Growing Returns

Gary J. Lanigan[1], John Finnan[2], Reamonn Fealy[3], Karl Richards[1], Bruce A. Osborne[4], Mike Jones[5]

Faye Carroll[5], Orlaith Ni Chonchubair[1,4], Dominika Krol[1,5], Matt Saunders [4], Marta Dondini[5]

[1] Johnstown Castle, Wexford
[2] Oak Park, Carlow
[3] RERC, Kinsealy
[4]BES, UCD Dublin 4,
[5] Trinity College, Dublin

Outline

- Effects of Land Use Change
- Shifting to Biomass – How is it measured
- Effect of land transition
- Change in emissions associated with LUC
- Potential for fossil fuel displacement
- Conclusions

Future challenges

- Post Kyoto –
  - –20% from the non-ETS sectors *without* a global agreement
  - –30% *with* an agreement
- Agriculture will come under sustained pressure to reduce emissions in the medium term
- Impetus for increased production
- NZ are placing agriculture within national ETS

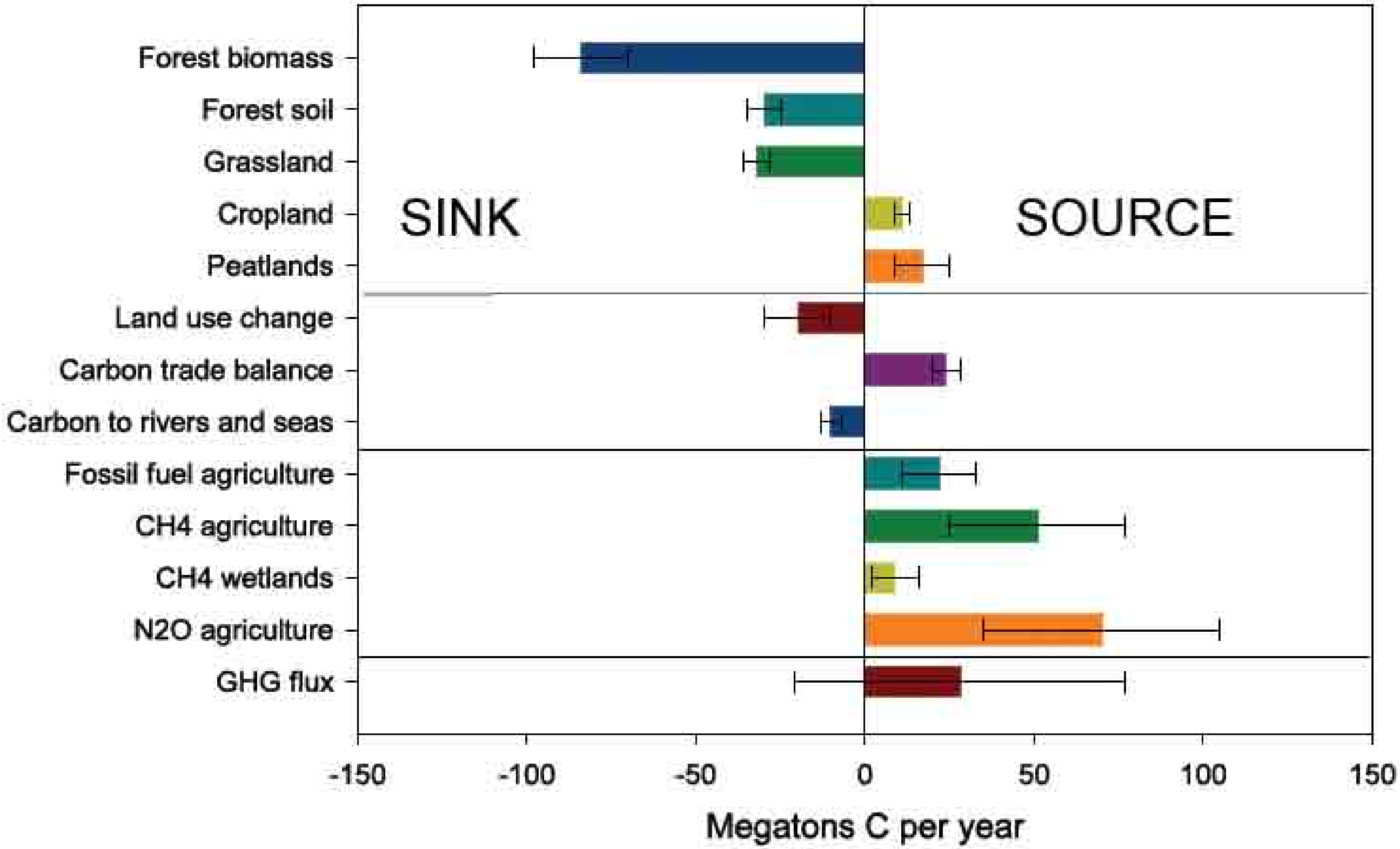
Soil carbon sequestration

- Carbon sequestration implies transferring atmospheric CO_2 into non-labile pools and storing it securely so it is not immediately re-emitted

1. Additionality and Leakage
2. Monitoring & Verification (Measuring)
3. Permanence
4. Value of Carbon

Teagasc
Agriculture and Food Development Authority

EU25 terrestrial greenhouse gas balance* including C sequestration



* CH_4 and N_2O fluxes as carbon in CO_2-equivalents with a GHG warming potential of 100 year horizon

Shifting to biomass production

- Enhanced Carbon sequestration – direct removal of CO_2 from the atmosphere
- Displacement of N_2O emissions
- Substitution of fossil fuel emissions

- Under current international default values – the conversion of pasture to biomass crops is considered to be zero as ~2 tC ha^{-1} is considered to be released on ploughing
- The actual situation should be more favourable

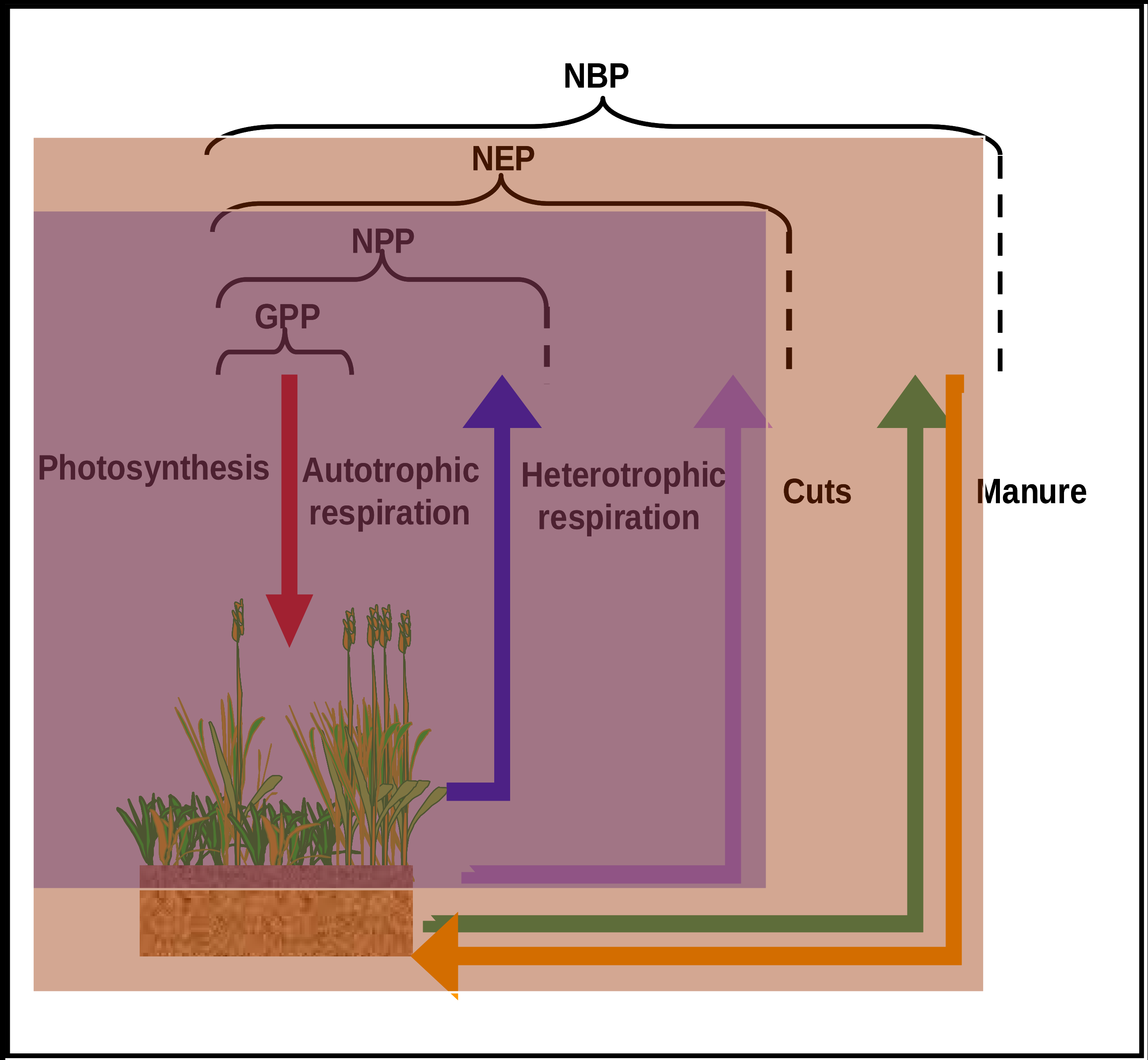
What do we need?

