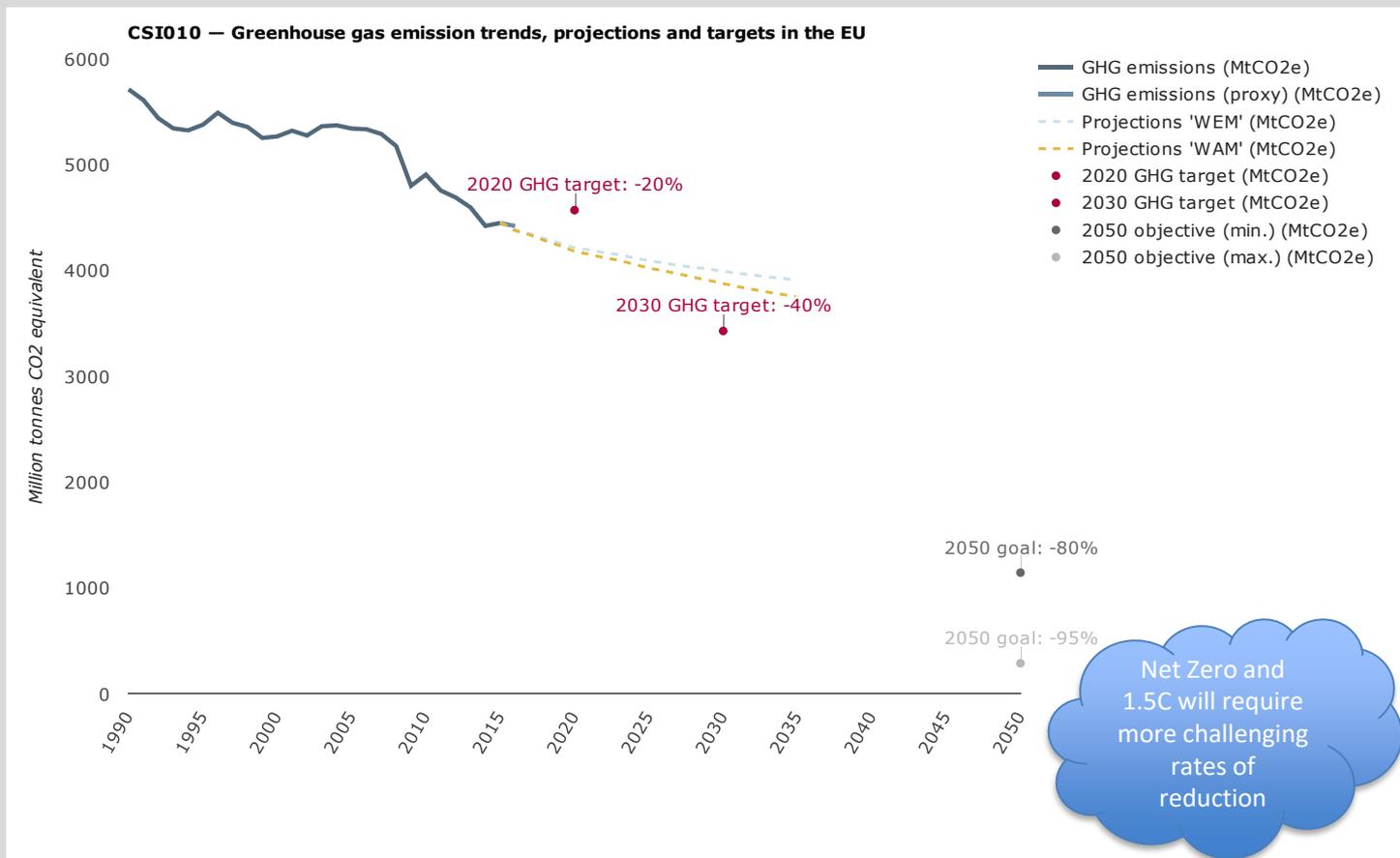
Whilst controversial and contested, there is a growing recognition of the importance of soil organic matter (soil carbon) in the management of agricultural soils for resilience and enhanced / sustained productivities.

Should bioenergy play a role in enhancing soil carbon stocks for intensive agriculture for food production? Is this possible / probable?

# Global Emissions Trajectory (RCP 2.6)



Source: [tool.globalcalculator.org](http://tool.globalcalculator.org), 2015

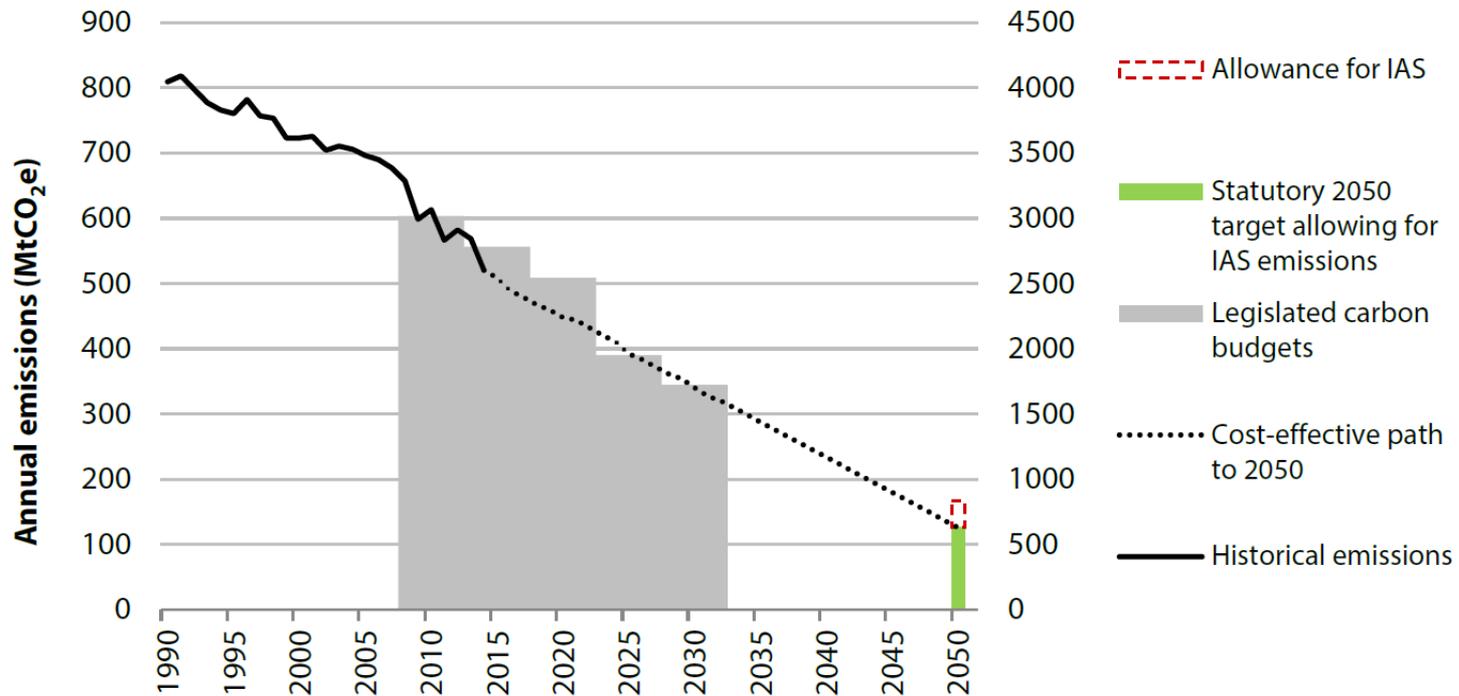


Source: European Environment Agency. Annual Indicator Report Series (AIRS). Environmental indicator report 2017

