

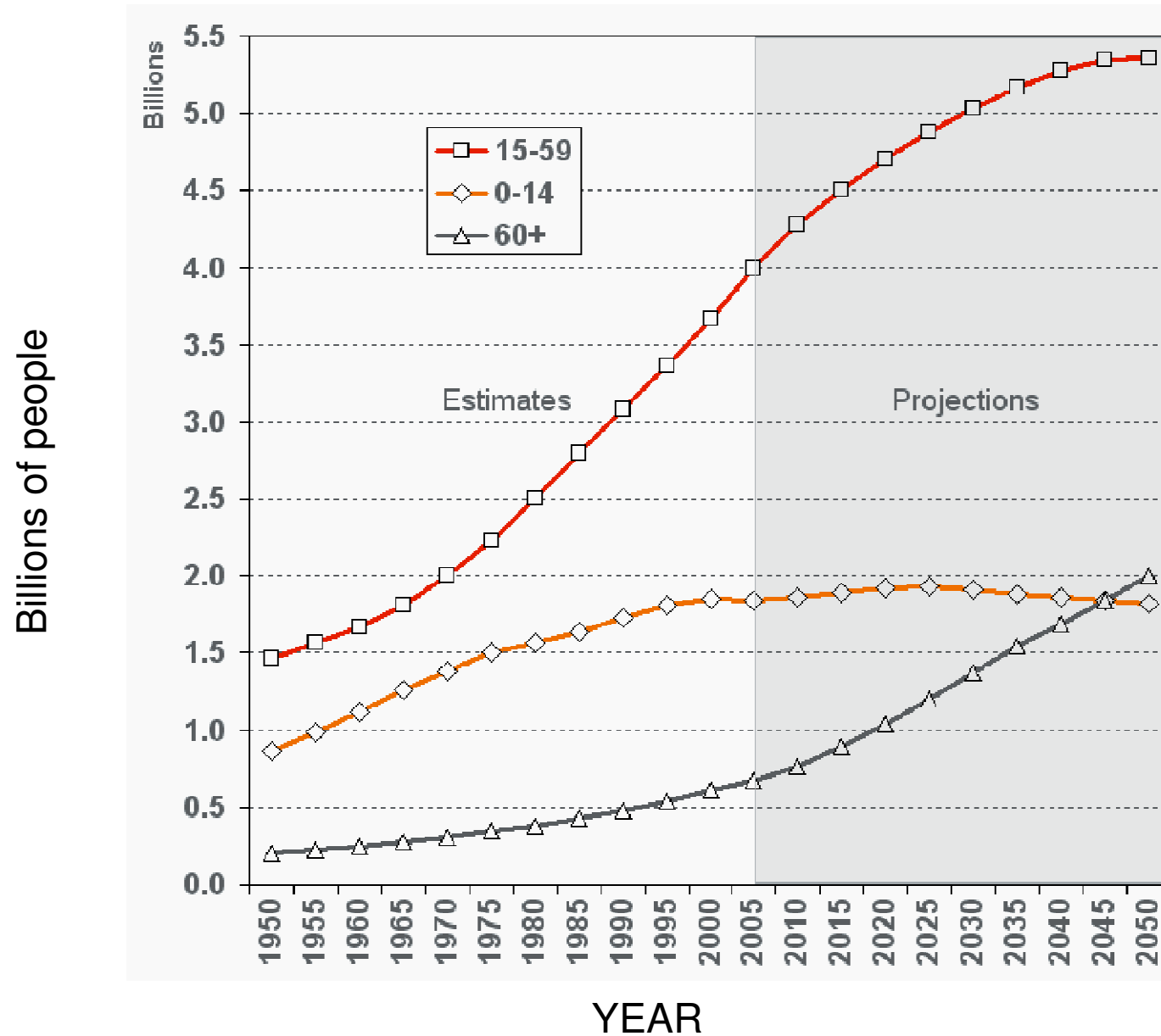
E2.3

Bioenergy technology – balancing energy output with environmental benefits

John Clifton-Brown and Astley
Hastings

Pete Smith, Paul Stampfl, John Valentine, Mike
Jones, Iain Donnison (IGER, Aberystwyth, UK)