- Quantify LUC
- Annual C fluxes
- C input into soil – rhizome, root turnover, litter input

Components of the agricultural C budget

NEE: Net Ecosystem Exchange, Atmospheric C balance

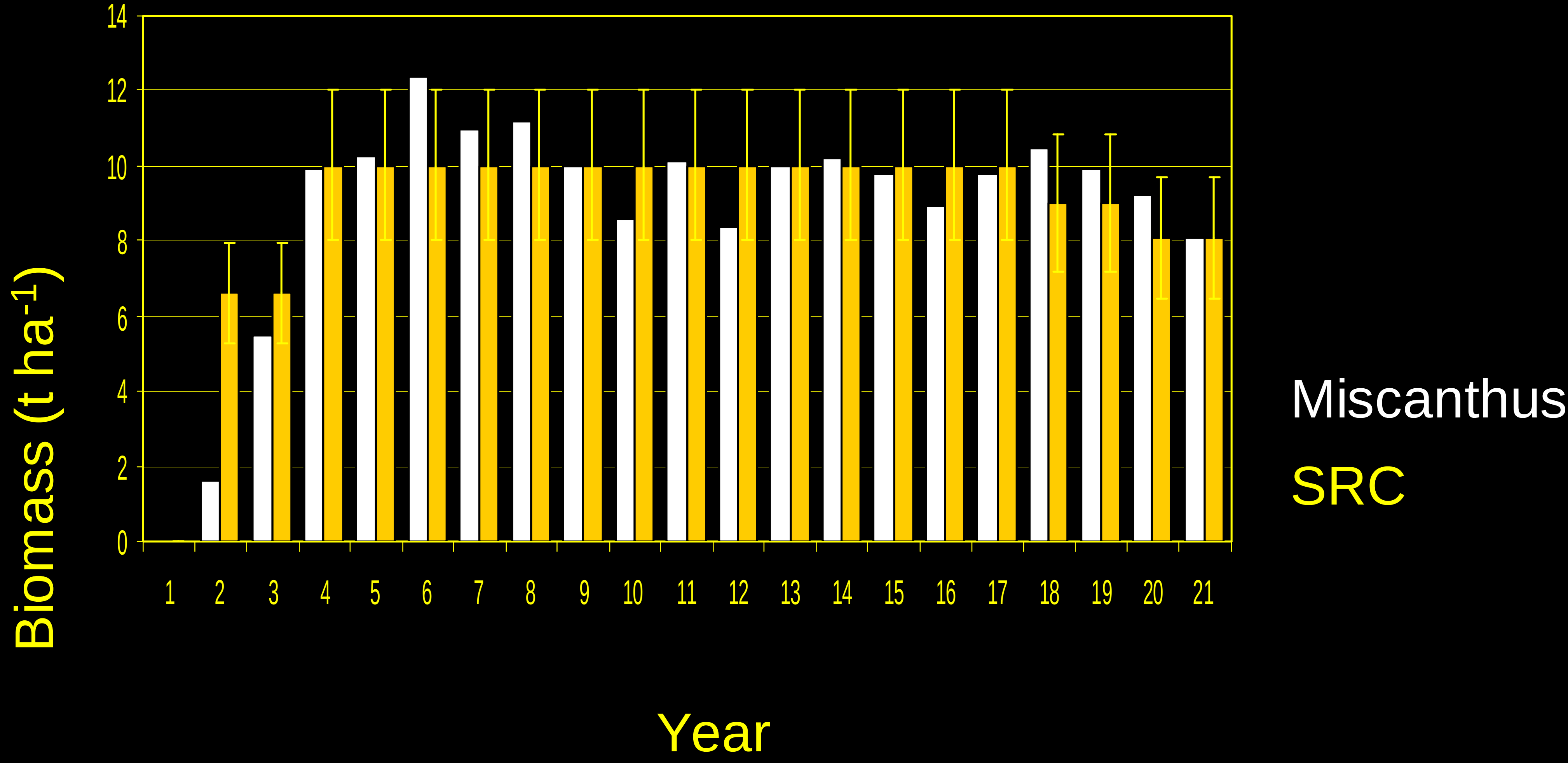
NBP: Net Biome Productivity, Soil C balance