# Net Zero – The UK’s contribution to stopping global warming

## Committee on Climate Change. 2019

**Figure 1.2.** The UK’s existing long-term emissions target (set in 2008) has guided the setting of earlier targets and actions to deliver them



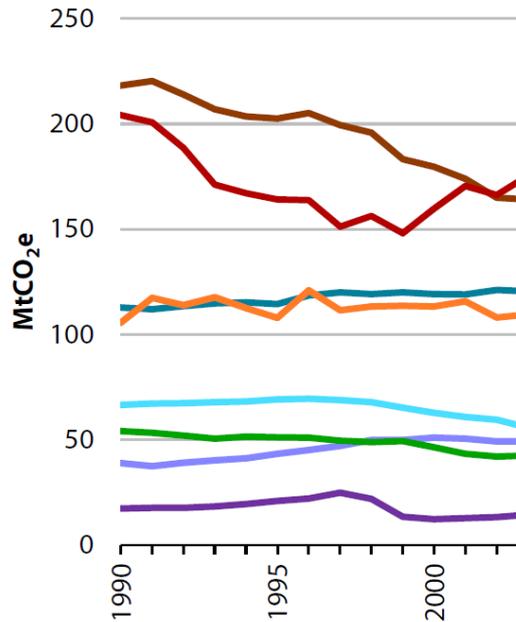
**Source:** Adapted from CCC (2015) *Fifth Carbon Budget Advice*. Based on DECC (2015) *Final UK greenhouse gas emissions national statistics: 1990-2013*; CCC analysis.

**Notes:** This chart is from the CCC's 2015 fifth carbon budget report. GHG emissions shown are the actual emissions, while carbon budgets represent the emissions under the net carbon account; IAS stands for International Aviation and Shipping, which are included in the 2050 target but not the carbon budgets.

# Net Zero – The UK’s contribution to stopping global warming

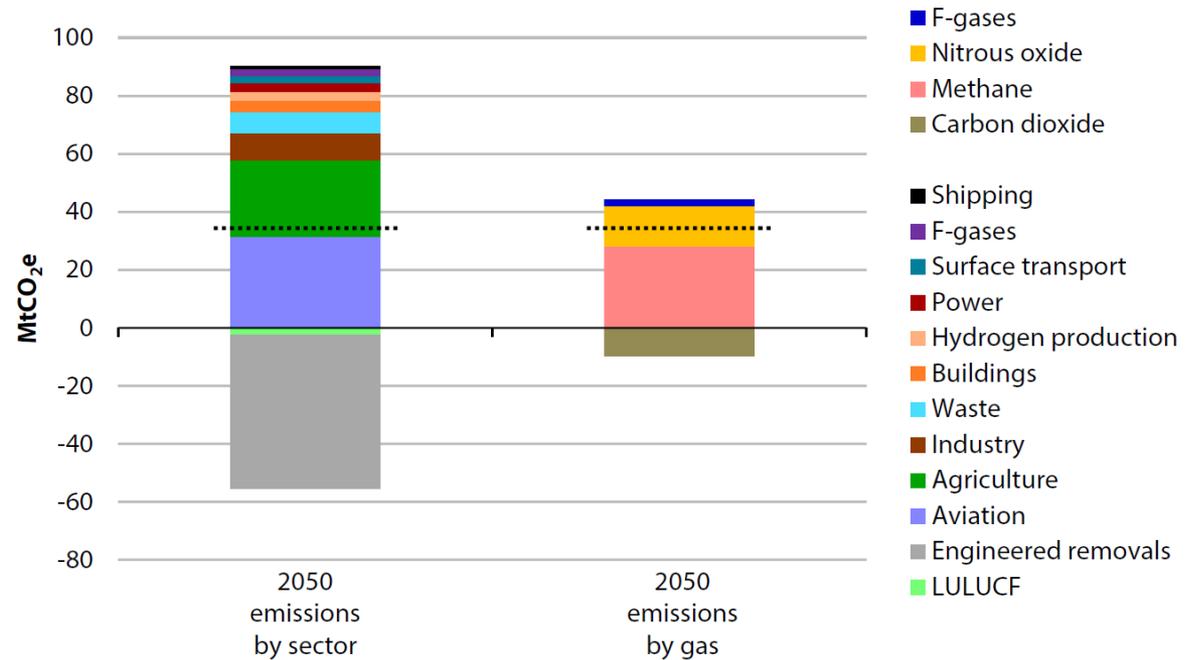
## Committee on Climate Change. 2019

**Figure 5.2.** Progress reducing UK emissions (1990-2017)



**Source:** BEIS (2019) 2017 Greenhouse Gas Emissions Report  
**Notes:** 2017 is the latest year for which final data is available and does not reflect forthcoming revisions to the data.

**Figure 5.5.** Remaining emissions in the Further Ambition scenario by sector and gas (2050)



**Source:** CCC analysis.

**Notes:** Dotted line shows net emissions in 2050, taking into account negative emissions. Figure includes high estimate of additional peatland emissions and is based on the current inventory GWPs (see Box 5.1).