World Population



Sustaining people on Planet earth

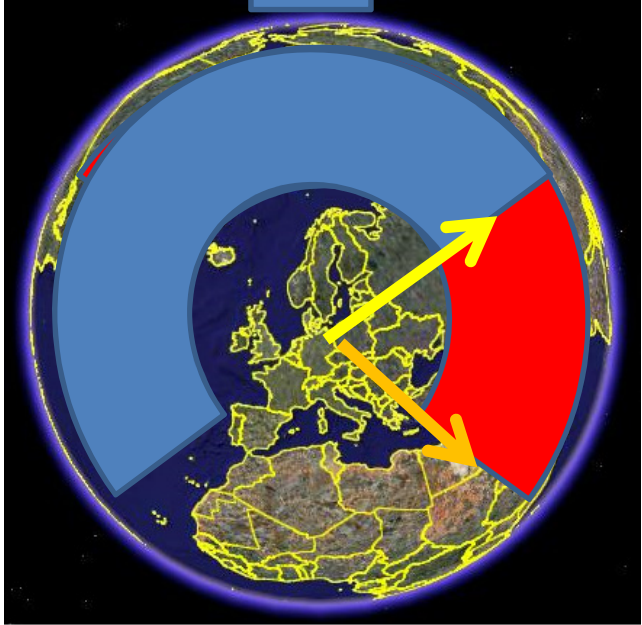
9 Billion in 2050

Population growth

Food

Energy

Energy from the sun



Ethics & Morality

- **Ethics**

- plural noun Definition: **code of morality:** a system of moral principles governing the appropriate conduct for a person or group (*takes a plural verb*)

Morality

- **how right or wrong something is:** the rightness or wrongness of something as judged by accepted moral standards

Is it right to grow bioenergy?

Or

**How much bioenergy
production is right?**

Historical bioenergy



Farmers historically used 25% land for horse feed

Energy crops are 'solar panels'

Solar energy

$4 \text{ MJ m}^{-2} \text{ d}^{-1} = \sim 2393 \text{ Barrels of oil per year ha}^{-1}$



Some bioenergy questions

Do we have
enough land
for food?

What impact
will climate
change have?

Can we
increase
production?

Can we
increase
energy ratio?

What are the
technical
options?

Is it
economic?

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Improving energy capture

M. X giganteus



Hybrid 2



Under canopy photograph

M. X giganteus

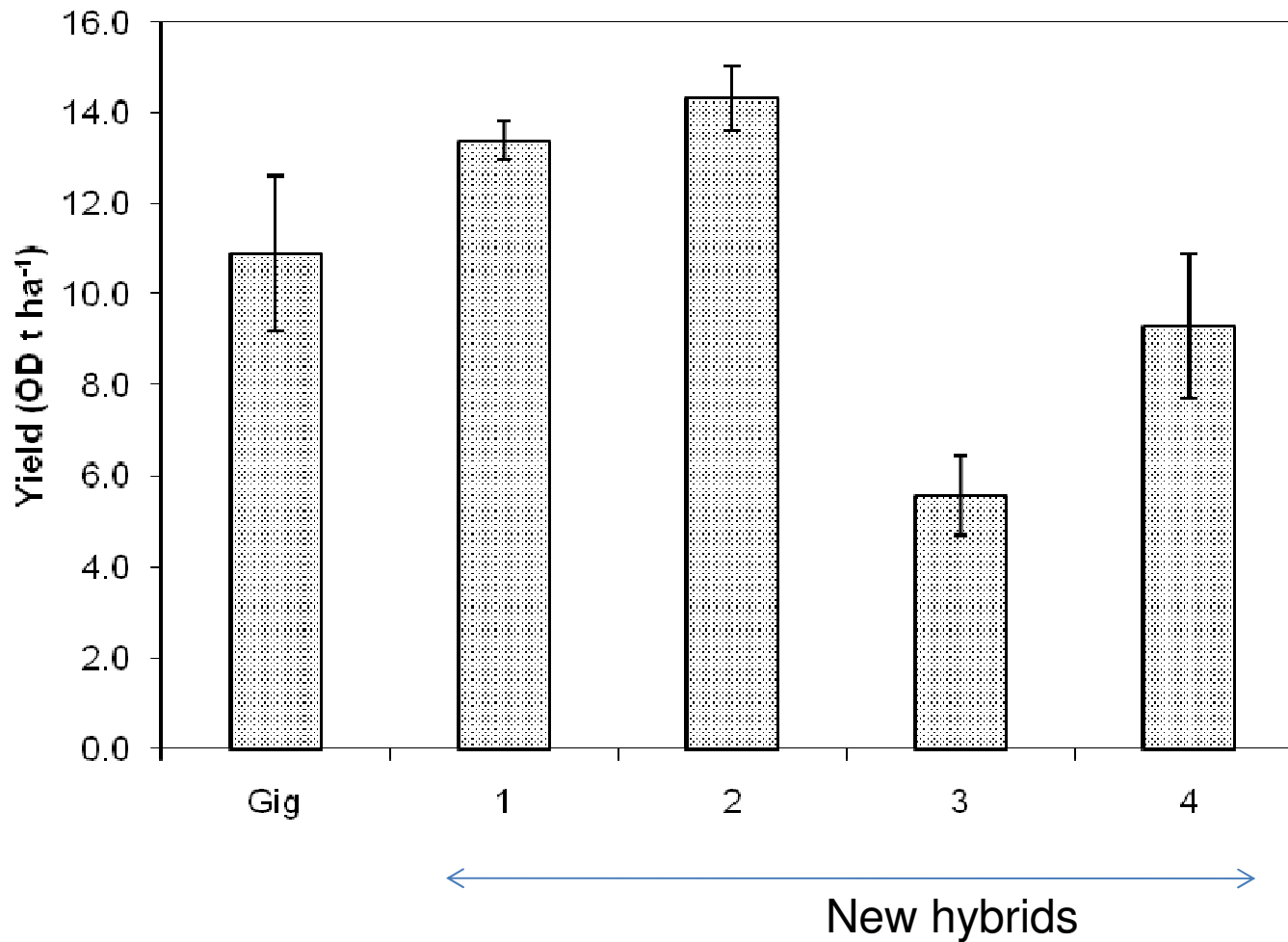


New Hybrid 2



Spring harvest (t DM ha⁻¹)

Welsh slope (fairly Marginal land!)