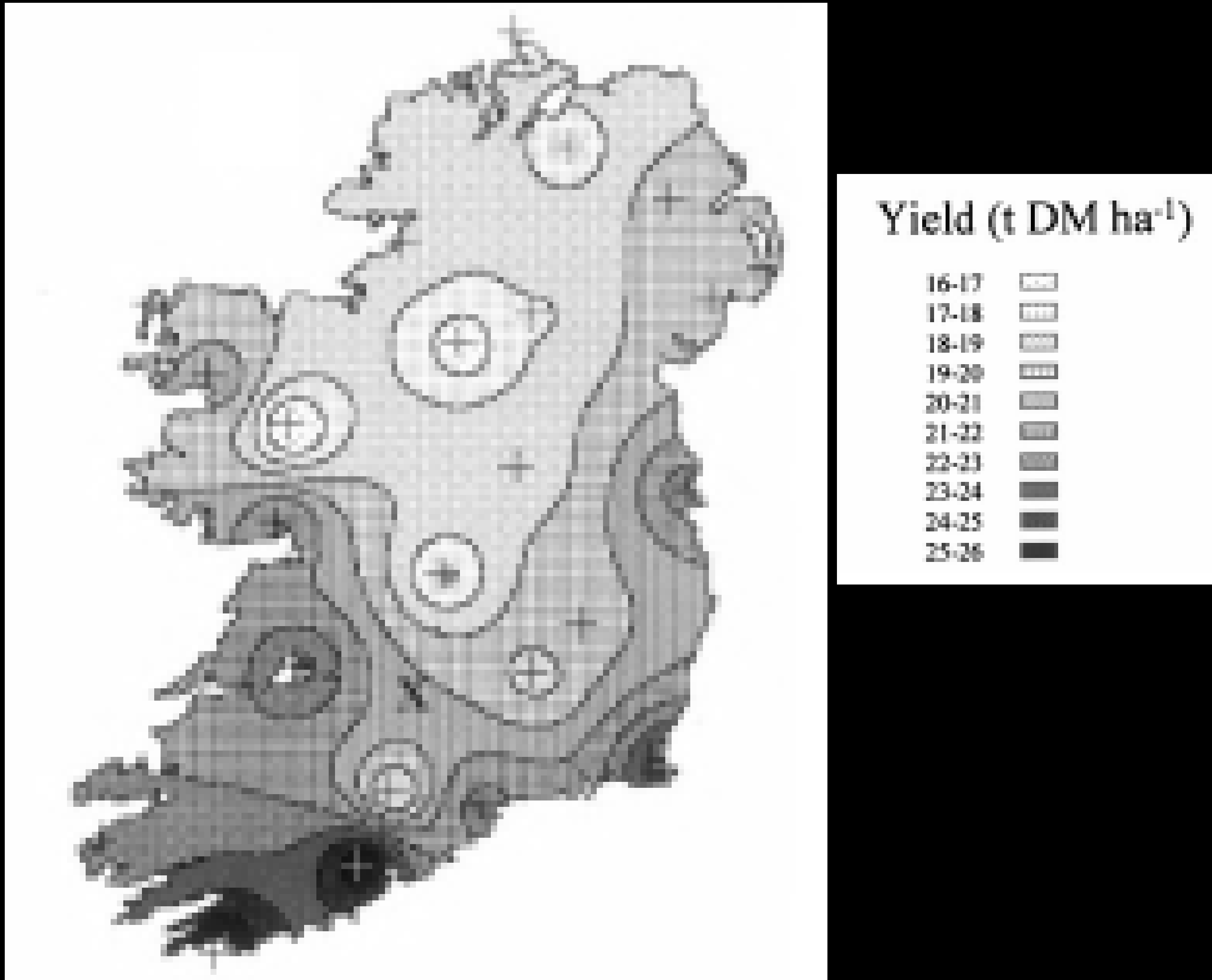


Teagasc

Agriculture and Food Development Authority

Potential Biomass Production



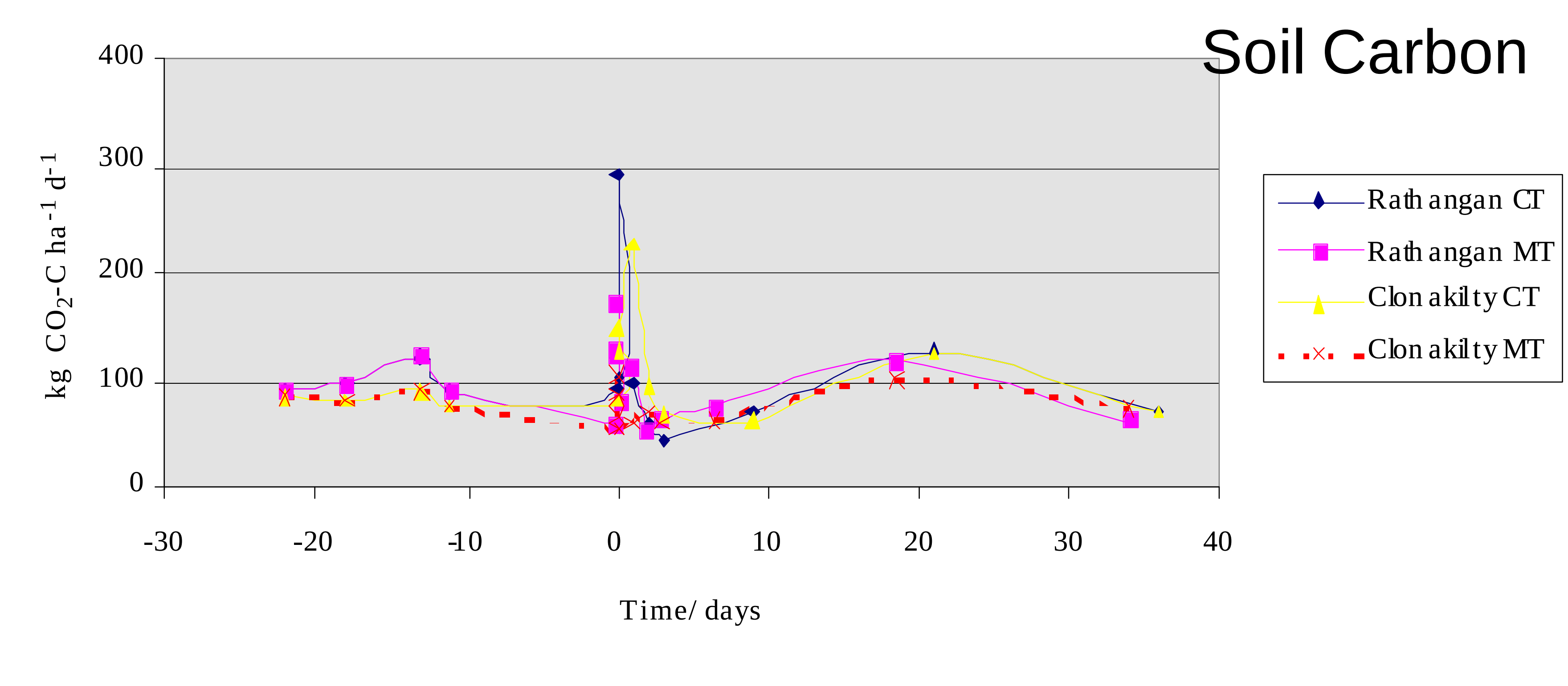


Clifton-Brown et al. (2000)

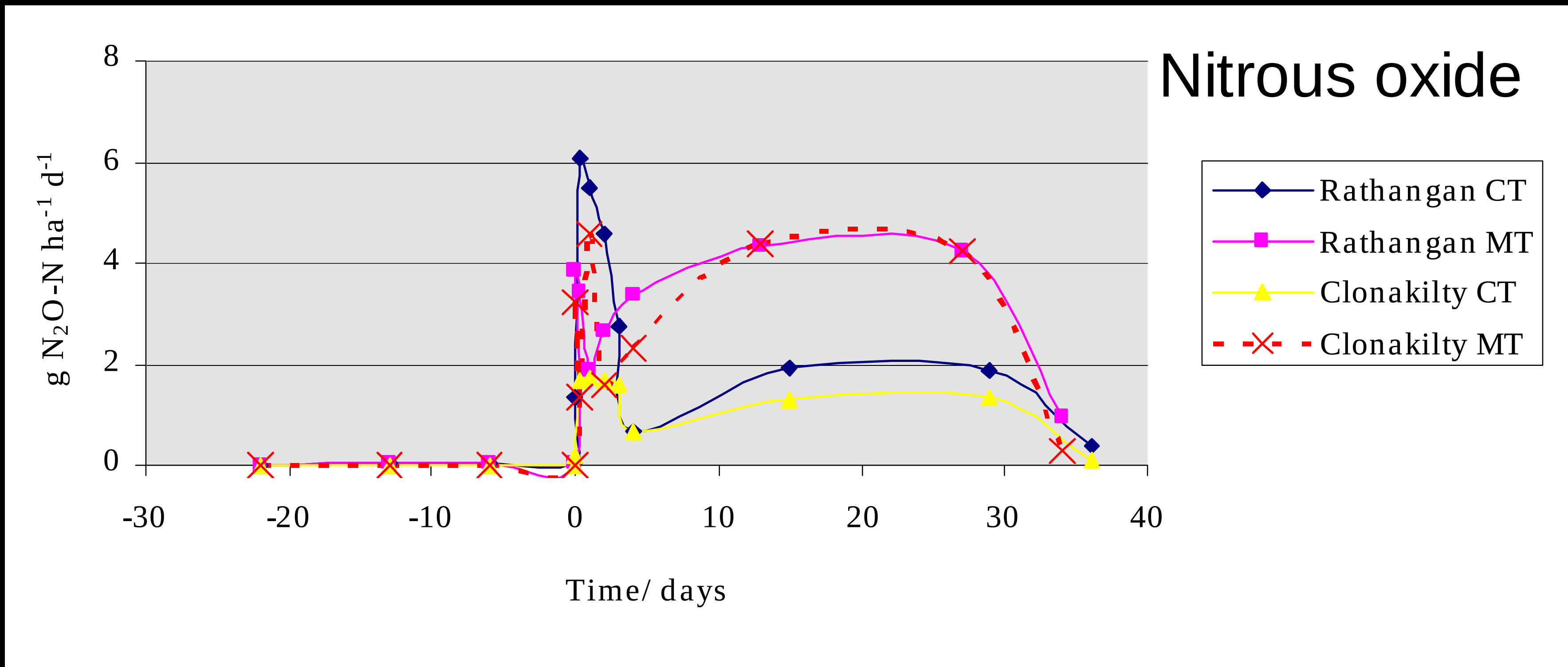
Emissions during land preparation

Ecosystem fluxes – Eddy covariance

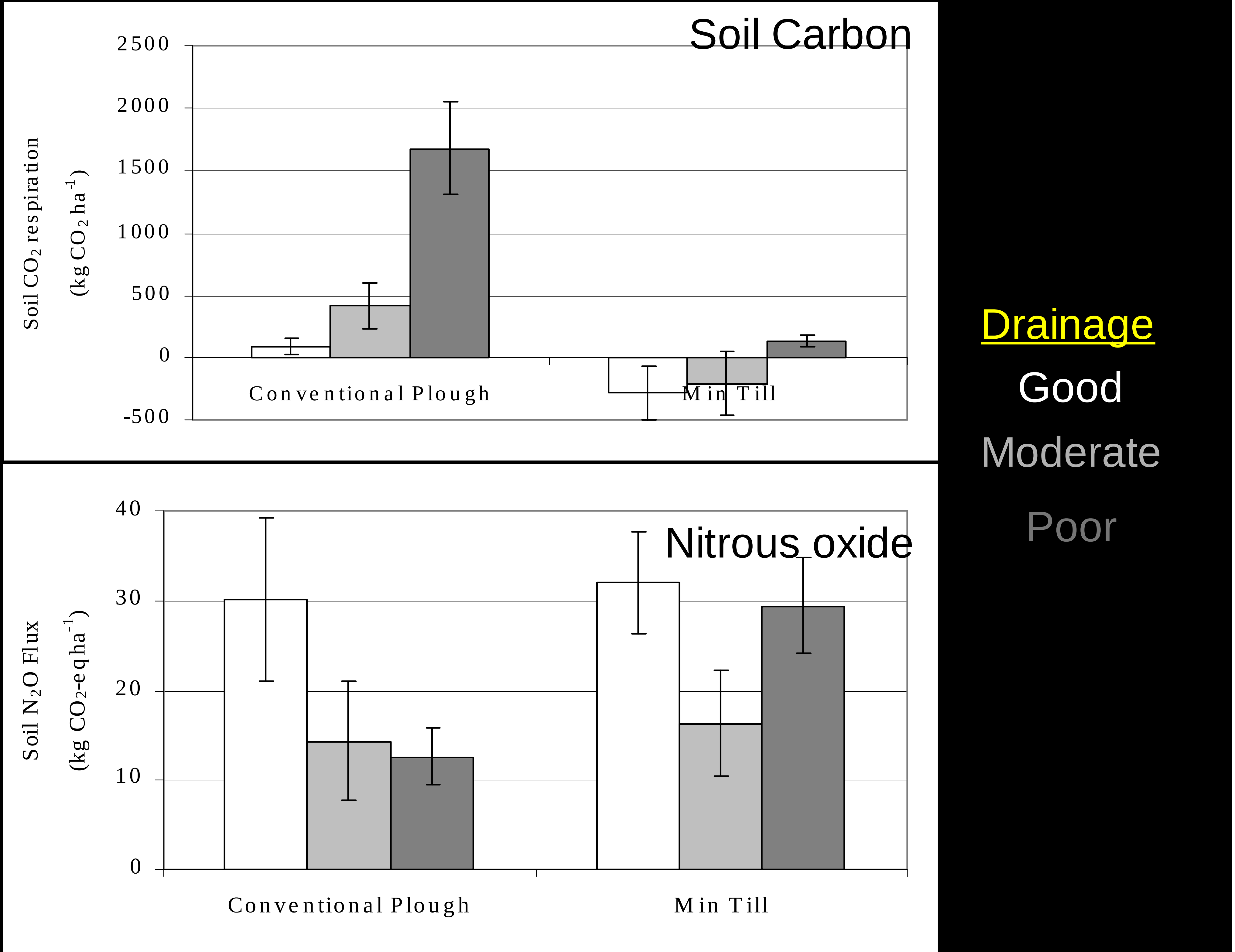
Soil respiration



Soil Carbon
400
300
200
100
0
kg CO_2-C ha^{-1} d^{-1}
-30
-20
-10
0
10
20
30
40
Time/ days
Rathangan CT
Rathangan MT
Clonakilty CT
Clonakilty MT