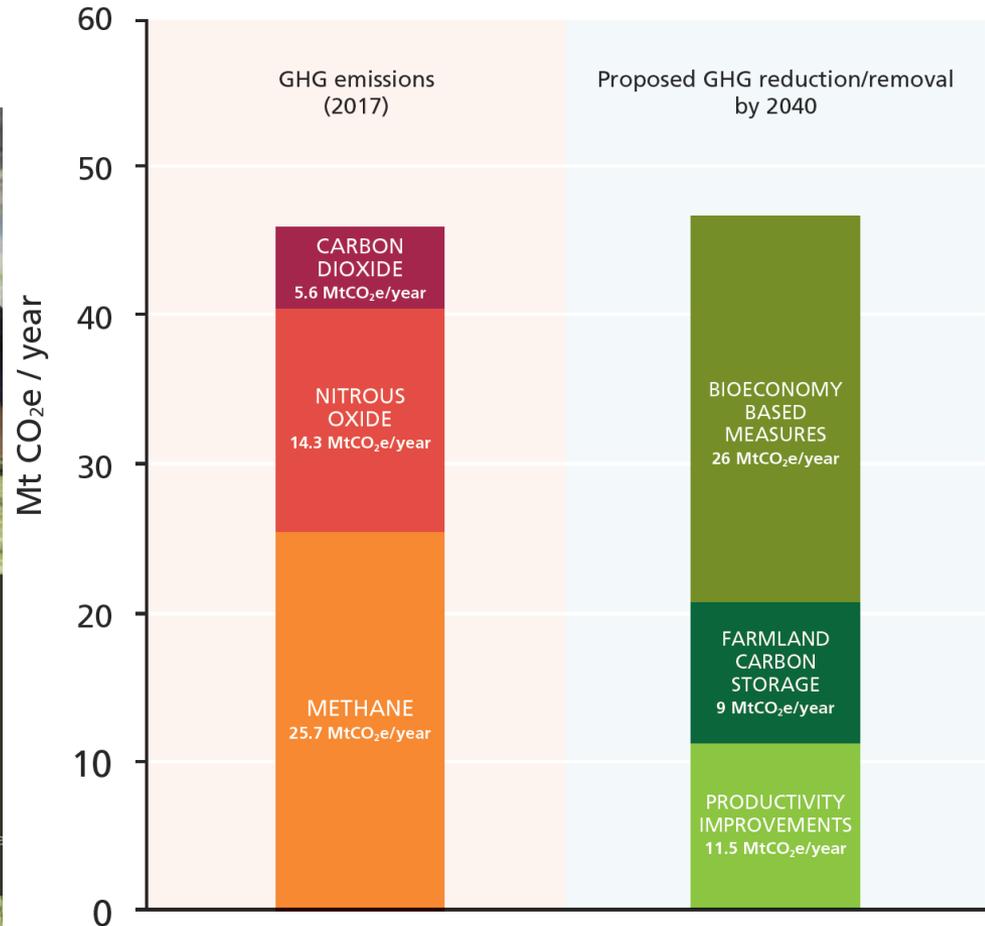
# Importance of Land Use in the UK

- Emissions and removals occur in the UK's agriculture sector
- Agriculture is a significant net source of GHG emission in E&W, 8.5% (33.9 MtCO<sub>2</sub>e) of total England & Wales emissions
- Overall, land has been a net sink since 1991 (BEIS, 2016)
  - woodland and grassland net sinks,
  - cropland a net source
- Land in England and Wales (including settlements and wetlands) contributed net removals (from the atmosphere) of 4.9 MtCO<sub>2</sub>e in 2017, offsetting 1.2% of total English & Welsh emissions (or 14.6% of agricultural emissions)
  - woodland provided 9,468 ktCO<sub>2</sub>e + grassland 4,767 ktCO<sub>2</sub>e of removals, and
  - cropland emitted 5,476 ktCO<sub>2</sub>e (Jones *et al.*, 2019).
- With nearly 72% of land in E&W on agricultural holdings, how farmers choose to alter and manage their land has implications for attempts to achieve net zero (CCC, 2020).

What does farming have to do to be compatible with 'net-zero'?

# **FARMING ON A NET-ZERO PATHWAY**

# NFU's Net Zero by 2040 (NFU, 2019)



Current (2017) agricultural emissions balanced against potential GHG reduction through productivity measures and GHG removals by various methods



# EUCALC Changes in land use will have effects on health, water, biodiversity jobs, economy

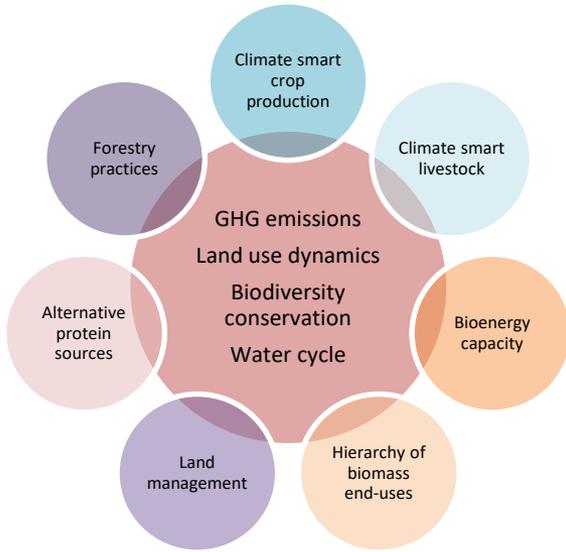
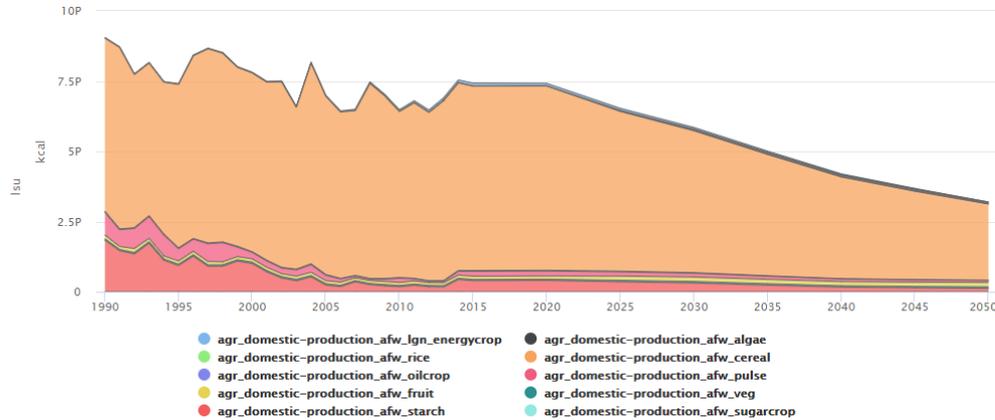
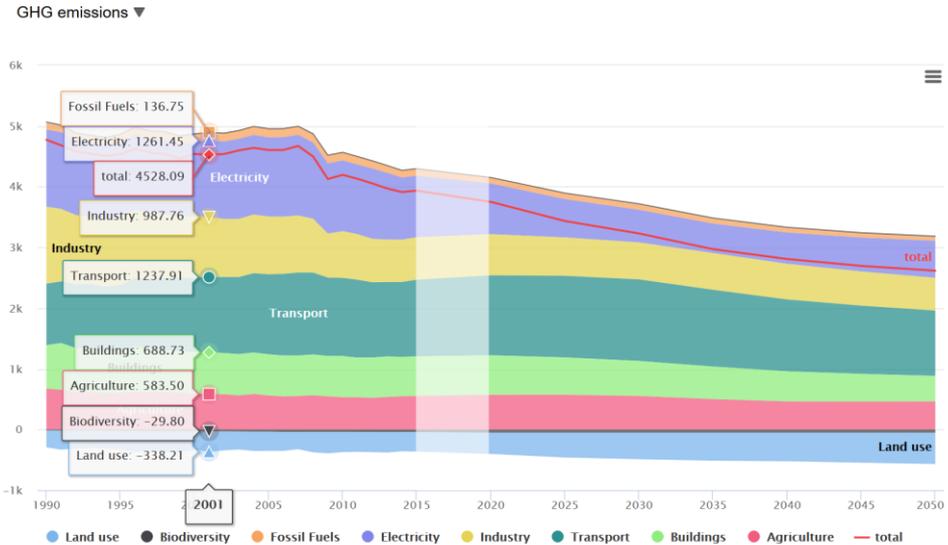


Figure 1: Agriculture and Land-Use Levers in the EUCalc

**Warning!**  
Trade-offs and co-benefits and complex interactions are likely to result from changes to ANY and ALL of the 7 Land Use & Food Production levers

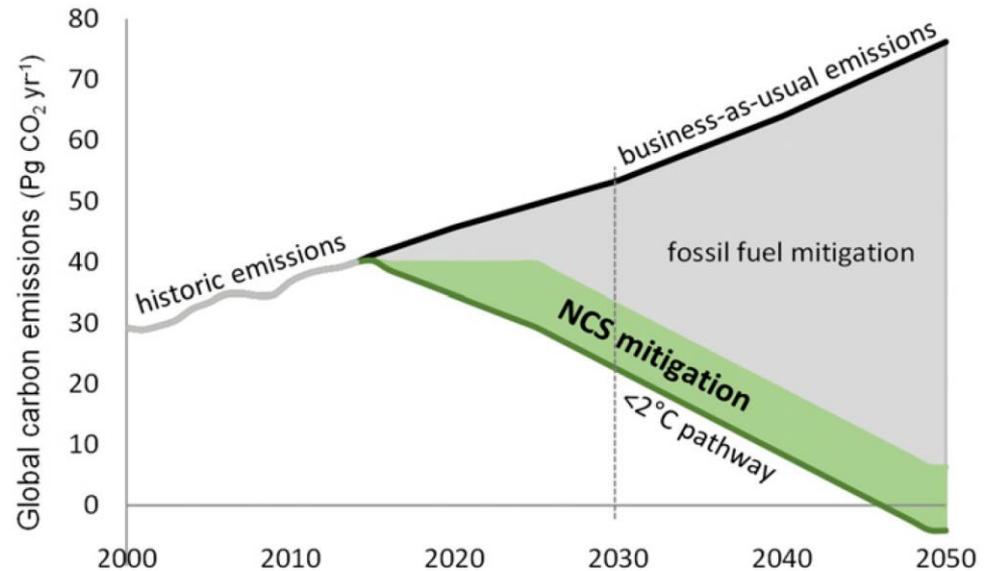
Emissions Energy Transport! Buildings Industry Land-use Agriculture Water Minerals! Air Climate! Jobs Costs 1 >