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Competing in the food chain?



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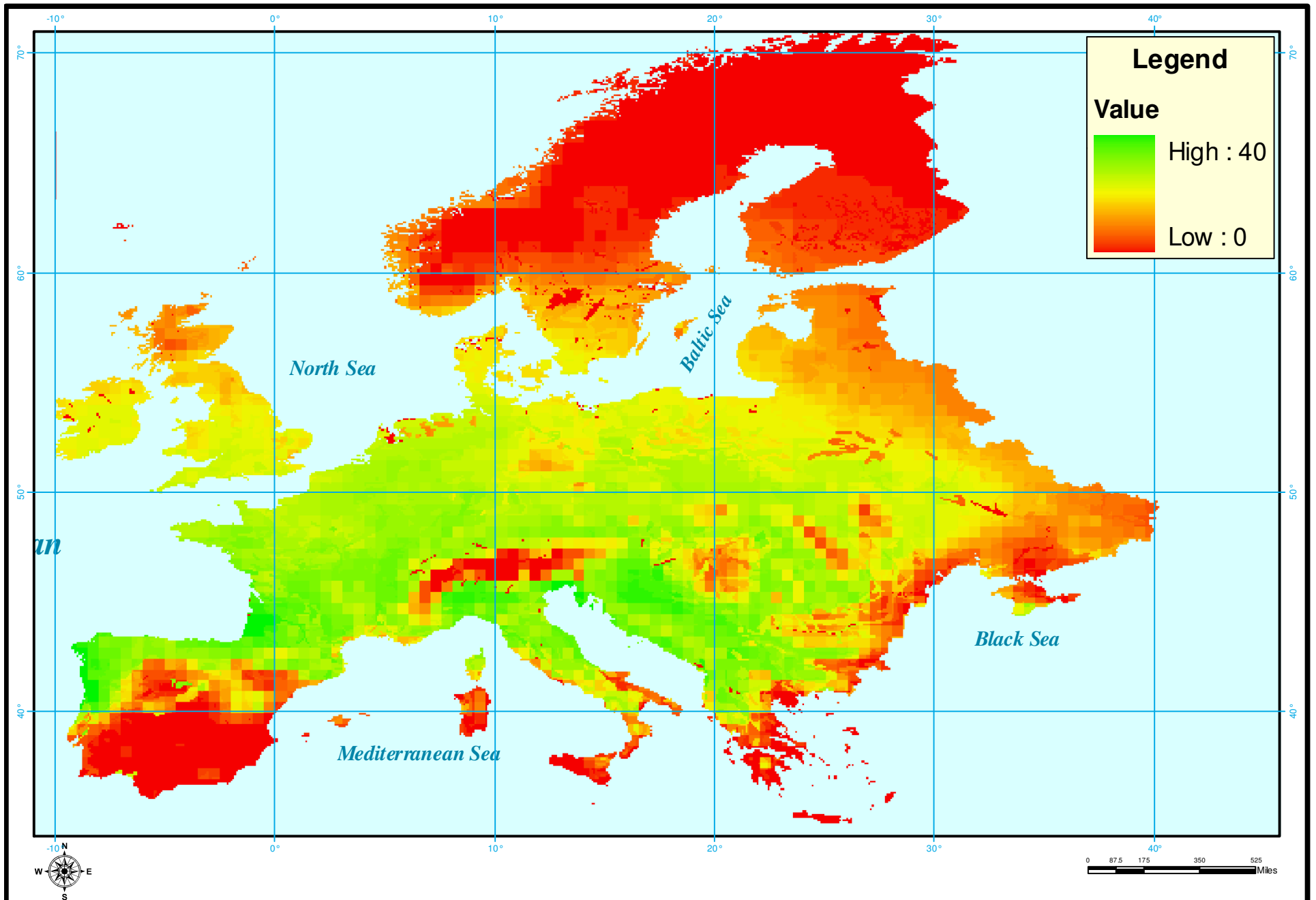