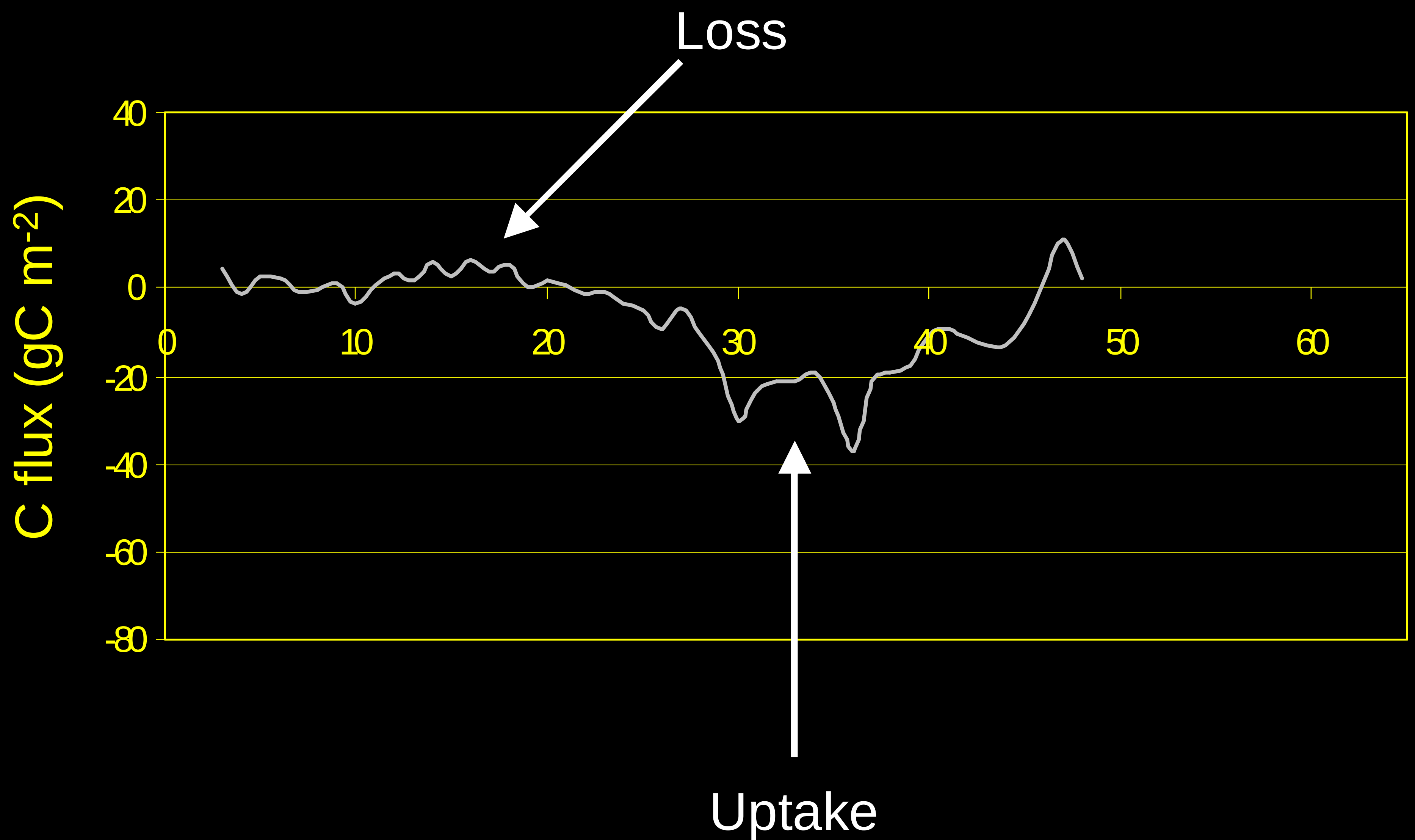


Nitrous oxide
8
6
4
2
0
g N_2O-N ha^{-1} d^{-1}
-30
-20
-10
0
10
20
30
40
Time/ days
Rathangan CT
Rathangan MT
Clonakilty CT
Clonakilty MT

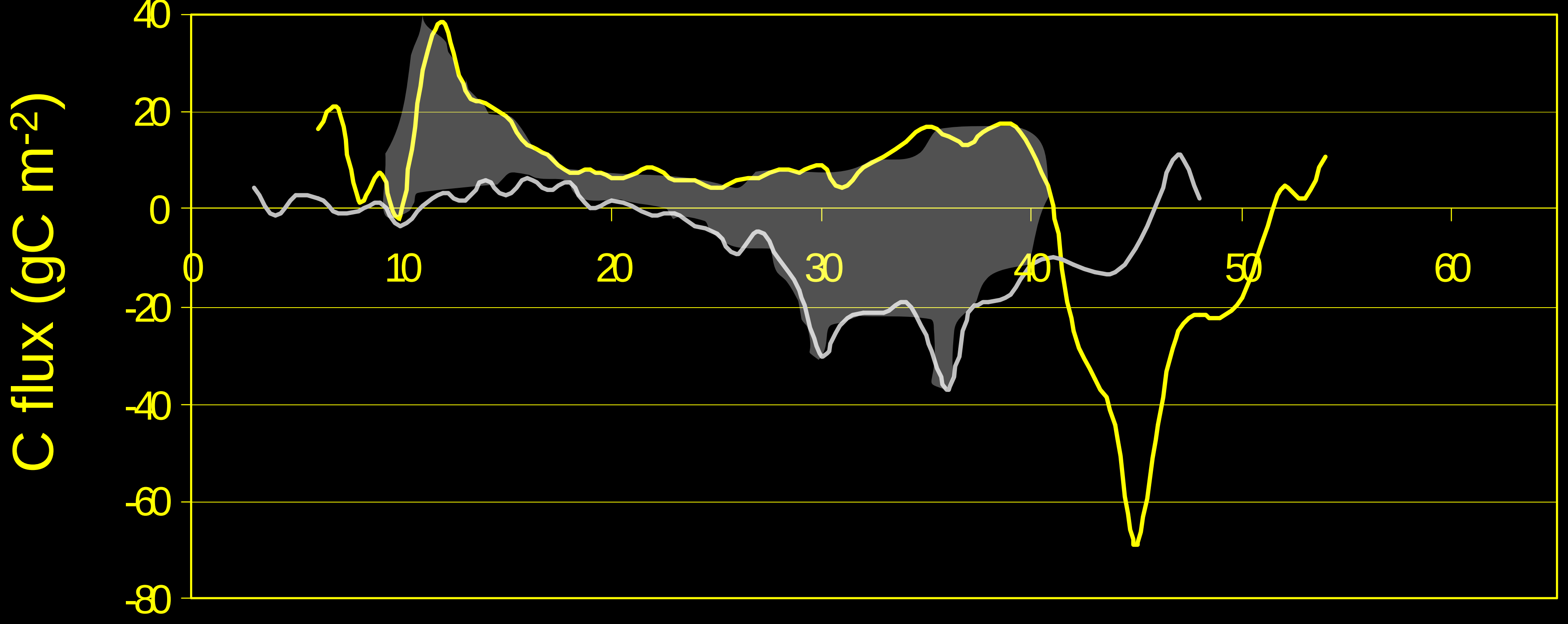


Soil Carbon
2500
2000
1500
1000
500
0
-500
Soil CO2 respiration
(kg CO2 ha-1)
Conventional Plough
Min Till
Nitrous oxide
40
30
20
10
0
Soil N2O Flux
(kg CO2-eq ha-1)
Conventional Plough
Min Till
Drainage
Good
Moderate
Poor