# Natural Climate Solutions

Griscomb et al. 'Natural Climate Solutions.' PNAS, 2017

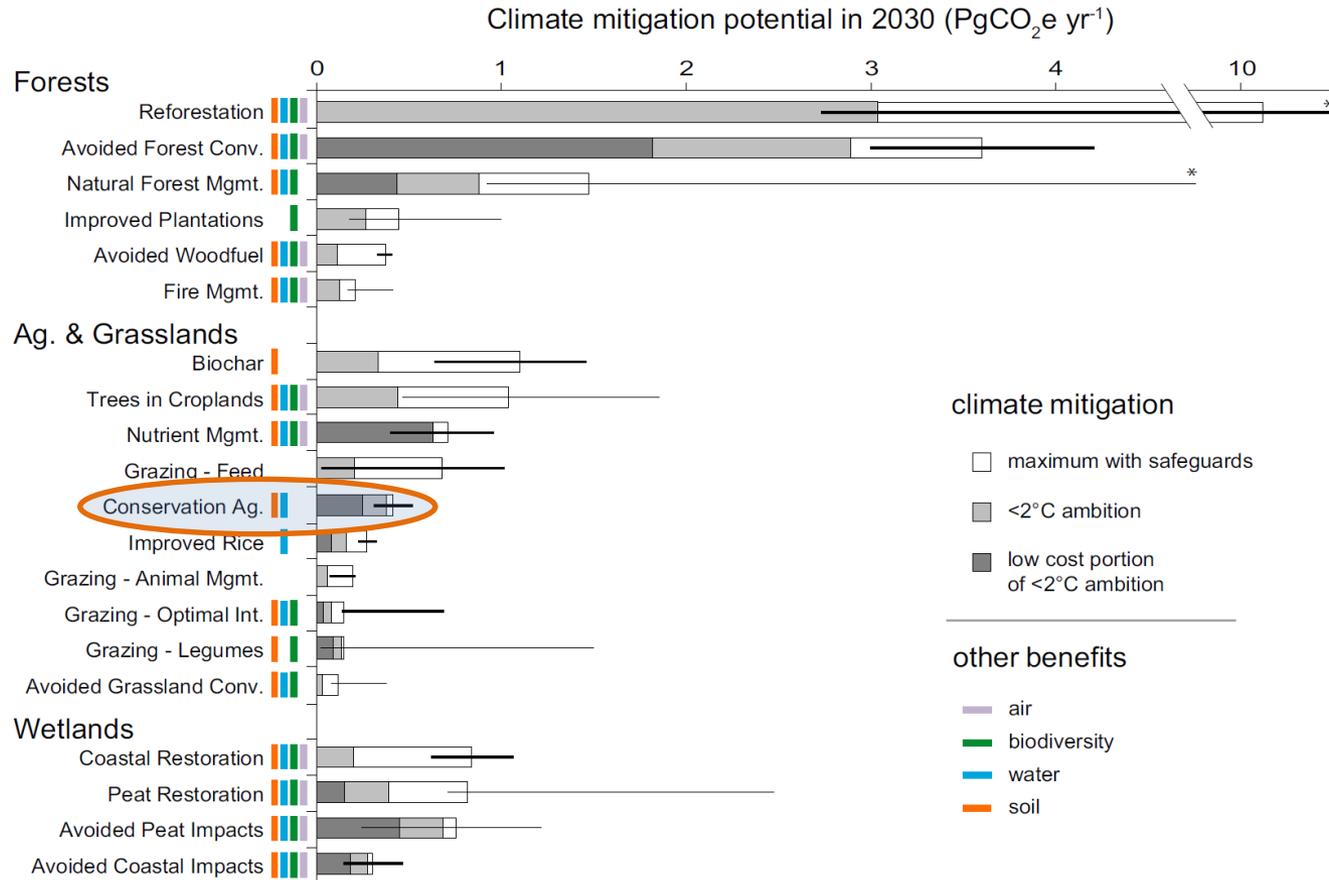
Defines a '<2°C (limiting warming to below 2°C) “cost-effective” level of mitigation as a marginal abatement cost not greater than ~100 USD MgCO<sub>2</sub><sup>-1</sup> as of 2030.



**Fig. 2.** Contribution of natural climate solutions (NCS) to stabilizing warming to below 2 °C. Historical anthropogenic CO<sub>2</sub> emissions before 2016 (gray line) prelude either business-as-usual (representative concentration pathway, scenario 8.5, black line) or a net emissions trajectory needed for >66% likelihood of holding global warming to below 2 °C (green line). The green area shows cost-effective NCS (aggregate of 20 pathways), offering 37% of needed mitigation through 2030, 29% at year 2030, 20% through 2050, and 9% through 2100. This scenario assumes that NCS are ramped up linearly over the next decade to <2 °C levels indicated in Fig. 1 and held at that level (=10.4 PgCO<sub>2</sub> y<sup>-1</sup>, not including other greenhouse gases). It is assumed that fossil fuel emissions are held level over the next decade then decline linearly to reach 7% of current levels by 2050.