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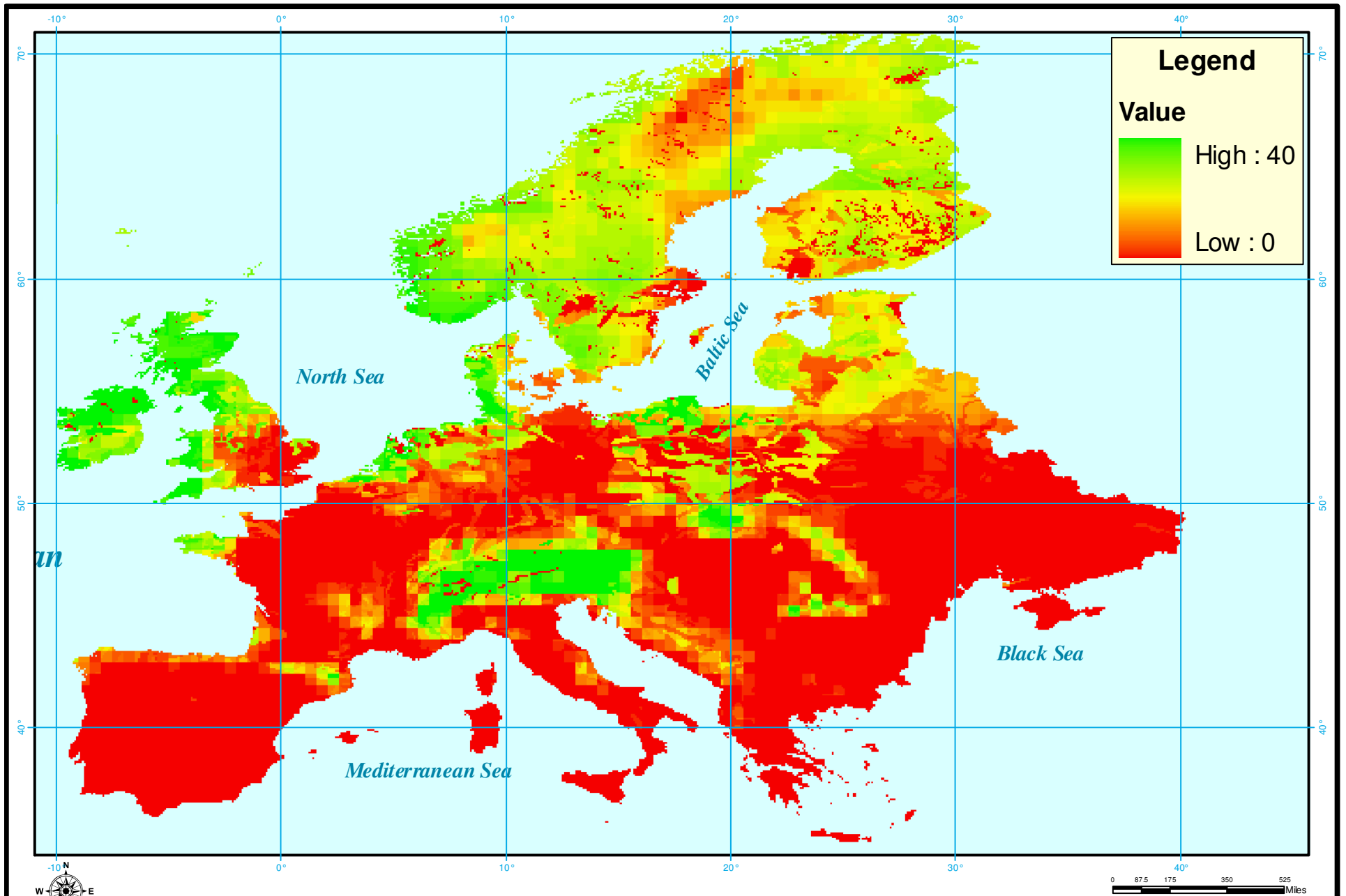
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Miscanthus x giganteus mean peak yield 1960-1990