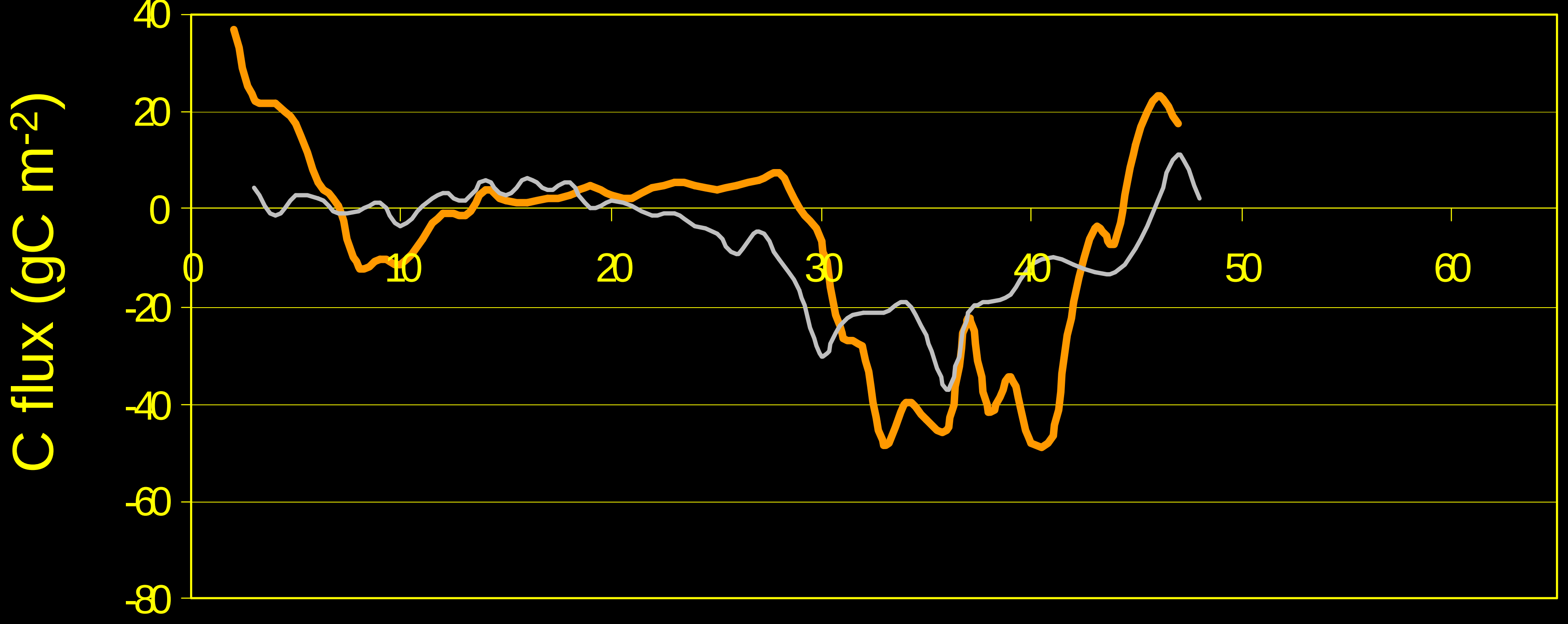
Pasture Net C Balance



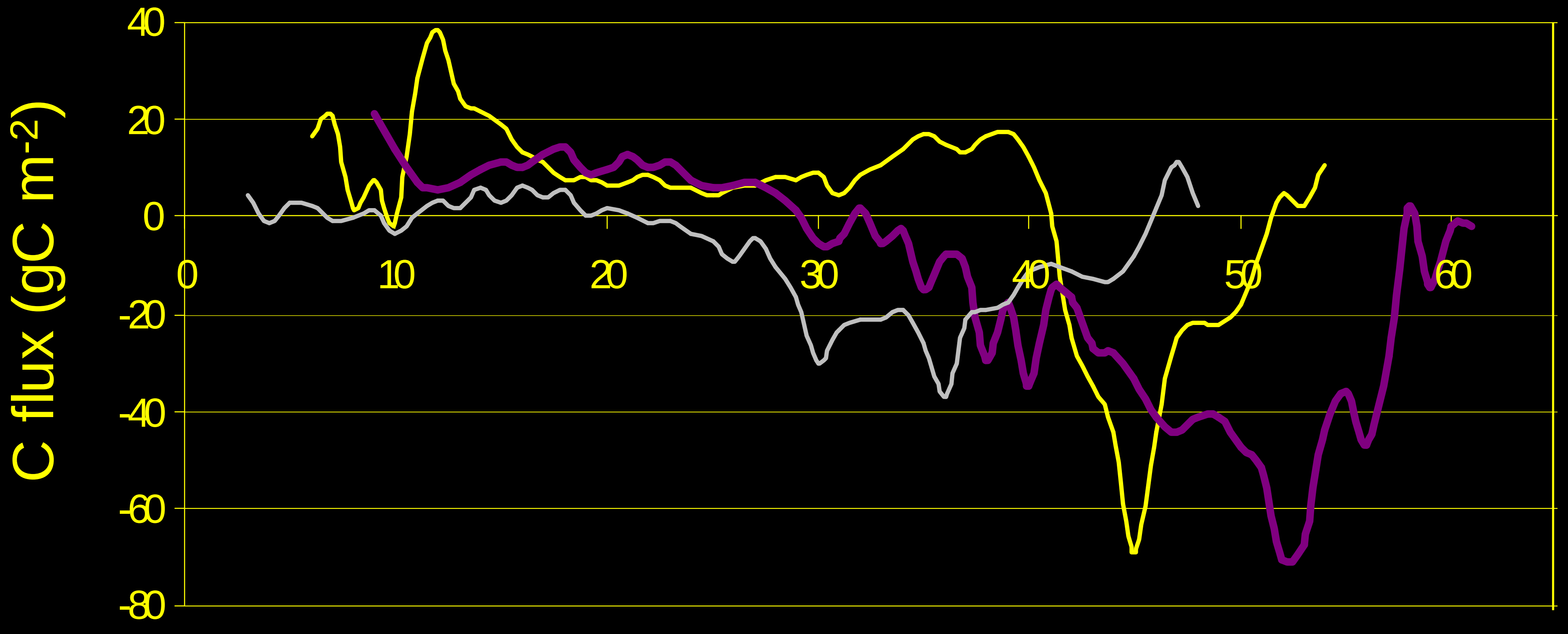
Pasture/Maize Net C Balance



Pasture/OSR Net C Balance

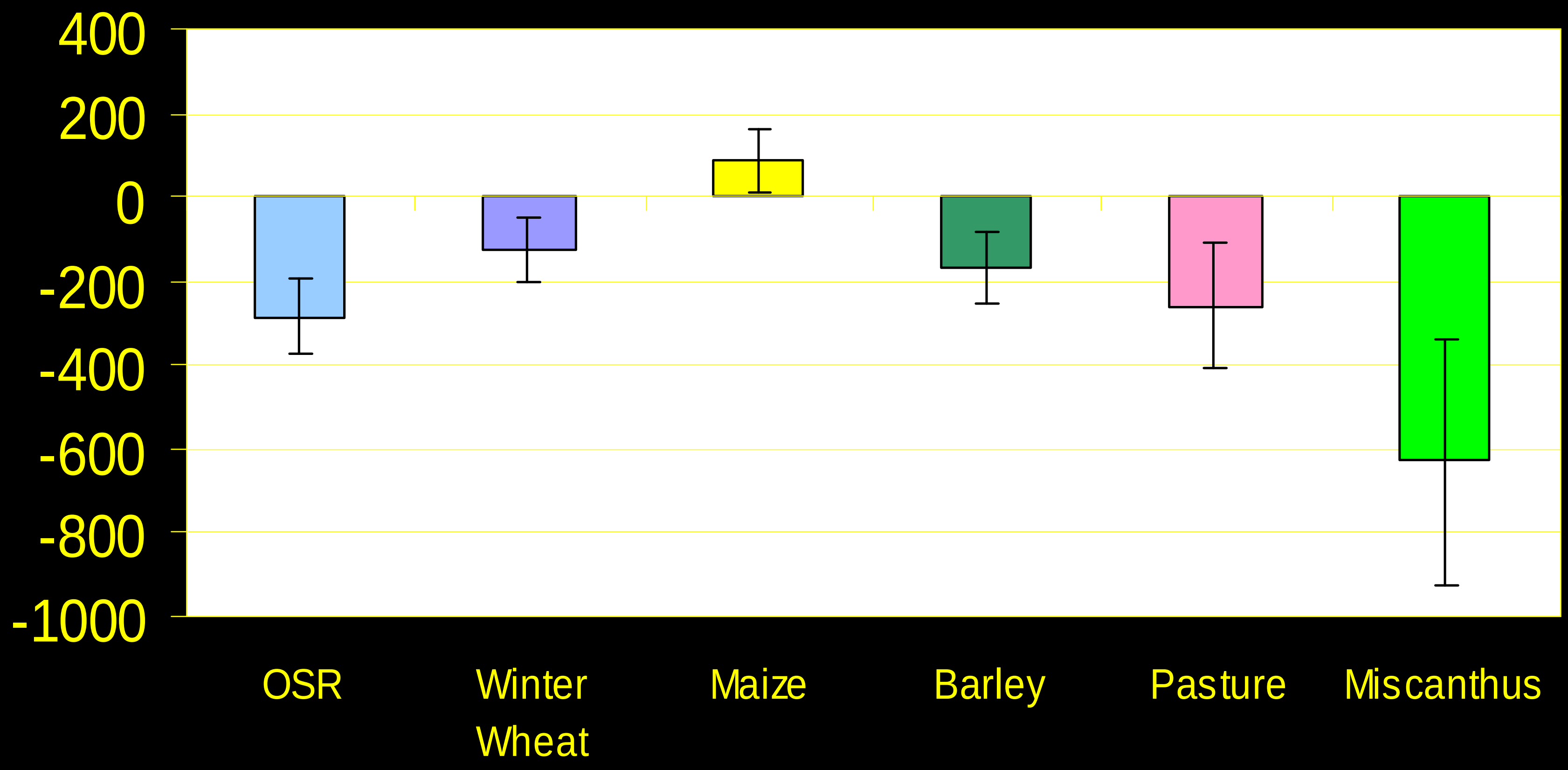


Pasture/Maize/Miscanthus Net C Balance

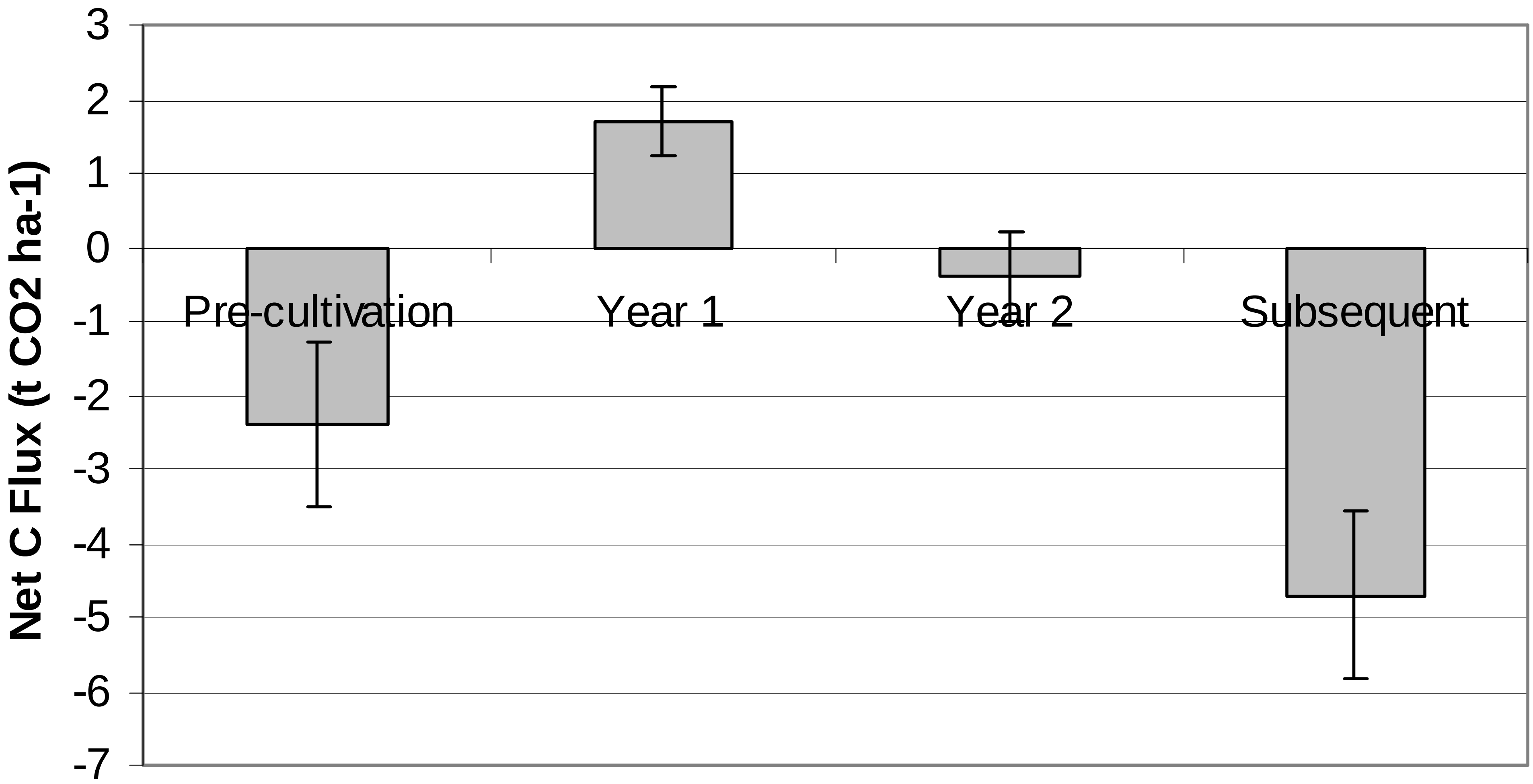