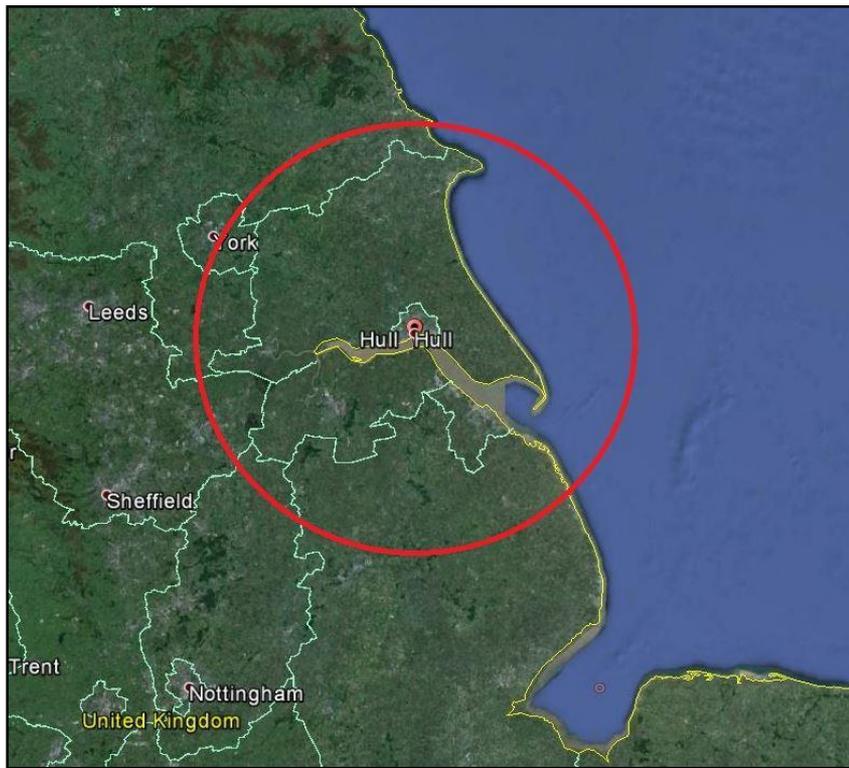
# Natural Climate Solutions

## Griscomb et al, 2017



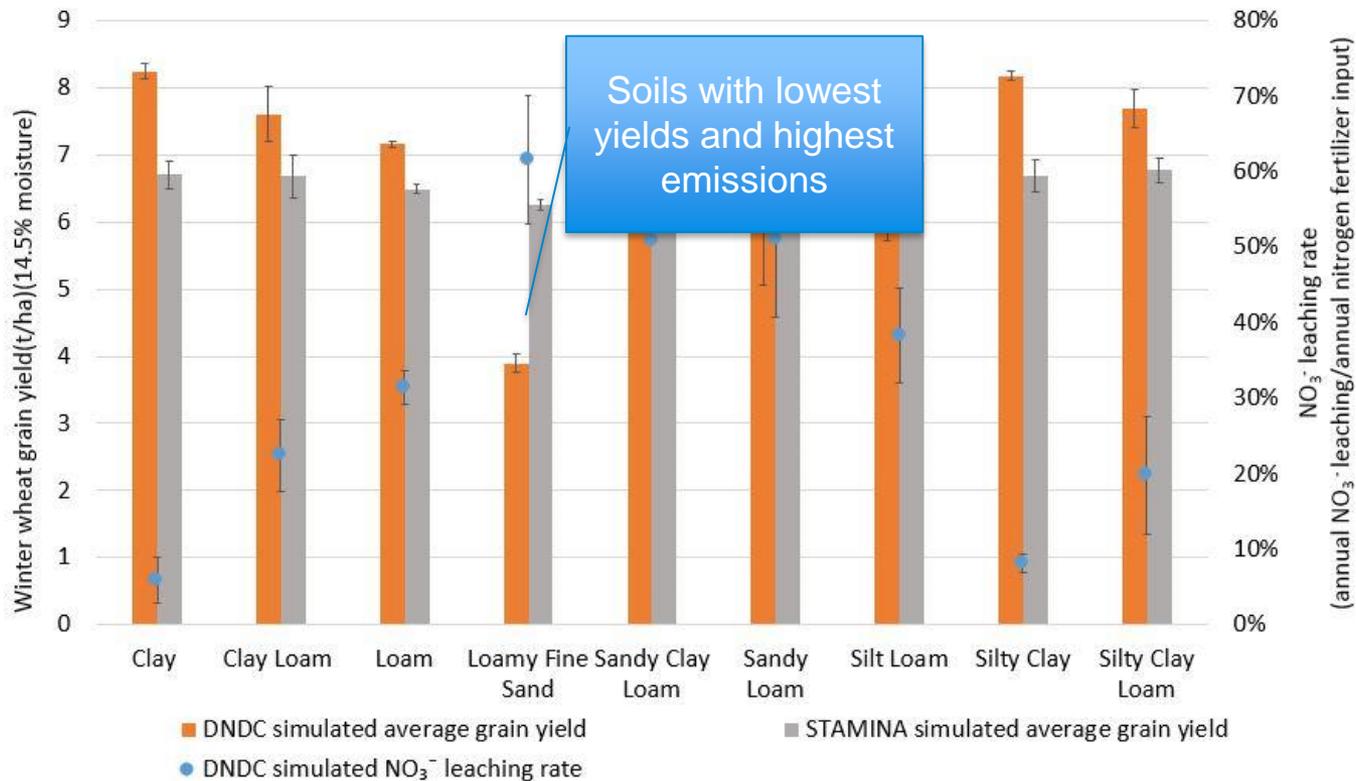
**Fig. 1.** Climate mitigation potential of 20 natural pathways. We estimate maximum climate mitigation potential with safeguards for reference year 2030. Light gray portions of bars represent cost-effective mitigation levels assuming a global ambition to hold warming to <2 °C (<100 USD MgCO<sub>2</sub>e<sup>-1</sup> y<sup>-1</sup>). Dark gray portions of bars indicate low cost (<10 USD MgCO<sub>2</sub>e<sup>-1</sup> y<sup>-1</sup>) portions of <2 °C levels. Wider error bars indicate empirical estimates of 95% confidence intervals, while narrower error bars indicate estimates derived from expert elicitation. Ecosystem service benefits linked with each pathway are indicated by colored bars for biodiversity, water (filtration and flood control), soil (enrichment), and air (filtration). Asterisks indicate truncated error bars. See [SI Appendix, Tables S1, S2, S4, and S5](#) for detailed findings and sources.

# Productive options –A UK Case study evaluating impacts of integrating lignocellulosic cropping in annual cropping systems for bio-plastics