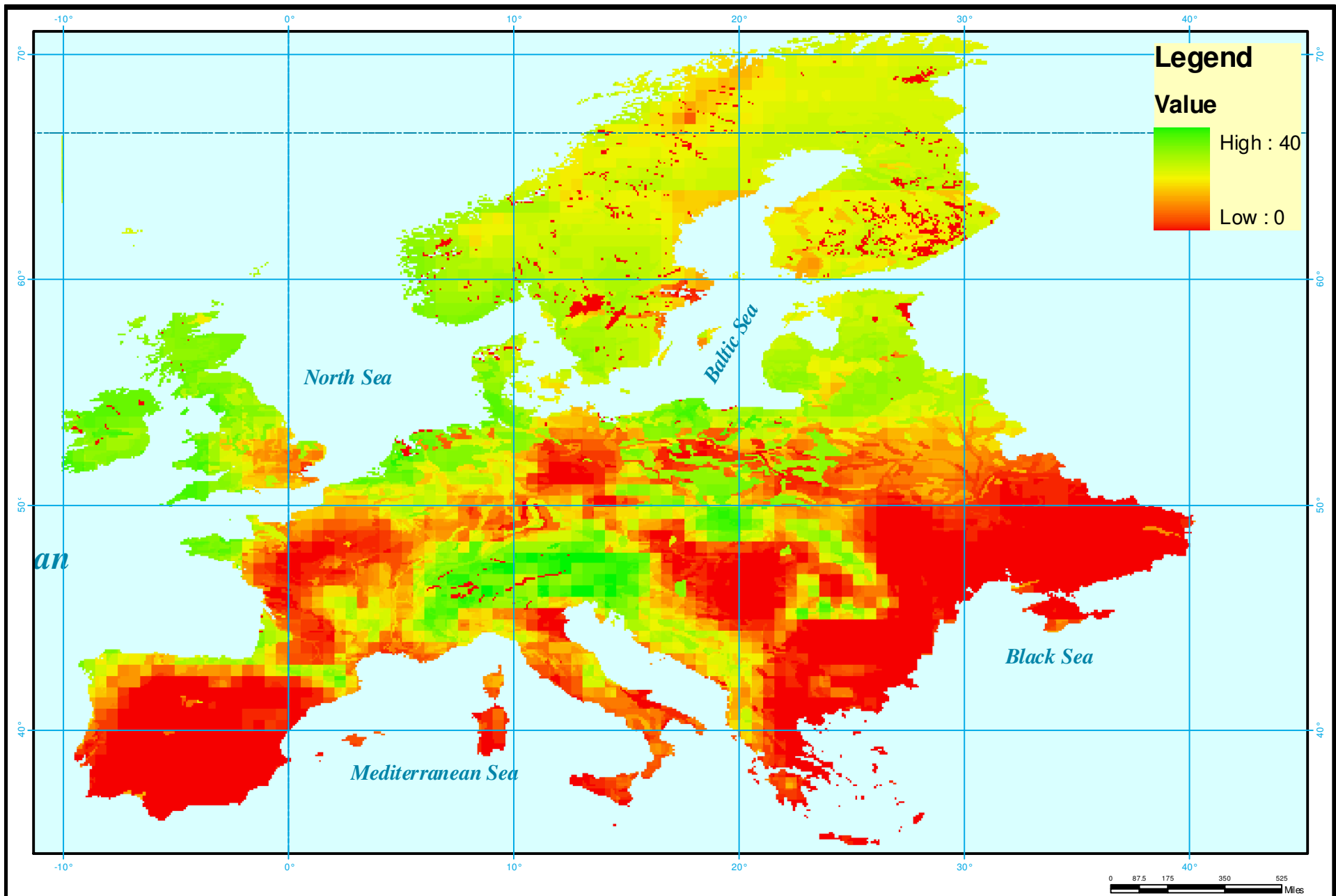


Miscanthus x g mean peak yield AIF1 2080

Logistics

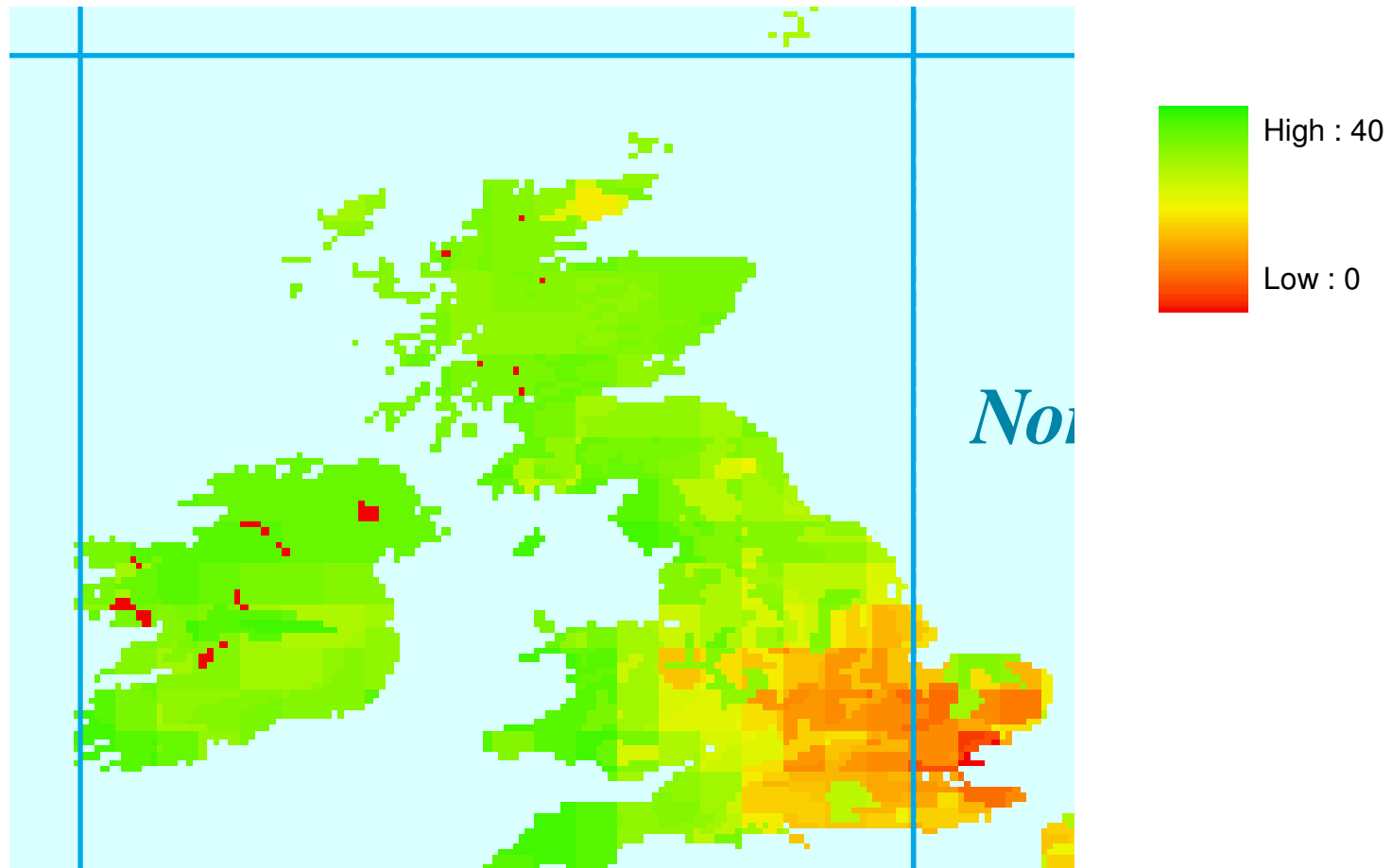


JH crops Ireland. Photo: Keith Armitage



New tech hybrid mean yield AIF1 2080

Same climate data (A1F1 scenario for 2050 - 2080) but the genotype is one which is less sensitive to drought and also winter frost (we have measured this physiological variation)