Miscanthus has a long growing season and little disturbance

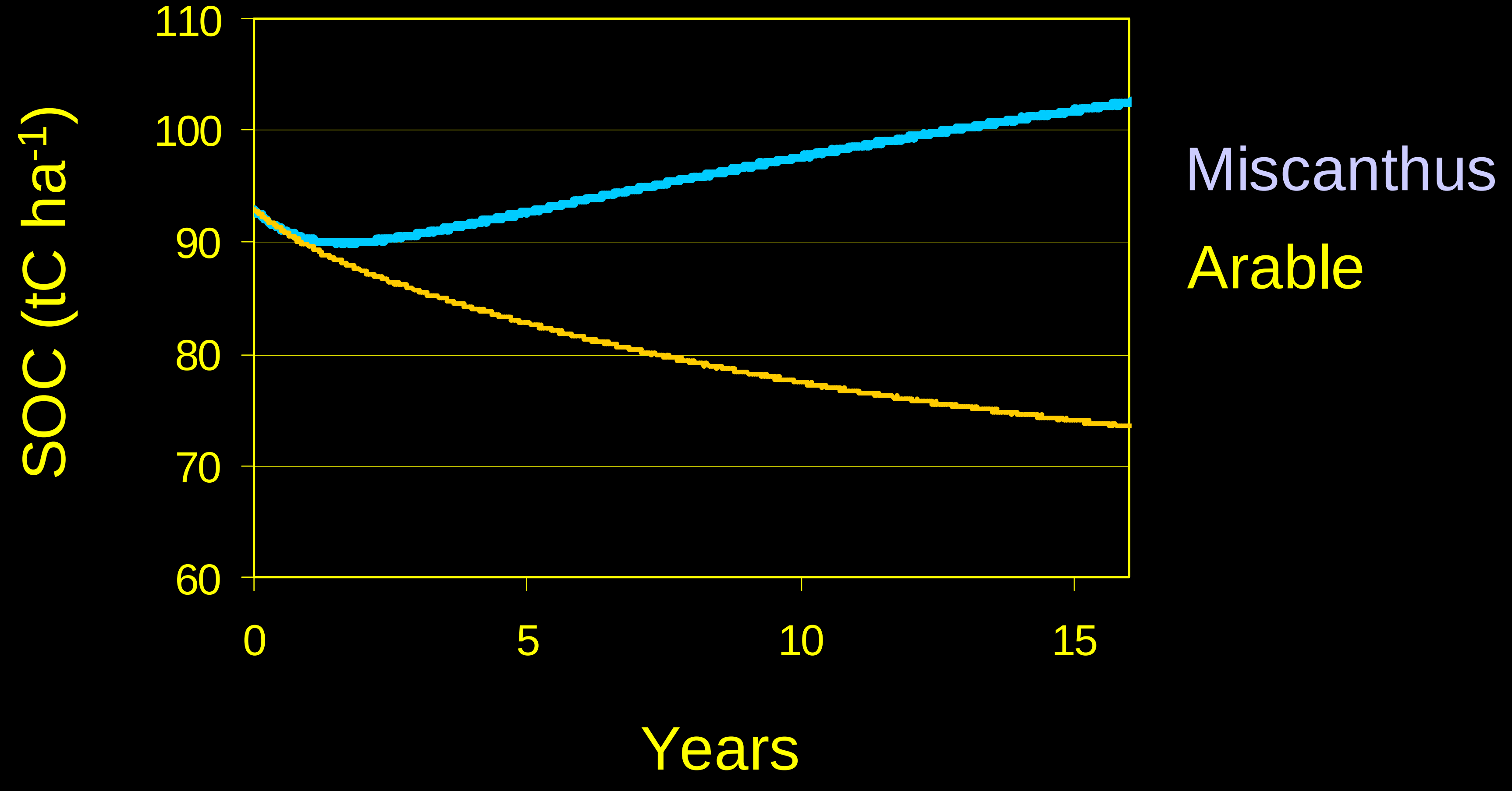
NEE of various land uses

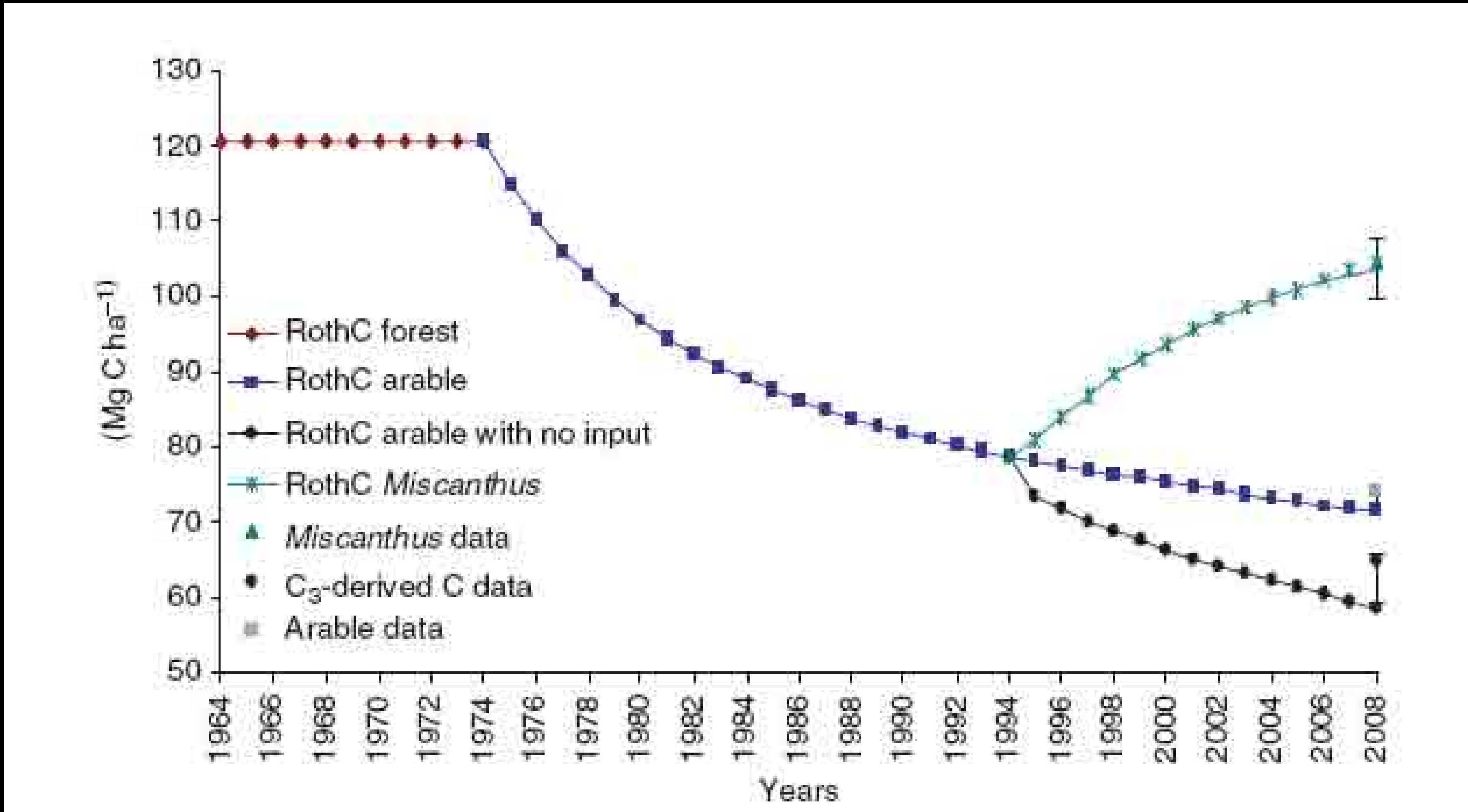


Net Productivity



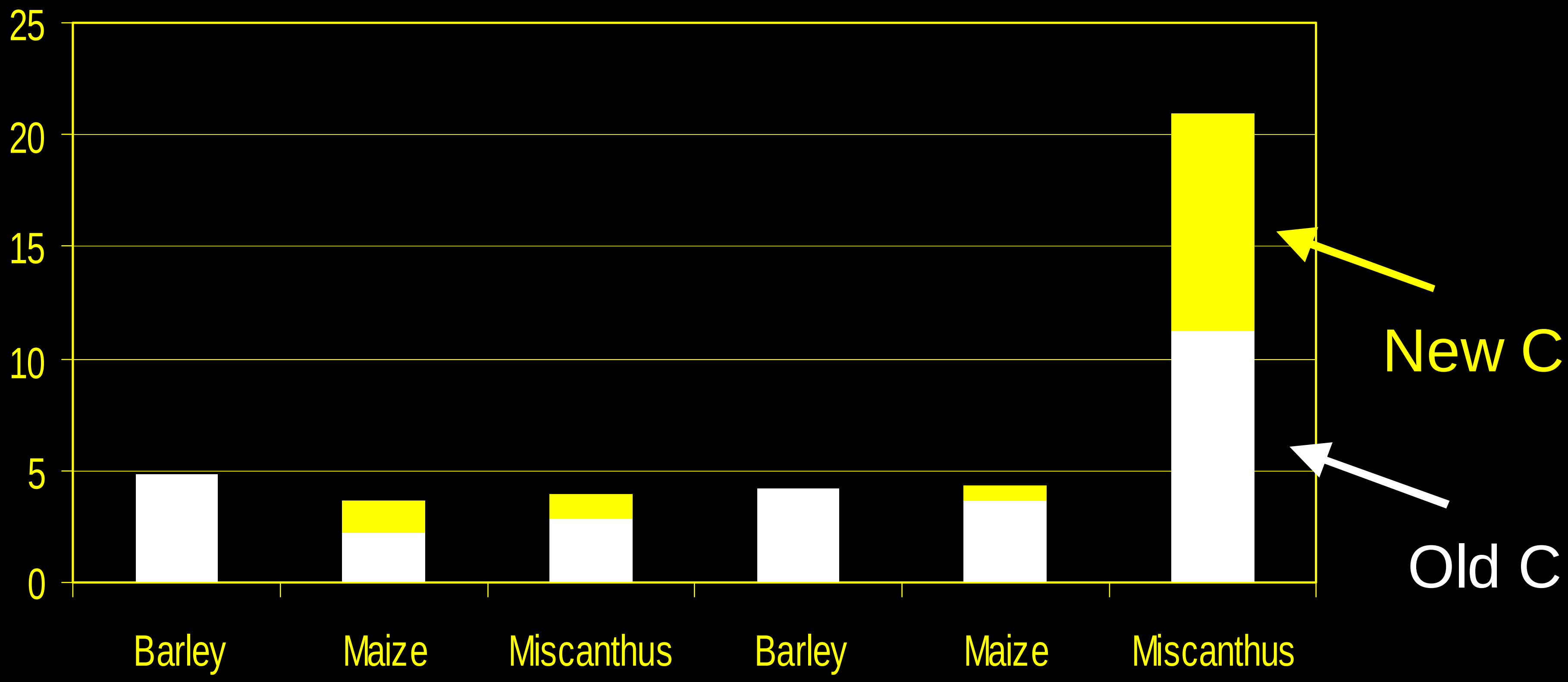
Effect of pasture conversion on SOC (DAYCENT)