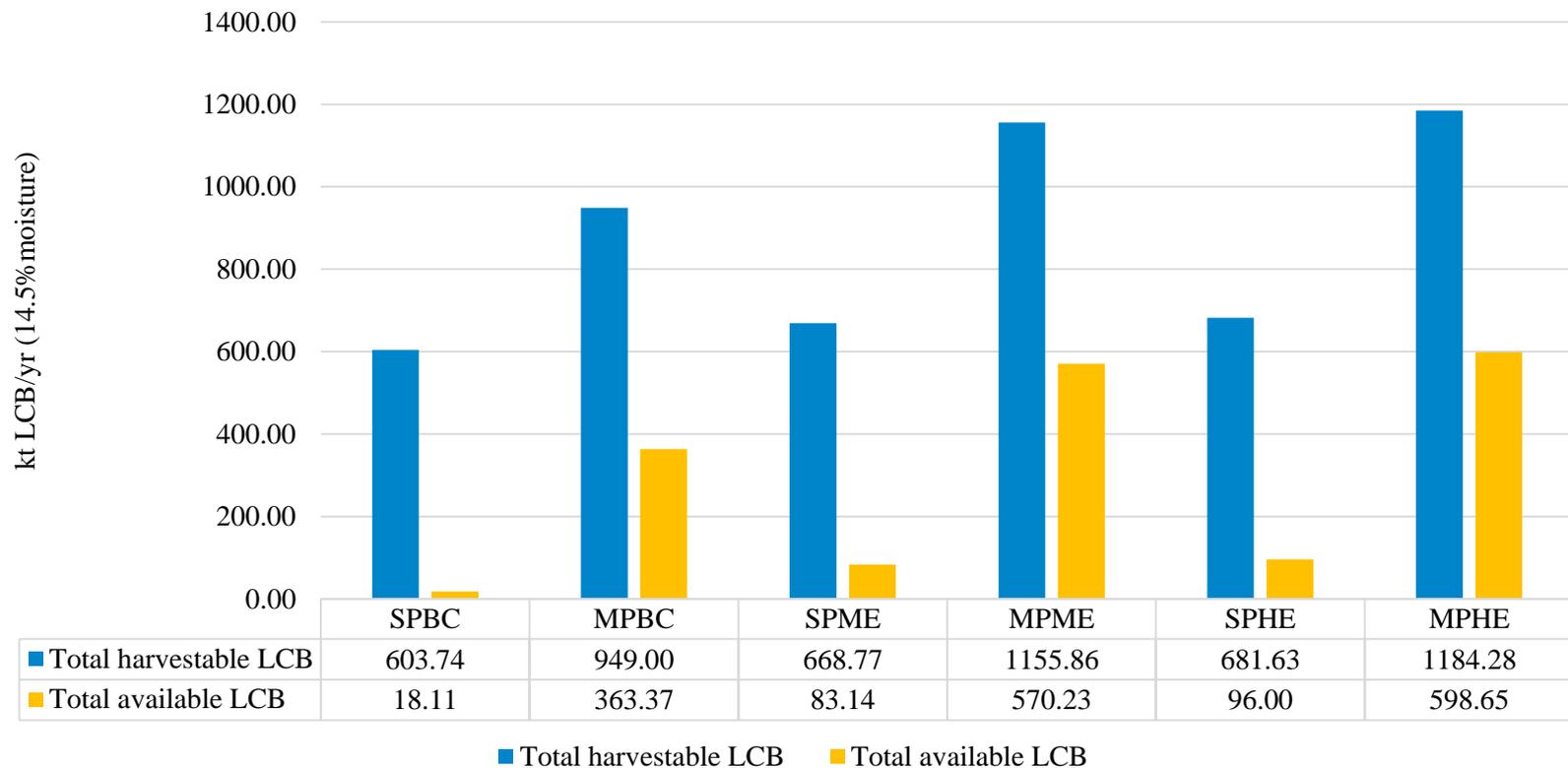


- A rural area nearby the city of Hull in England (max. 50 km as feedstock transport distance from farm to conversion plant);
- 5856 km<sup>2</sup> and comprised highly variable soil types taken from the UK National Soil Map (1 km<sup>2</sup> grid);
- One of the main wheat production areas in England.

# Where to start – e.g. in wheat production. A spatial assessment in Hull catchement area



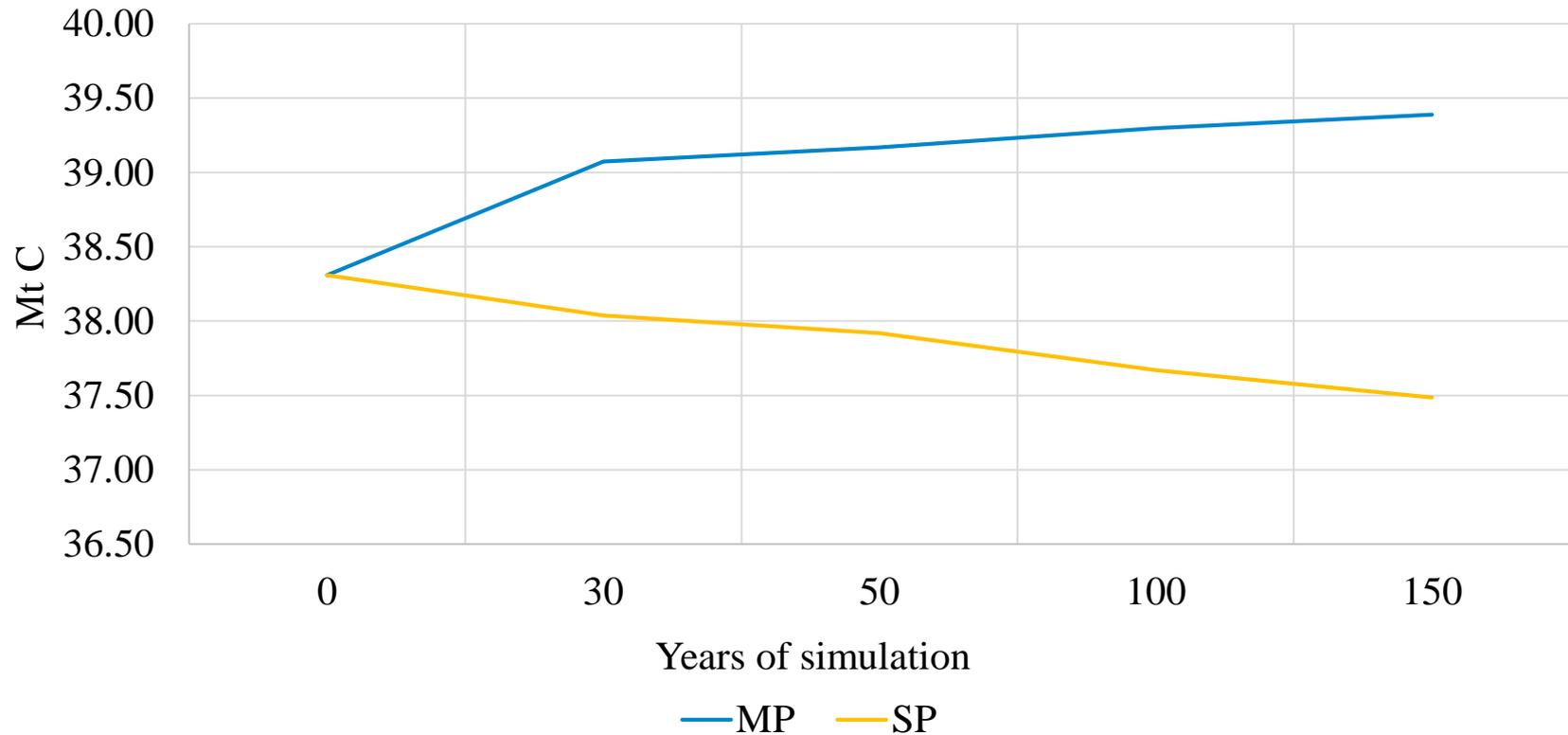
## Projected Lignocellulosic Biomass (LCB) feedstock availability for biopolymer production under 2 climate change scenarios (Y. Ni, 2019)



SPBC = Winter wheat single crop production under baseline climate conditions [CO<sub>2</sub>] 352 ppm

SPME = Winter wheat single crop production under medium emission (atmospheric CO<sub>2</sub>) climate conditions [CO<sub>2</sub>] 447 ppm

# Simulated SOC change for 'single crop' (SP) and mixed crop (MP) production scenarios in case study area



## Main Conclusions – Yuanzhi's thesis

- Large range in the climate change impacts among different LCB-bioplastic production pathways, -25.1 to 6.71 kg CO<sub>2</sub>eq/kg biopolymer
- Without introducing Miscanthus into arable landscapes, the GHG reduction potentials of biopolymer (PBS) material were limited, cf starch and petrol based cases;
- Highlights importance of land-based carbon management in the bio-material value chain.
- 'Trade-offs' and opportunities:
  - 8% of wheat production area transferred to perennial miscanthus
  - reduced grain production (-6.6%) but in practice might be avoidable.
  - 24% decrease Grain GHG emissions even accounting for displaced prod<sup>n</sup>.
  - Other potential benefits possible, including, enhanced bio-diversity and improved water quality; rural development; even food security through enhanced resilience in agricultural systems.