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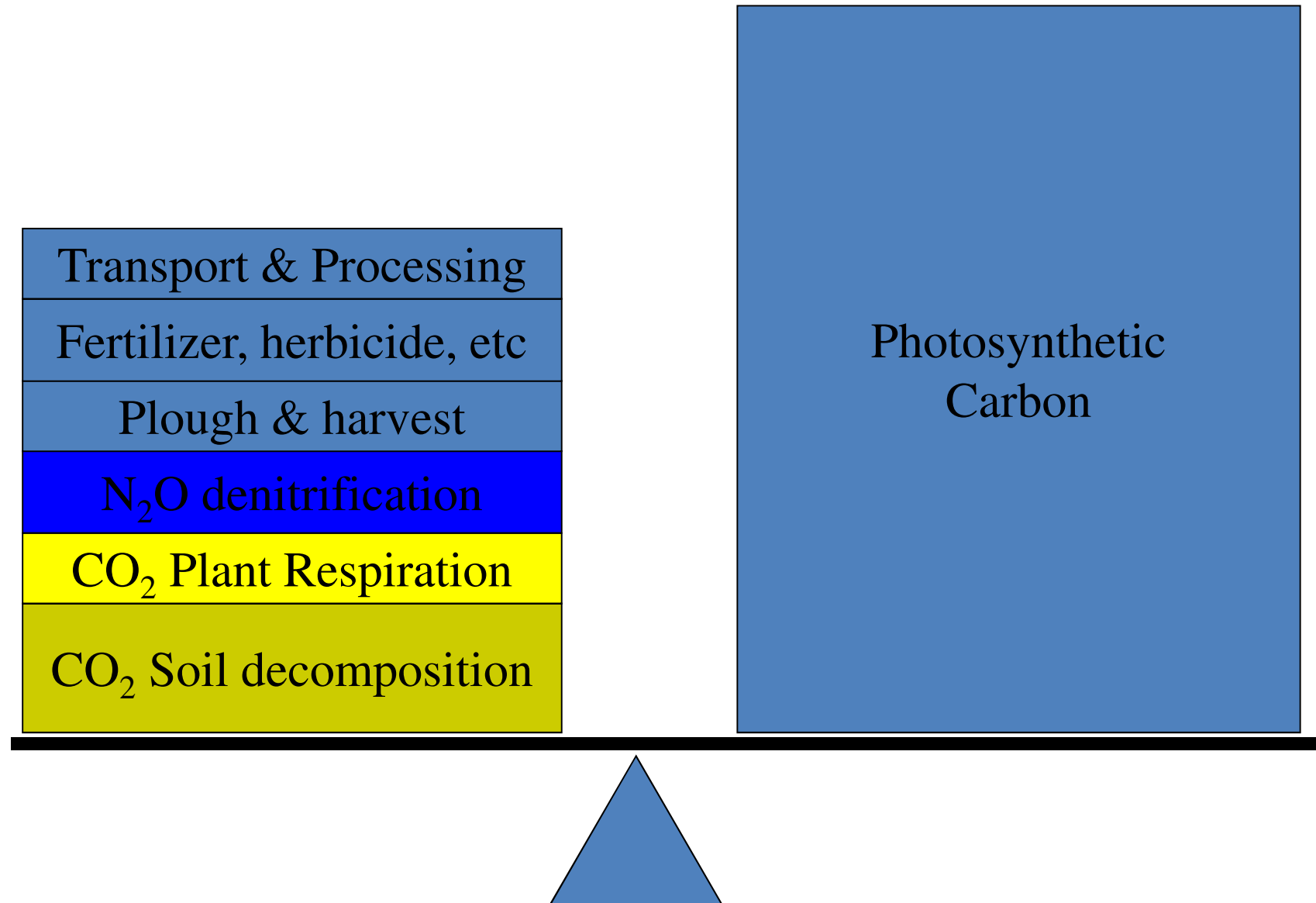
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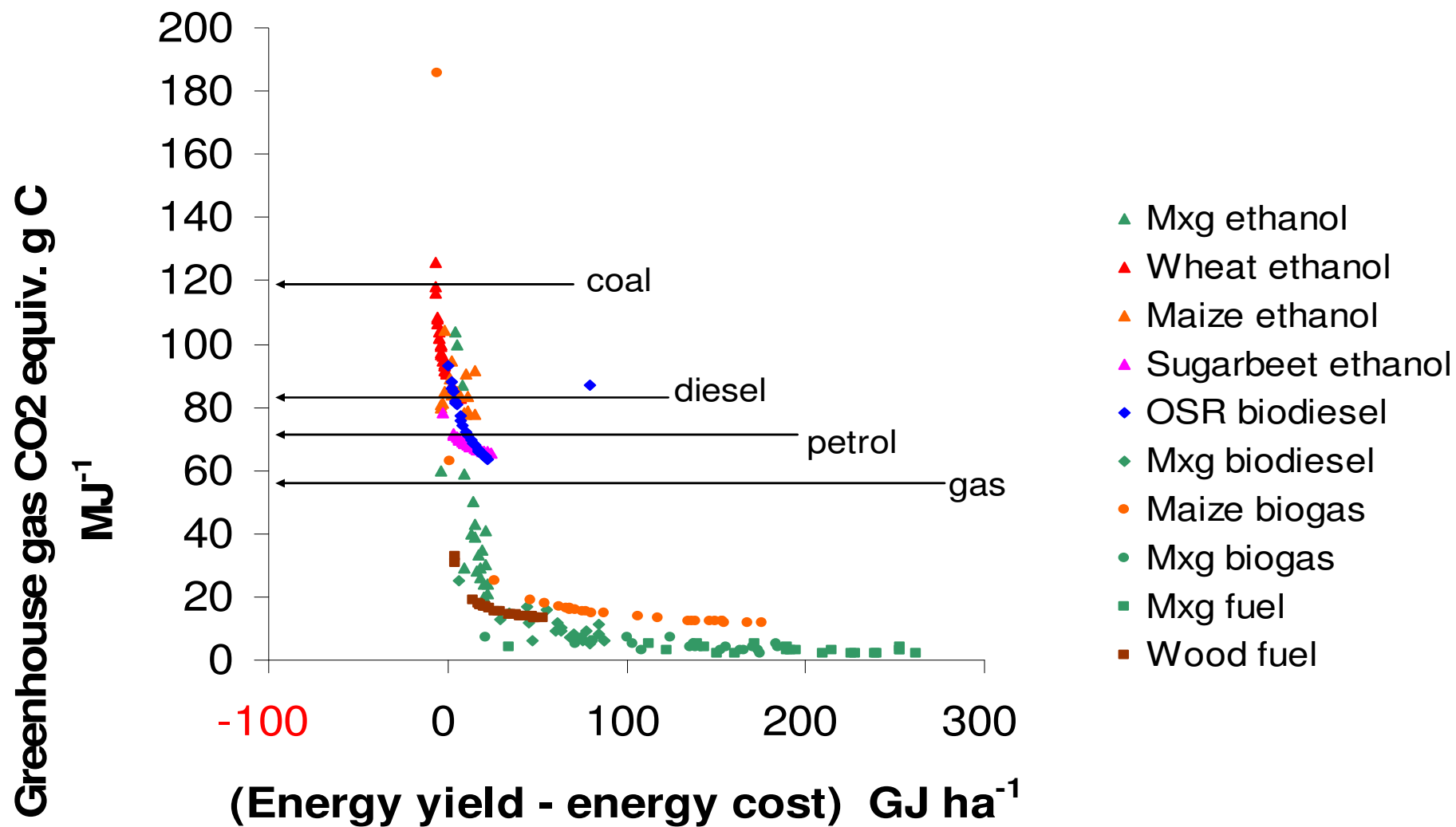
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Greenhouse gas and energy balance



Bio energy comparison EU27



Following methods of Patzek, 2008.