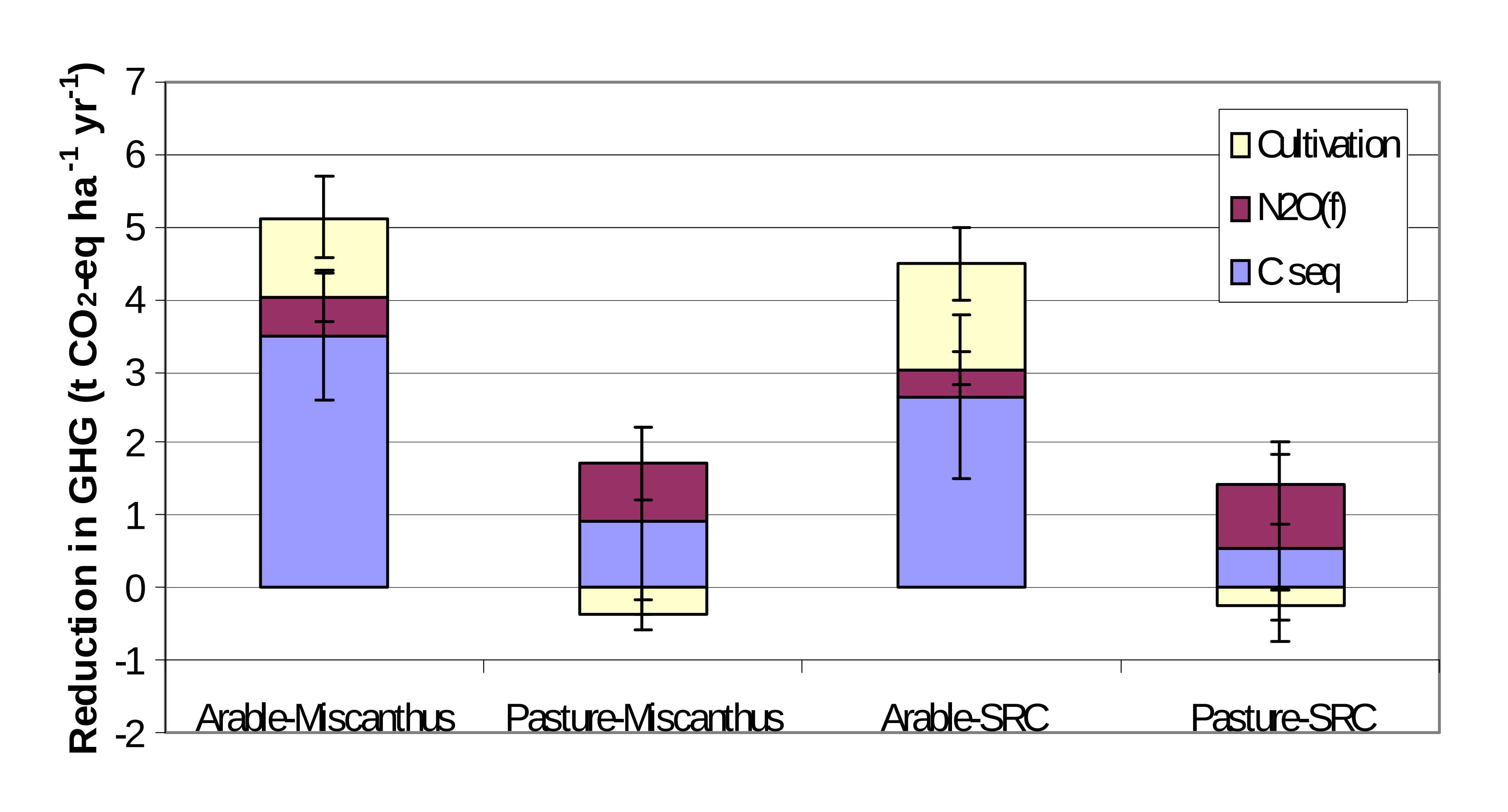


Dondini et al 2009 GCB-Bioenergy

Quality as well as quantity: The ultimate fate of SOC



Emission change associated with LUC to biomass

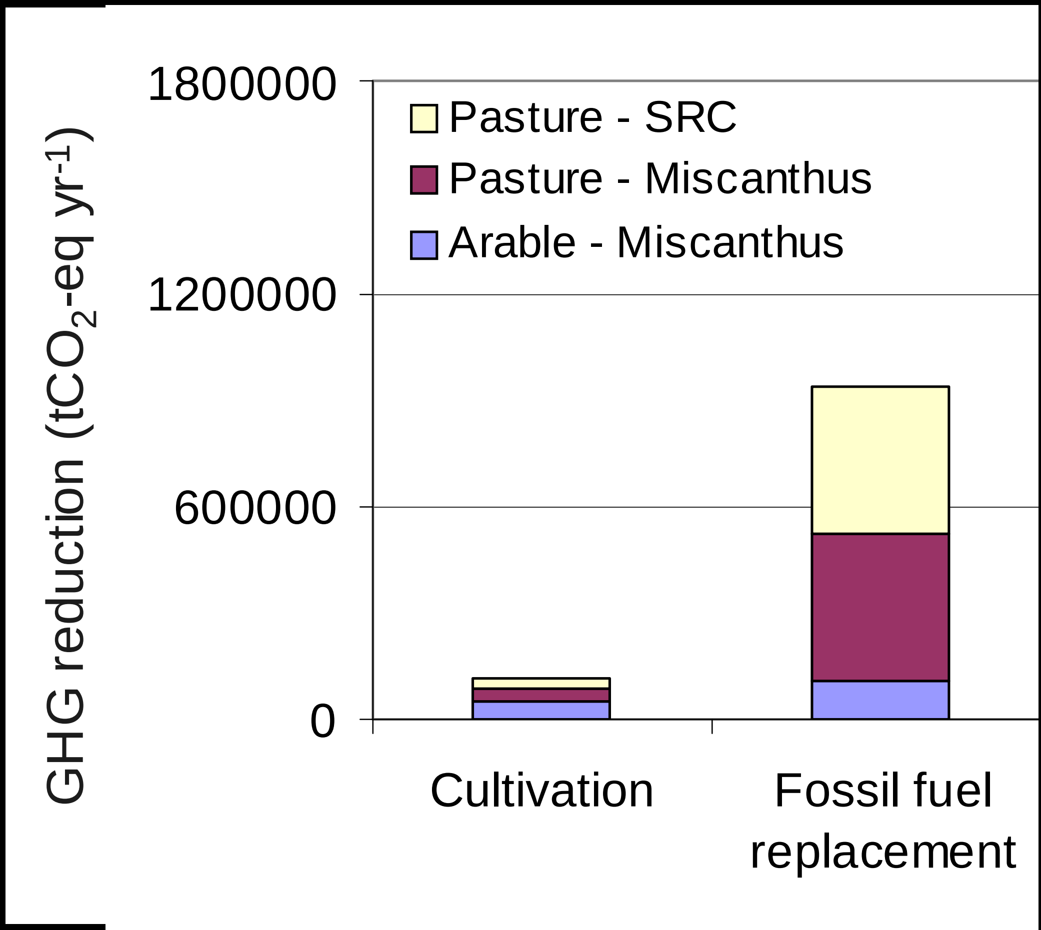


Total Reductions Achievable……..