# ‘Sustainable Intensification’? What is the role of innovation in agriculture?



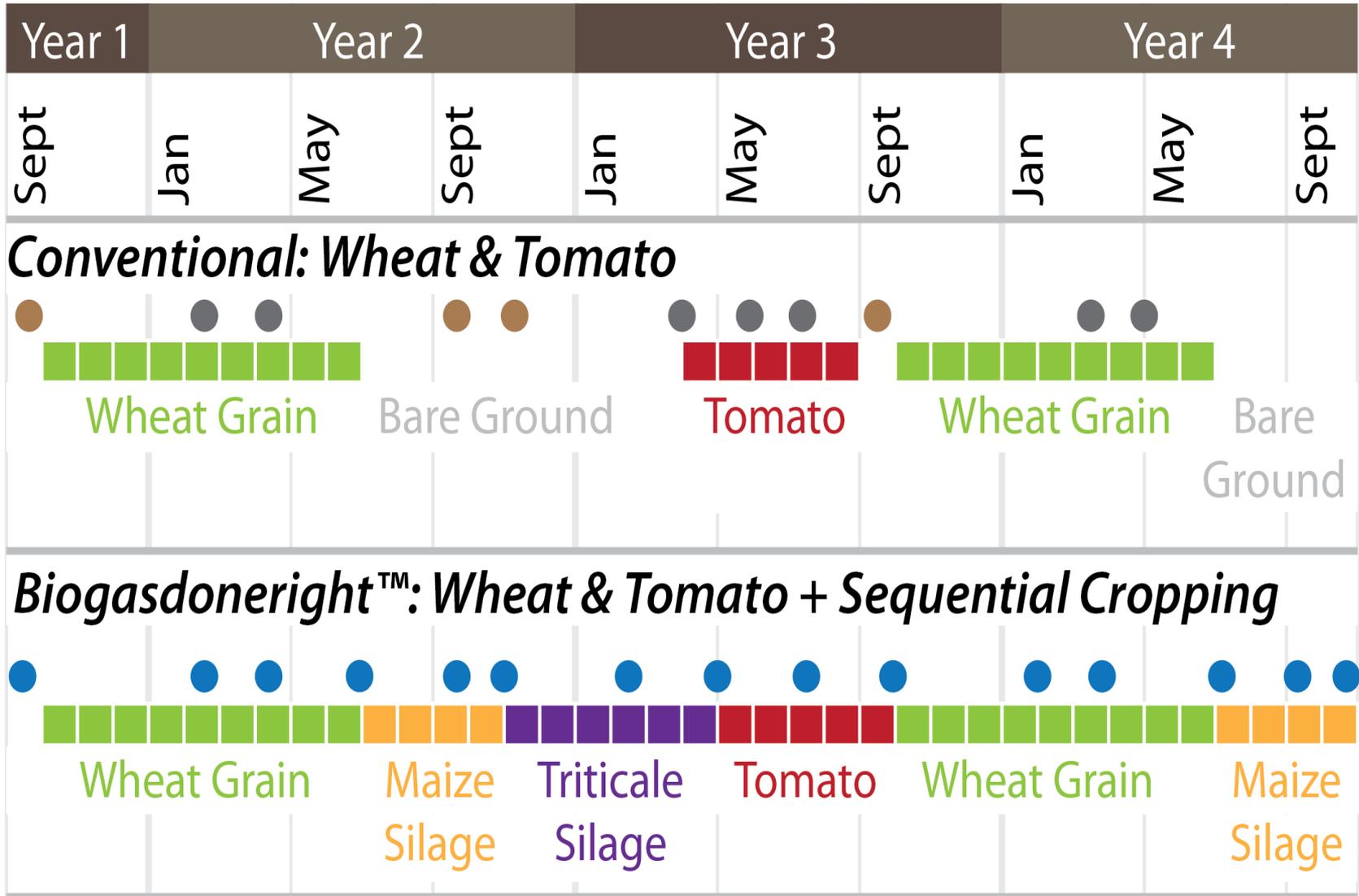
Photos taken during Biogasdoneright™ visit, Italy, February 2017 (J. Woods, 2017)

# Anaerobic Digestion providing biogas as a despatchable source of power



1. 2 x 1MWe biogas power plants (Po Valley, Italy, 2017), 2. Biogas plant with maize silage (stored for 1 year; Italy, 2017), 3. Gorge Valley AD plant, Naivasha, Kenya (2017)

# Driving Integrative thinking in Agriculture – an Italian example



● Chemical Fertilizer   
 ● Livestock Effluent   
 ● Digestate

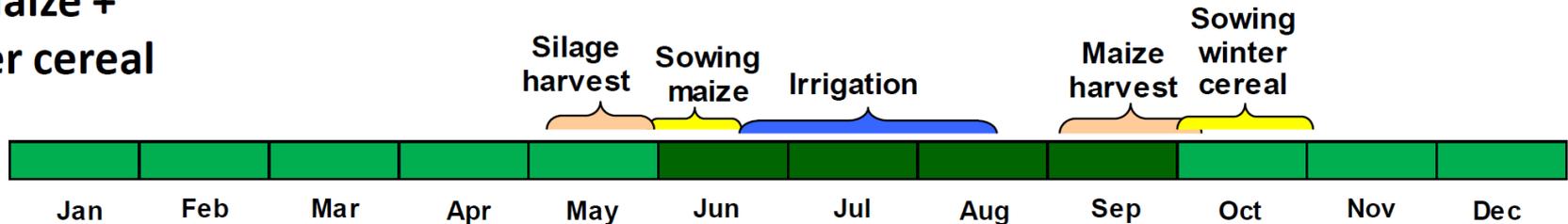
# BiogasDoneRight® concept

Dairy farm, crop production to feed/food/energy

Arable/no till crops, two crops per year (several)

Fertilisation based on digestate

## Ex. Maize + winter cereal



- ✓ Soil covered **12 months** per year
- ✓ Total above ground biomass around **30 DM t/ha/year (18 m + 12 wc)**
- ✓ Irrigation: **necessary**
- ✓ **Herbicides: usually not required if both crops (cover and main crops) are harvested**
- ✓ Soil tillage: **reduced**
- ✓ Organic matter level in soil: **increase**

## Organic matter inputs to soils in the BDR system (2009 to 2015)

- Digestate comprises the longer life carbon fractions that were not turned into methane
- When digestate was applied regularly to soils, the organic matter / carbon content of the soils increases although multiple factors may be associated with increased soil organic matter levels measured in trials of the BDR system

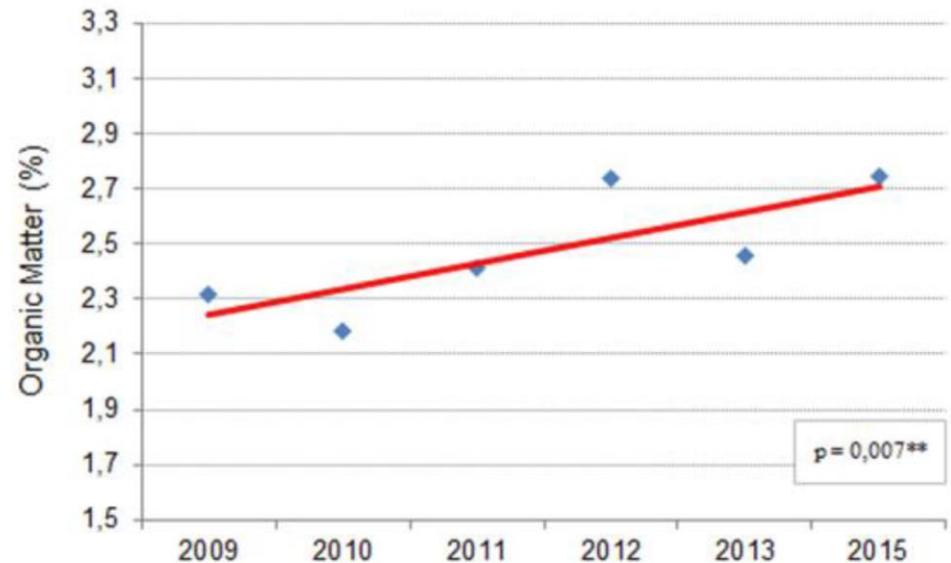
## OM sources for soil

	OM from manure (t/ha/year)	OM from crops (t/ha/year)	OM from digestate (t/ha/year)
Conventional	6,8	s&r*	-
Organic	6,8	s&r*	-
Conservation	6,8	5,5 + s&r*	-
BiogasDoneRight	-	s&r*	7,3