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Brief *Miscanthus* economics

- UK /IRL annual *Miscanthus* yield 12 t DM ha⁻¹
- 1 tonne dry matter = 18 GJ
- 1 Hectare (12 x 18) = 216 GJ
- 1 tonne oil = 42 – 45 GJ
- 1 ha *Miscanthus* ~ 5 t oil = 36 Barrels of oil.
- If 1 Barrel of oil = \$145. ∴ 1 tonne oil = \$1044
- 1 ha (\$145 x 36) = \$5220 = €3236
- Potential value 1 t biomass = €269
- Wheat currently £200 per tonne (and rising) € 280

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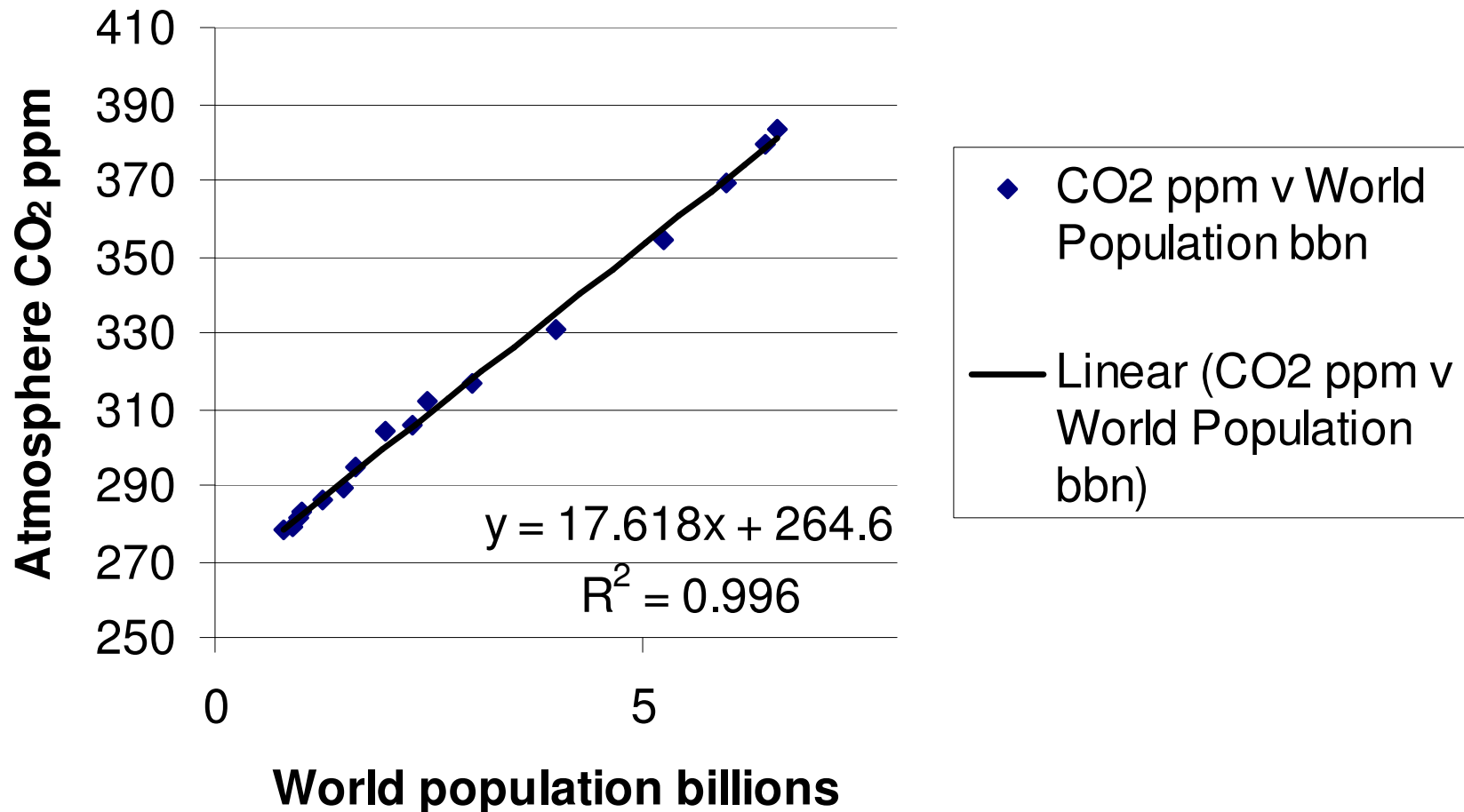
Genetic improvement for proper use
of marginal lands – thus avoiding the
direct conflict with food crop
production

Dreaming of Technological break through.....

- A perennial C4 plant with edible grains and biomass for energy
- How could you do it?
- Breed a maize, sugarcane and Miscanthus intermediate?
- Systems biology 'modular breeding'
- Terrestrial resource

Is the quest for improving life quality sustainable?

Another model of global warming



Complex and tough challenges ahead

- ***"All that is necessary for the triumph of evil is that good men do nothing." (Edmund Burke)***

Sustainable energy options

- Terrestrial
 - Solar biomass 1.4% efficiency
 - Solar Photo-Voltaic 5% efficiency
 - Wind – can be combined with biomass
- Marine resource
 - Tidal
 - Wave
 - Wind

Current and Future Energy

A dedicated energy crop

- 'I have seen the future: Grass growing 12 feet (4m) high that will fuel power stations' (ca. 1990)