Assuming ~60,000 ha required for co-firing target

110,000 ha required to replace 6% of heating

Energy generated of 160 -170 GJ ha^{-1}

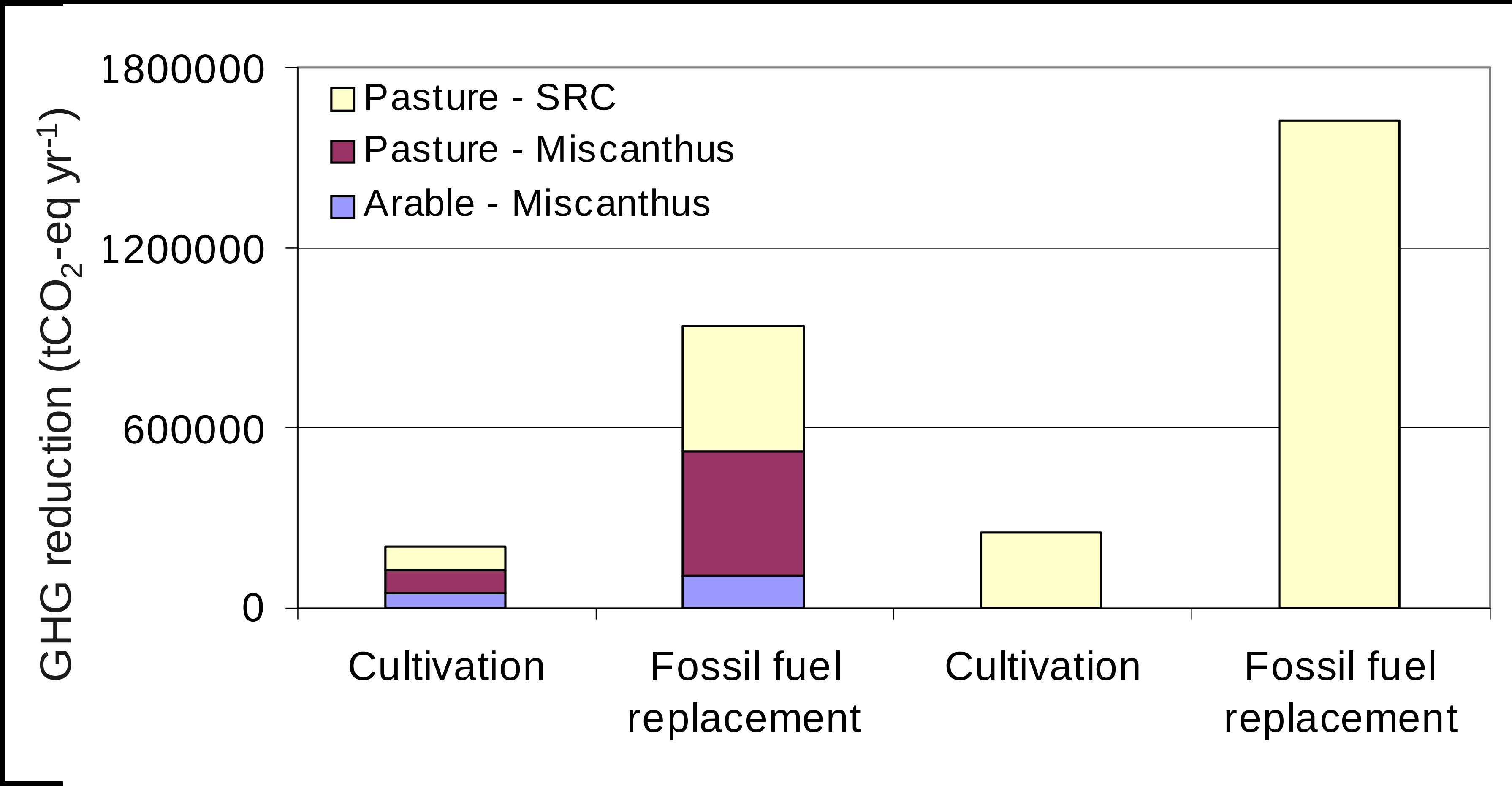


Total Reductions Achievable……..

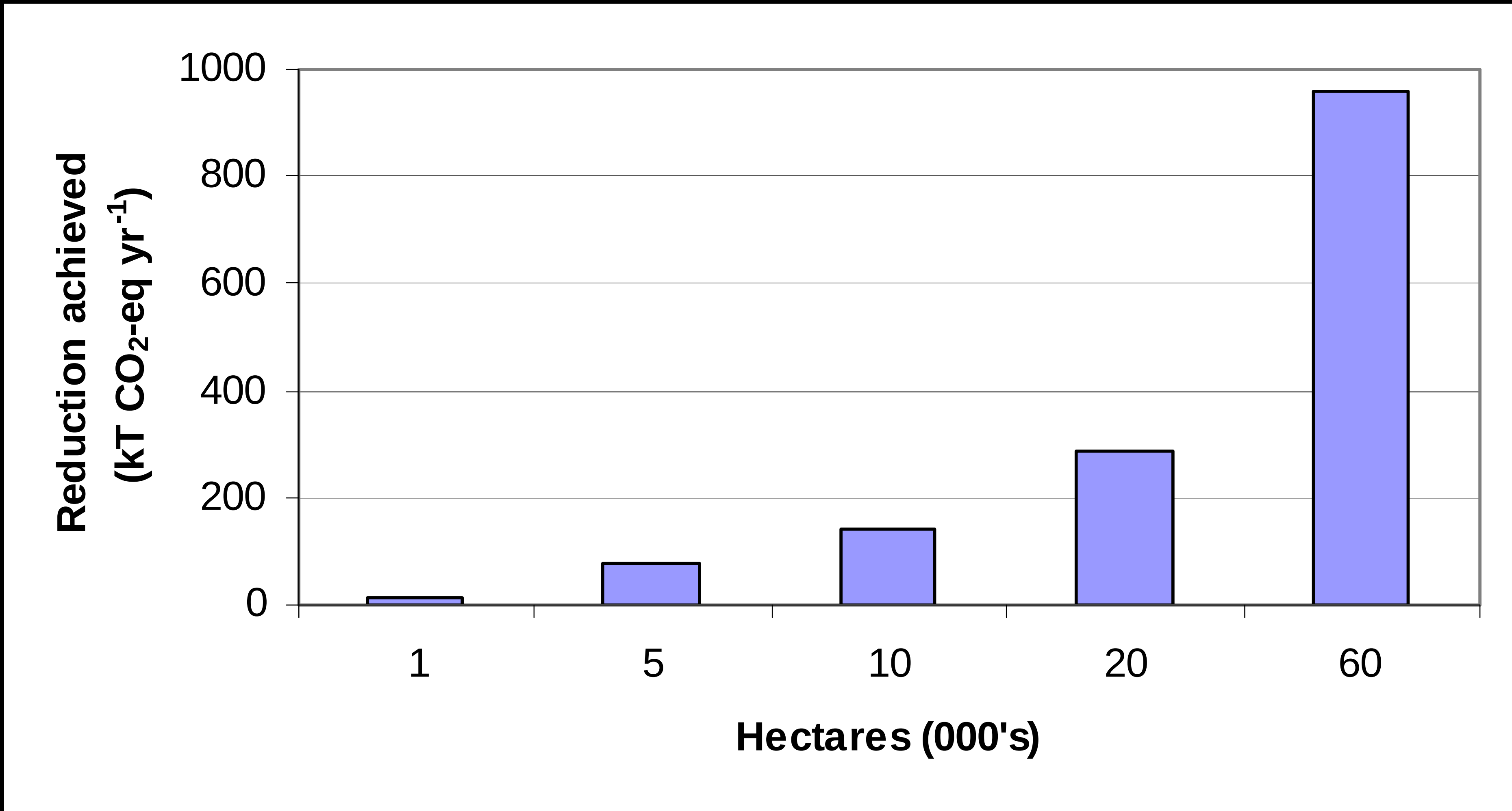
Assuming ~60,000 ha required for co-firing target

110,000 ha required to replace 6% of heating

25% of the pasture needed is de-stocked



Implementation would need to be soon….



Conclusions

- Sequestration potential of perennial biomass crops could be high: 1-5 $tCO_2\ ha^{-1}\ a^{-1}$
- SOC loss due to ploughing of pasture NOT as high as defaults
- 30% Co-firing Target: Replacement of ~0.91 million tonnes of peat = 0.85 Mt CO_2-eq – Heat Production C savings potentially even greater (+1.5 million tonnes)
- Who gets the credits?

Acknowledgements

Caroline Narayan[1], Órlaith Ní Chonchubair[1,2], Dominika Krol [1,3]

Marta Dondini[3], Karl Richards[1], Bruce Osborne[2], Mike Jones[3], Chris Mueller[2], Mike Williams[3]

Saul Otero[2], Matt Saunders[2], Wanne Kromdijk[4], Howard Griffiths[4], Pete Smith[5]

1 Teagasc, Johnstown Castle Environmental Research Centre, Wexford
2 School of Biological & Environmental Science, UCD, Dublin 4
3 School of Natural Sciences, Trinity College, Dublin 2
4 Department of Plant Sciences, Cambridge University, CB2 3EA
5 Department of Soils & Global Change, Aberdeen University

Funding

RSF 06 403, RSF 07 528 & RSF 07 527

Department of Agriculture, Fisheries and Food
An Roinn Talmhaíochta, Iascaigh agus Bia