\* s&r: stubble and roots

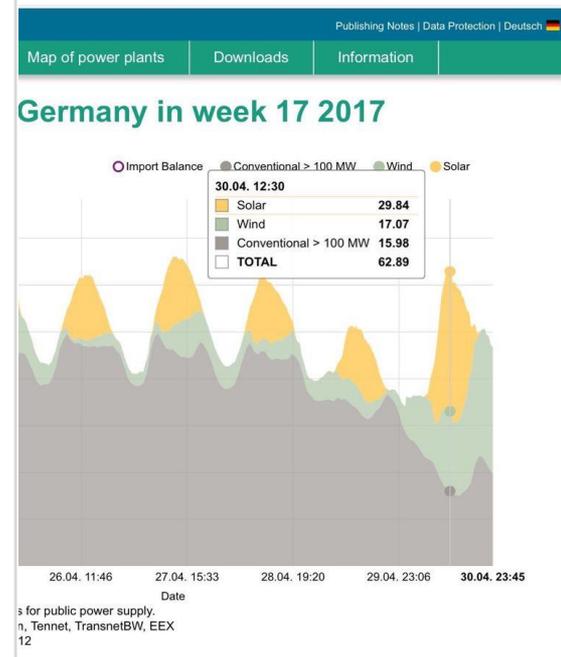
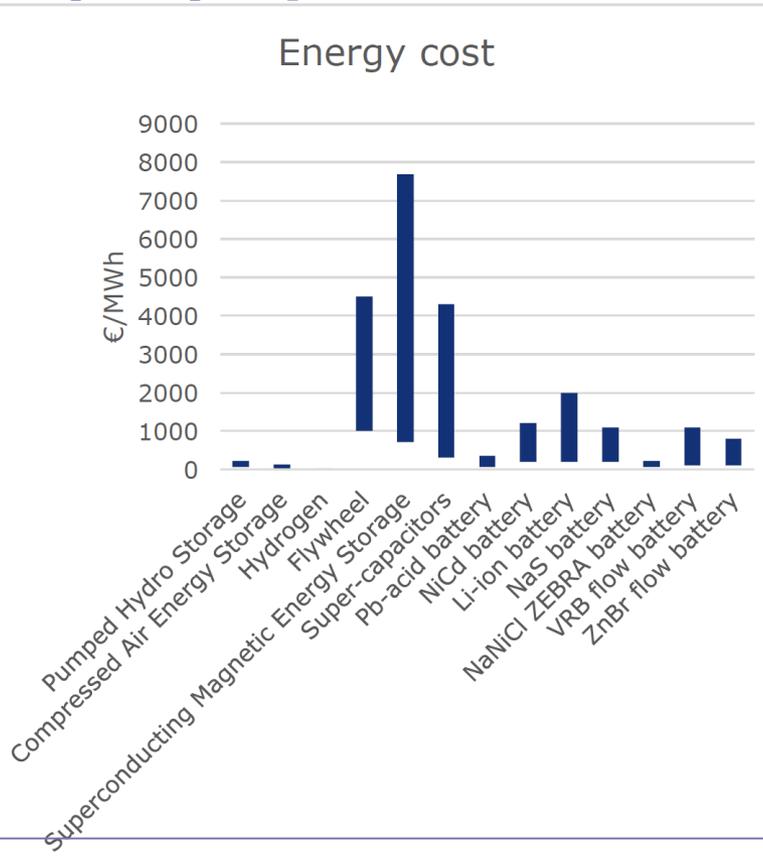
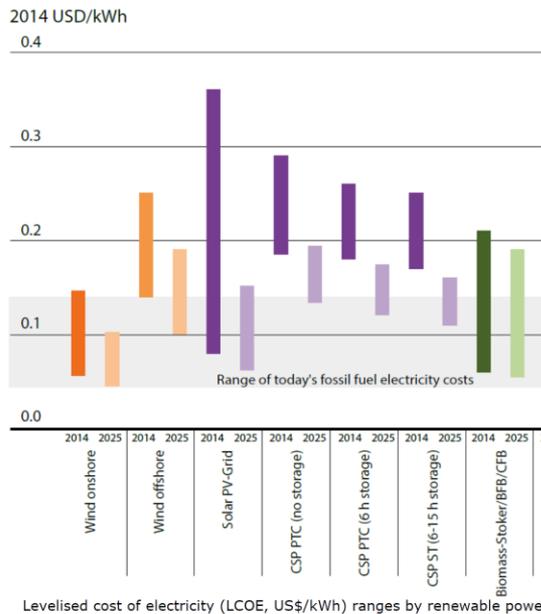
# Digestate mediated increases in Soil Organic Matter / Soil Carbon

- Data from field measurements over 7 years of continuous digestate application
- Continuous return of digestate with good soil management according to BiogasDoneRight® model, showed a significant effect on soil organic matter content (OM).
- Over the 7 years (2009-2015) OM increases about 0.5% (from 2.2% to 2.7%)



# Renewables are driving disruptive change in utility business models in Europe

## Cost of different technologies



Currently, the role of bioenergy in balancing is increasing as time interval of balancing increases, being most significant in seasonal balancing especially in connection with heat grids. The role in the future is seen to develop more towards short term balancing as the balancing needs also increase due to the increasing share of variable power generation. (IEA Bioenergy. 2017)

# Land use (photosynthesis) as a tool for climate mitigation and adaptation

A real opportunity exists to use integrative perspectives to link increasingly complex markets and drivers to advance sustainable development.

A substantive / material role for anaerobic digestion as part of a much wider land-use toolbox needs to be made for climate mitigation and adaptation linked to sustainable development- but it needs careful implementation – ‘BiogasDoneRight’ – critical issues to consider include:

- AD in the circular economy
- AD in nutrient looping
- Biogas as a dispatchable source of power
- Biomethane and energy storage in national gas grids
- Digestate injection and carbon sequestration in soils

Currently maize production is regarded by environmental NGOs as the exemplar of bad agricultural intensification – what needs to be done to change this perspective?

# Thank You

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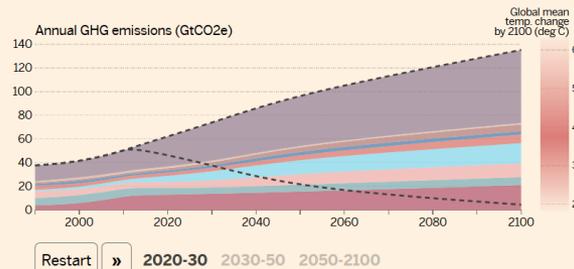
Dr Obinna Anejonu (Spatial: UK Space Agency)

## Prosperous living for the world in 2050: insights from the Global Calculator

### FINANCIAL TIMES

#### Climate calculator

Use the sliders to set regional ambitions for emissions reduction, first for 2020-2030. Each slider's scope and impacts are unique, based on analysis of the region's capabilities by academics at Imperial College London. After setting yours, let's proceed to the next period...



<http://ig.ft.com/sites/climate-change-calculator/>



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## Bioenergy & Sustainability: bridging the gaps

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<http://www.globalcalculator.org>

<http://bioenfapesp.org/scopebioenergy/index.php>

# Global economic consequences of deploying BECCS

Muratori, Calvin, Wise, Kyle and Edmonds (2016)

